EFFECTS OF GEOMETER'S SKETCHPAD ON STUDENTS' ACHIEVEMENT OF COMBINED TRANSFORMATIONS AND ATTITUDE TOWARDS MATHEMATICS

Suraini binti Haji Bujang

Doctor of Philosophy
(Learning Sciences)
2014
Effects of Geometer's Sketchpad on Students' Achievement of Combined Transformations and Attitude towards Mathematics

Suraini binti Haji Bujang

A thesis submitted in fulfillment of the requirements for the degree of Doctor of Philosophy

Faculty of Cognitive Sciences and Human Development
UNIVERSITI MALAYSIA SARAWAK
2014
ACKNOWLEDGEMENT

My sincere gratitude to my project supervisor Professor Dr. Hong Kian Sam for his continuous encouragement, direction, and advice given ever since I started the Ph.D program. I also appreciate my second project supervisor, Dr. Norazila binti Abdul Aziz for her ideas, suggestions and guidance throughout my doctorate program.

I would like to thank my principal, administrative staffs, Head of Science and Mathematics Department, Madam Cheam Chai Fong, members of Mathematics Panel, all my colleagues, friends, and students of Kolej Datu Patinggi Abang Abdillah. My sincere appreciation also goes to Madam Noor Adzlina binti Bolhan and Dr Surena binti Sabil for their help and support during the completion of this dissertation.

My heartiest gratitude also goes to the principal SMK Green Road Kuching, Mr Putit bin Haji Ped, for giving me permission to carry out my pilot study. This also goes to Dr. Chai Bun Khiun and teachers who helped me in conducting the pilot study among the Lower Six students of SMK Green Road, Kuching.

I also wish to express special appreciation to Assoc. Prof. Dr Hasbee Hj. Usop and Dr. Philip Nuli Anding of the Faculty of Cognitive Sciences and Human Development, University Malaysia Sarawak, for their help and valuable comments on the proposal of this study. I also thank the evaluation committee, Assoc. Prof. Dr Hasbee Hj. Usop as my internal examiner and my external examiner, Dr Lay Yoon Fah from Universiti Malaysia Sabah for their many ideas and suggestions that have vastly improved this study.

Finally, I would like to dedicate this doctoral dissertation to my loving husband, Mr Putit bin Haji Ped, my adorable son, Mohammad Daniel, my mother, my late father and other members of my family who have been a constant source of encouragement and strength. Thank you.
ABSTRACT

Effects of Geometer's Sketchpad on Students' Achievement of Combined Transformations and Attitude towards Mathematics

This study examined the effects of using Geometer's Sketchpad (GSP) on students' representation, understanding and achievement of combined transformations. It further investigated the main and interactions effects of gender, treatment types and ability level on the scores on the Transformation Achievement Test and Aiken's Mathematics Attitude Scale.

The study involved 110 Form Four students of Kolej Datu Patinggi Abang Haji Abdillah, Kuching. The research design was quasi-experimental which consisted of a crossover 2 x 2 x 2 factorial design included gender (male and female) x mathematics ability levels (high and low ability) x treatments (GSP software and construction tool teaching and learning). The study used a mixed method of quantitative and qualitative data collection techniques. The qualitative data from the interviews were analyzed using Constant Comparison Method which was developed by Glaser and Strauss (1967). The quantitative data from the pre and post-test and questionnaires were analyzed using descriptive and inferential statistics with the aid of SPSS.

The quantitative analysis found that there was a gain in scores from the Diagnostic Mathematics Test (pre-test) to the Transformation Achievement Test (post-test). The students using GSP also showed higher gain scores compared to the construction tool group. Findings from the qualitative data indicated students' representation and understanding of transformation did not differ between the GSP and construction tool groups. However, for both treatment and control group in terms of representation, pictorial representation was more dominant than verbal representation. Furthermore, both groups also did not show differences in their written representation abilities. For students' growth of understanding in
Combined Transformations was based on a) their understanding of basic concepts, b) the applicability of these basics, and c) their mathematical understanding of the given situations. Due to the complexity of mathematical contents, the "Don't Need Boundary" stage in Pirie and Kieren's model (1994) was not apparent among students in both the treatment and control group. However the "Folding Back" stage of the model was demonstrated in this study.

The respondents also listed some obstacles and benefits of using GSP in their classrooms. One of the key obstacles voiced by the respondents was images on computer screen restricted learners' logical thinking and resulted in misconception. As for benefits, students could quickly make a conjecture and evaluate their conjectures by constructing images using GSP. The dynamic visualisation function of GSP played an important role in students' proposing and testing of conjectures in transformation.
ABSTRAK

Kesan Geometer's Sketchpad terhadap Pencapaian Pelajar dalam Penjelmaan Gabungan dan Sikap terhadap Matematik

Kajian ini menyelidik kesan penggunaan perisian Geometer's Sketchpad (GSP) terhadap representasi, pemahaman dan pencapaian pelajar bagi tajuk Gabungan Penjelmaan. Kajian ini juga mengenalpasti kesan utama dan interaksi jantina, jenis rawatan dan tahap keupayaan pelajar terhadap skor dalam Ujian Pencapaian Penjelmaan dan Skala Sikap Matematik Aiken.

Kajian ini melibatkan 110 orang pelajar Tingkatan Empat di Kolej Datu Patinggi Abang Haji Abdillah, Kuching. Reka bentuk kajian ini berbentuk kuasi eksperimen yang melibatkan lintasan 2 x 2 x 2 reka bentuk faktoran yang melibatkan jantina (lelaki dan perempuan) x tahap keupayaan matematik (keupayaan tinggi dan rendah) x rawatan (perisian GSP dan pengajaran dan pembelajaran menggunakan alatan matematik). Kajian ini menggunakan kedua-dua teknik pengumpulan data kualitatif dan kuantitatif. Data kualitatif yang diperolehi daripada temubual dianalisa menggunakan Kaedah Perbandingan Malar yang dibangunkan oleh Glaser dan Strauss (1967). Data kuantitatif daripada ujian pra, ujian pasca dan soal selidik dianalisa menggunakan statistik perihalan dan statistik takbiran dengan bantuan perisian SPSS.

Dapatan analisis kuantitatif memunjukkan bahawa terdapat peningkatan dalam skor antara Ujian Diagnostik Matematik (ujian pra) dan Ujian Pencapaian Transformasi (ujian pasca). Kumpulan rawatan (GSP) menunjukkan skor peningkatan yang lebih tinggi berbanding dengan kumpulan kawalan. Dapatan data kualitatif mendapati representasi dan pemahaman penjelmaan tidak berbeza antara kumpulan GSP dan kumpulan alatan matematik. Walau bagaimanapun, bagi kedua-dua kumpulan rawatan dan kawalan, representasi gambar lebih
dominan berbanding dengan representasi lisan. Tambahan lagi, kedua-dua kumpulan tidak menunjukkan perbezaan dalam keupayaan representasi bertulis. Perkembangan pemahaman pelajar dalam Gabungan Penjelmaan adalah berdasarkan a) pemahaman mereka terhadap konsep asas, b) kebolehgunaan konsep asas, c) pemahaman matematik mereka terhadap situasi yang diberikan. Disebabkan oleh isi kandungan matematik yang kompleks, aras "Don't Need Boundary" dalam Model Pirie dan Kieren (1994) tidak ketara dalam kalangan pelajar dalam kedua-dua kumpulan kawalan dan rawatan. Namun, aras "Folding Back" untuk model ini dipaparkan dalam kajian ini.

Pelajar-pelajar menyenaraikan beberapa rintangan dan manfaat menggunakan GSP dalam bilik darjah. Salah satu rintangan yang dinyatakan adalah imej yang dihasilkan oleh skrin komputer boleh menghadkan pemikiran logikal pelajar dan menyebabkan miskonsepsi. Manfaat penggunaan teknologi termasuklah memudahkan pelajar membuat konjektur dan menilai konjektur melalui konstruksi imej dengan GSP. Fungsi visualisasi dinamik GSP juga memainkan peranan yang penting dalam membantu pelajar.
TABLE OF CONTENTS

CONTENT PAGE

Acknowledgement i
Abstract ii
Abstrak iv
Table of Contents vi
List of Tables xii
List of Figures xiii

CHAPTER ONE: INTRODUCTION

1.0 Introduction 1
1.1 Background of the Research 1
1.2 Statement of the Problem 5
1.3 Research Objectives 7
1.4 Research Questions 9
1.5 Research Hypotheses 10
1.6 Research Framework 13
1.7 Significance of the Study 13
  1.7.1 Contributions to the Literature 14
  1.7.2 Implications for Practice 15
1.8 Limitations of the Study 15
1.9 Definitions of Terms 16
  1.9.1 Achievement in Combined Transformations 16
  1.9.2 Gain in the Scores 17
  1.9.3 Geometers' Sketchpad 18
  1.9.4 Mathematics Ability 18
  1.9.5 Mathematics Attitude 18
  1.9.6 Students' Representation 19
  1.9.7 Students' Understanding 19
  1.9.8 Students' Visualization 19
1.10 Summary 20
CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction 21
2.1 Visualization and Representation in Mathematics Education 21
2.2 Importance of Deep Understanding for Mathematics Learning 22
2.3 Models of Understanding 23
2.4 Growth of Understanding in Mathematics 26
2.5 Technology in Mathematics Education 33
2.6 Teaching and Learning Environment with Technology 35
   2.6.1 Geometers’ Sketchpad in Teaching and Learning of Mathematics 40
2.7 Gender Differences in the Learning of Mathematics 42
2.8 Ability Levels and Achievement in Mathematics 44
2.9 Gender Differences in Attitudes toward Mathematics 45
2.10 Ability Levels and Attitudes toward Mathematics 46
2.11 Contribution of the Literature Review to the Study 47
2.12 Summary 48

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction 49
3.1 Research Design 49
3.2 Research Samples 50
3.3 Geometers’ Sketchpad 50
3.4 Research Instruments 52
   3.4.1 The Diagnostic Transformation Test 52
   3.4.2 The Transformation Achievement Test 52
   3.4.3 The Test Specification Table (TST) 53
   3.4.4 The Difficulty Index and Discrimination Index 53
   3.4.5 Aiken’s Mathematics Attitude Scale 53
   3.4.6 Informal Interview 54
   3.4.7 Formal Interview (Personal Interview Questionnaire) 54
3.5 Pilot Study 55
CHAPTER FOUR: RESULTS

4.0 Introduction 68
4.1 Reliability of the Research Instruments 68
4.2 Demographic Variables 69
4.3 Testing of Assumptions for Three-way ANOVA on Gain Scores
   4.3.1 Assumption of Normality for the Gain Scores 70
   4.3.2 Assumption of Homogeneity for the Gain Scores 71
4.4 Effects of Gender, Treatment Types and Mathematics Ability Level on Student’s Gain Marks in Transformation Achievement Test
   4.4.1 Research Question 1a: Were there any differences in the gain scores of Diagnostic Transformation Test (pre-test) and Transformation Achievement Test (post-test) for the two types of treatment? 74
   4.4.2 Research Question 1b: Were there any gender differences on the gain scores of Diagnostic Transformation Test (pre-test) and Transformation Achievement Test (post-test)? 74
   4.4.3 Research Question 1c: Were there any differences in the gain score of Diagnostic Transformation Test (pre-test) and Transformation Achievement Test for different ability levels? 75
4.4.4 Research Question 1d: Were there any interactions between gender treatment types and ability levels on the gain score of Diagnostic Transformation Test (pre-test) and Transformation Achievement Test (post-test)?

4.5 Testing of Assumptions for Three-way ANOVA on Scores of Aiken's Mathematics Attitude Scale

4.5.1 Assumption of Normality for the Scores of Aiken's Mathematics Attitude Scale

4.5.2 Assumption of Homogeneity for the Scores of Aiken's Mathematics Attitude Scale

4.6 Effects of Gender, Treatment Types and Ability Level on Attitudes toward Mathematics

4.6.1 Research Question 2a: Were there any differences in the scores from the Aiken's Mathematics Attitude Scale for the two types of treatment?

4.6.2 Research Question 2b: Were there any gender differences on the scores from the Aiken's Mathematics Attitude Scale?

4.6.3 Research Question 2c: Were there any ability differences in the scores from the Aiken's Mathematics Attitude Scale for different ability levels?

4.6.4 Research Question 2d: Were there any interactions between gender, treatment types and ability levels on the scores from the Aiken's Mathematics Attitude Scale?

4.7 Effects of Representation when the Students Studied Transformation in Construction Tool and Technology (GSP)-Based Classroom

4.7.1 Research Question 3: How did students present each component of representation when they study transformation in a technology (GSP)-based classroom? If there was any difference between the first (before treatment) and second presentation (after treatment) for each component, how is it
different?

4.7.2 Summary of the Third Research Question

4.8 Effects of Representation on Students’ Understanding and the Growth of Understanding

4.8.1 Research Question 4: How and to what extend did representation affect the students’ understanding and the growth of understanding in a technology (GSP)-based classroom? If there was any difference between before and after treatment, how is it different?

4.9 Benefits and Obstacles in Integrating GSP in Mathematics Classrooms

4.9.1 Research Question 5: What types of benefits and obstacles were there when students study ‘transformation’ in a technology (GSP)-based classroom?

4.9.2 Comparison Between the Use of GSP and Construction Tools

4.10 Summary

CHAPTER FIVE: DISCUSSIONS AND CONCLUSIONS

5.0 Introduction

5.1 Summary of the Research

5.2 Discussions of the Findings

5.2.1 Effect of Types of Treatment, Gender and Ability on Achievement in Transformations

5.2.2 Effects of Types of Treatment, Gender and Ability on Students’ Attitudes toward Mathematics

5.2.3 Students Representation in Studying Transformation in a Technology (GSP)-based classroom

5.2.4 Effects of Representation on Students’ Understanding and Growth of Understanding in a Technology (GSP)-Based Classroom
5.2.5 Benefits and Obstacles in Studying Transformation in a Technology (GSP)-Based Classroom

5.3 Implication of the Research

5.3.1 Implication to the Literature

5.3.2 Implication for Practice

5.4 Recommendations for Future Research

5.5 Conclusion

REFERENCES

APPENDICES

APPENDIX A Geometers’ Sketchpad Activity 1 – 4 (with Daily Lesson Plan)

APPENDIX B Construction Tool Activity (TG) 1 – 4 (with Daily Lesson Plan)

APPENDIX C Diagnostic Mathematics Test

APPENDIX D Transformation Achievement Test

APPENDIX E Aiken’s Mathematics Attitude Scale

APPENDIX F Informal Interview

APPENDIX G Formal Interview

APPENDIX H Getting Start Tutorial

APPENDIX I Test Specification Table
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Number</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 3.1</td>
<td></td>
<td>Reliability coefficients of the research instruments</td>
<td>56</td>
</tr>
<tr>
<td>Table 3.2</td>
<td></td>
<td>Classification of Difficulty Index for the research instruments</td>
<td>57</td>
</tr>
<tr>
<td>Table 3.3</td>
<td></td>
<td>Classification Item for Discrimination Index of the research instruments</td>
<td>57</td>
</tr>
<tr>
<td>Table 3.4</td>
<td></td>
<td>Difficulty Index of the research instruments</td>
<td>58</td>
</tr>
<tr>
<td>Table 3.5</td>
<td></td>
<td>Discrimination Index of the research instruments</td>
<td>59</td>
</tr>
<tr>
<td>Table 3.6</td>
<td></td>
<td>Data analysis (Quantitative Study)</td>
<td>62</td>
</tr>
<tr>
<td>Table 3.7</td>
<td></td>
<td>Data analysis (Qualitative Study)</td>
<td>64</td>
</tr>
<tr>
<td>Table 3.8</td>
<td></td>
<td>Data coding system (Jung, 2002)</td>
<td>65</td>
</tr>
<tr>
<td>Table 4.1</td>
<td></td>
<td>Cronbach's Alpha coefficients of the research instruments</td>
<td>69</td>
</tr>
<tr>
<td>Table 4.2</td>
<td></td>
<td>Total number of participants in terms of mathematics</td>
<td>69</td>
</tr>
<tr>
<td>Table 4.3</td>
<td></td>
<td>Normality test for gain scores by gender, ability level and treatment types.</td>
<td>70</td>
</tr>
<tr>
<td>Table 4.4</td>
<td></td>
<td>Levene's Test of Equality of Error Variances</td>
<td>71</td>
</tr>
<tr>
<td>Table 4.5</td>
<td></td>
<td>ANOVA result for gain of student's mark</td>
<td>72</td>
</tr>
<tr>
<td>Table 4.6</td>
<td></td>
<td>Descriptive statistics for gain of student's mark</td>
<td>73</td>
</tr>
<tr>
<td>Table 4.7</td>
<td></td>
<td>Normality test for the scores of Aiken's Mathematics</td>
<td>76</td>
</tr>
<tr>
<td>Table 4.8</td>
<td></td>
<td>Levene's Test of Equality of Error Variances</td>
<td>78</td>
</tr>
<tr>
<td>Table 4.9</td>
<td></td>
<td>Descriptive statistics the scores from the Aiken's Mathematics Attitude Scale</td>
<td>79</td>
</tr>
<tr>
<td>Table 4.10</td>
<td></td>
<td>ANOVA results for attitude toward mathematics</td>
<td>79</td>
</tr>
<tr>
<td>Table 4.11</td>
<td></td>
<td>Verbal representation of 12 students on rotation and enlargement</td>
<td>112</td>
</tr>
<tr>
<td>Table 4.12</td>
<td></td>
<td>Verbal representation of three students from TG and SG</td>
<td>115</td>
</tr>
<tr>
<td>Table 4.13</td>
<td></td>
<td>Examples of Students' Verbal Representation in Diagnostic Mathematics Test (Question 12 and 13)</td>
<td>116</td>
</tr>
<tr>
<td>Table 4.14</td>
<td></td>
<td>Examples of Students' Verbal Representation in Diagnostic Mathematics Test (Question 16 and 19)</td>
<td>117</td>
</tr>
</tbody>
</table>
Table 4.15 Students' Responses to the Personal Interview Questionnaire (Question 14, 15, 8 and 9)

Table 4.16 Students' Responses to the Personal Interview Questionnaire (Question 5, 6, 17 and 18)

Table 4.17 Students' Responses to the Personal Interview Questionnaire (Question 1 and 12)

LIST OF FIGURES

Figure 1.1 Research framework

Figure 2.1 Representation contains visualization

Figure 2.2 Three components of understanding

Figure 2.3 Model for the growth of understanding (Pirie & Kieren, 1994, p. 167)

Figure 2.4 The within level complementarities

Figure 2.5 Rings with acting and expressing complements identified

Figure 4.1a Example of a student’s error (SG8) on written representation in Diagnostic Transformation Test (Question 12)

Figure 4.1b Example of a student’s error (TG12) on written representation in Diagnostic Transformation Test (Question 12)

Figure 4.1c Example of a student’s error (SG3) on written representation in Diagnostic Transformation Test (Question 12)

Figure 4.2a Example of a student’s error (SG10) on written representation in Transformation Achievement Test [Question 12(a)]

Figure 4.2b Example of a student’s error (TG2) on written representation in Transformation Achievement Test [Question 12(a)]
Figure 4.2c Example of a student's error (SG1) on written representation in Transformation Achievement Test [Question 12(a)]

Figure 4.3a Example of a student's error (SG4) on written representation (symbol) in Diagnostic Transformation Test (Question 16)

Figure 4.3b Example of a student's error (SG11) on written representation (symbol) in Diagnostic Transformation Test (Question 16)

Figure 4.3c Example of a student's error (TG7) on written representation (symbol) in Diagnostic Transformation Test (Question 16)

Figure 4.4a Example of a student's answer (SG6) on written representation (symbol) in Transformation Achievement Test (Question 12)

Figure 4.4b Example of a student's answer (SG16) on written representation (symbol) in Transformation Achievement Test (Question 12)

Figure 4.5a Example of a student's answer (TG1) on written representation (symbol) in Transformation Achievement Test (Question12)

Figure 4.5b Example of a student's answer (TG4) on written representation (symbol) in Transformation Achievement Test (Question12)

Figure 4.6a Example of the correct answer (SG3) on pictorial representation in Diagnostic Transformation Test (Question 14)

Figure 4.6b Example of a student's error (SG2) on pictorial representation in Diagnostic Transformation Test (Question 14)
Figure 4.7a Example of a student’s correct answer (TG14) on pictorial representation in Diagnostic Transformation Test (Question 16)

Figure 4.7b Example of student’s error (TG10) on pictorial representation in Diagnostic Transformation Test (Question 16)

Figure 4.8 Example of a student’s correct answer (TG8) on pictorial representation in Transformation Achievement Test [Question 13(c)]

Figure 4.9a Example of student’s worksheet (TG9) on pictorial representation before and after treatment

Figure 4.9b Example of a student’s worksheet (TG15) on pictorial representation before and after treatment

Figure 4.9c Example of a student’s worksheet (TG3) on pictorial representation before and after treatment

Figure 4.9d Example of a student’s worksheet (TG16) on pictorial representation before and after treatment

Figure 4.10a Example of a student’s answer (TG11) in determining whether the combined transformations HG and GH are equivalent [Question 13(b)]

Figure 4.10b Example of a student’s answer (SG15) in determining whether the combined transformations HG and GH are equivalent [Question 13(b)]

Figure 4.11a Example of a student’s work (SG1) - GSP Activity 1 on the reflection of $\triangle ABC$ at the line of reflection in $y$-axis

Figure 4.11b Example of student’s work (SG6 - GSP Activity 1 on the combination of transformation RF with the final image $\triangle A''B''C''$

Figure 4.12 The growth of understanding on the combination of transformation RF of four students

Figure 4.13 The growth of understanding on the combination of transformation RF of majority of the students
Figure 4.14 The growth of understanding on the combination of transformation RF of six students

Figure 4.15a Example of a student’s work (SG14), GSP Activity 2, Question 2(b) in Appendix A

Figure 4.15b Example of a student’s work (SG16), GSP Activity 2, Question 2(b) in Appendix A

Figure 4.15c Example of a student’s work (SG9) GSP Activity 2, Question 2(b) in Appendix A

Figure 4.16a Example of a student’s work (SG3) GSP Activity 3, Question 2(c) in Appendix A

Figure 4.17a Example of a student’s work (SG12) GSP Activity 3, Question 2(c) in Appendix A

Figure 4.16b Example of a student’s work (SG5) GSP Activity 3, Question 2(c) in Appendix A

Figure 4.17b Example of a student’s work (SG11) GSP Activity 3, Question 2(c) in Appendix A
CHAPTER ONE

INTRODUCTION

1.0 Introduction

This chapter provides the introduction of the study and consists of ten sections. Section 1.1 presents the background of the study. This is followed by the problem statement in Section 1.2. Section 1.3 describes the purpose of the study while Section 1.4 presents the research questions and Section 1.5 outlines the research hypotheses that were investigated in this study. The conceptual framework is presented in Section 1.6 and Section 1.7 discusses the significance of the study. Section 1.8 outlines the limitations of the study and the definition of terms used in the study is listed in Section 1.9. Section 1.10 is the summary of the chapter.

1.1 Background of the Research

Technology has become one of the major concerns in the educational process at all levels. Technology is "not only a product of a given culture; it also shapes the culture that created it" (Mehligner, 1998, p.8). The use of computers in school provides learners (students) the capacity to take control of what they are learning while teachers and administrators have the ability to determine what would be taught and what would not be taught. Computers can be used to teach, to facilitate the study process, to help students to learn how to use technology, and to increase the effectiveness in performing academic tasks (Becker, 1991). According to Ittigson and Zewe (2003), information and communication technologies support constructivist pedagogy, which allows students to explore and reach an understanding of mathematical concepts. This approach promotes higher order thinking and better problem solving strategies (Ittigson & Zewe, 2003). Becta (2003) reiterated that teachers can maximize the impact of technology in
mathematics teaching by using technology as a tool in working towards achieving the learning objectives.

The Geometer's Sketchpad (GSP) is a dynamic mathematics visualization software used to explore algebra, calculus and other areas of mathematics as well as sciences. It is also a powerful program that helps students and teachers construct an endless variety of geometric figures. Key Curriculum Press, the publisher of GSP, claims that the software "is a dynamic construction, demonstration, and exploration tool that adds a powerful dimension to the study of mathematics" (Key Curriculum Press, 2009). It can enhance students' understanding and the pedagogical process (Habre & Grunmeier, 2007), allows mathematics to be taught visually to the class as a whole, to small groups, or to individual, and also enable to enhance interaction between teacher, student, and computer (Bahavand, 2001; Gaeddert, 2001; Lester, 1996; Myles, 2006; Thompson, 2006; Yousif, 1997). The software enables students and teachers to investigate and construct unlimited geometric shapes. The shapes are first created and then explored, manipulated and transformed to ideal concept (Venkataraman, 2007). The real power of the program lies in its ability to create dynamic figures that change shape while retaining the geometric properties they were constructed with. For example, a student can construct a triangle, measure each of its angles, and then, by selecting and dragging a single vertex of the triangle, change its shape and size and observe that the sum of the angles remains constant.

The Malaysian Ministry of Education (MMOE) made a decision to subscribe to this software in 2004. The subscription licenses was not only meant for the quarter of a million teachers and educators including lecturers of public universities but also for the almost five million students under the direct authority of the MMOE nationwide (Ministry of Education Malaysia, 2001).

According to Giamatti (1995), the GSP enables the user to explore simple, as well as highly complex, theorems and relations in geometry. It can also record
students' construction as scripts and according to Giamatti (1995), the most useful aspect of scripting ones' constructions is that students can test whether their constructions work in general or whether they have discovered a special case. In addition, the GSP software provides the process of learning and teaching mathematics with a remarkable help because "the power of the GSP combined with the power of proof gives a complete illustration of the theorem involved and the aspects of doing mathematics" (Giamatti, 1995, p. 458). Studies in the 1970s concerning geometric transformation (e.g., Kidder, 1976; Williford, 1972) used manipulatives such as plastic squares and acetate sheets rather than calculators and computers. Research began to include the use of technology in the 1980s (e.g., Ernest, 1986), but many studies were still carried out in its absence (e.g., Schultz & Austin, 1983; Soon, 1989). By the 1990s, majority of studies found in the mathematics education research literature related to the learning of transformations geometry utilized technology (e.g., Clements & Battista, 1994; Dixon, 1995; Edwards, 1991; Edwards & Zazkis, 1993; Johnson-Gentile, Pleet, 1990). The use of computer technology in teaching and learning is strongly advocated as it helps creates a learner-centered and open-ended learning environment (Hannafin, 2004).

Learners who are able to use technology-based tool to encapsulate their actions into objects and then build on these objects demonstrated reified knowledge (Sfard, 1991). For example, Patsiomitou (2008) argued that when students used Geometer's Sketchpad to create "personal tools" to enclose completely the series of steps required to construct algebraic or geometric objects, they were able to view the results of these operations as structural units. Patsiomitou concludes that "It is obvious that the processes in the software are more efficient when students are structuring algebraic expression than in a paper-pencil-scissors environment" (2008, p. 6). She also suggests that the "...tools comprising Dynamic Geometry Systems may well constitute a channel whereby children extend their imagination and conceive mathematics like a source of mathematical models and representations" (p. 7). Goldenberg, Scher and Feurzeig (2008) actually go so far
as to claim that "What we see as we watch children or adults 'play' with this software is often a change of perception of mathematics, from mathematics as a collection of rules and procedures to mathematics as an intellectual game, a response to curiosity, a human endeavor" (pp. 79-80).

Combination of transformation is a learning area within the form five Mathematics syllabuses of the Malaysian secondary school. Transformations such as translations, reflections, rotations and enlargements are useful in tasks involving designing. It is used to form patterns of shapes which can produce beautiful designs such as in making batik and attractive fabric prints. However, in the teaching of transformations, many Malaysian-secondary school teachers still rely on the chalk and talk approach. The availability of the GSP will make these sketches instantaneous and dynamic thus saving precious time in the instruction of transformation, the comprehension of geometrical concepts, problem solving and examples of applications. This however does not in any way undermine the importance of skills to solve geometrical problems without the use of GSP which are essential in the public examination.

Representations are useful in all areas of mathematics because they help us develop, share, and preserve our mathematics thought. Representations help to portray, clarify or extend a mathematical idea by focusing on its essential features (NCTM, 2000). Mathematical representation refers to the wide variety of ways to capture an abstract mathematical concept or relationship. A mathematical representation may be visible, such as a number sentence, a display of manipulate materials, or a graph, but it may also be an internal way of seeing and thinking about a mathematical idea. Regardless of their form, representations can enhance students' communication, reasoning, and problem-solving abilities; help them make connection among ideas; and aid them in learning new concepts and procedures.
Attitudes towards mathematics play a crucial role in the teaching and learning processes of mathematics. Usually, the way that mathematics is represented in the classroom and perceived by students, even when teachers believe they are presenting it in authentic and context dependent way stands to alienate many students from mathematics (Barton, 2000; Furinghetti & Pekhonen, 2002). Ma and Xu (2004) concluded that positive attitudes toward mathematics lead students towards success in mathematics. Attempt to improve attitudes toward mathematics at lower level provides the necessary bases for higher studies in mathematics. It also impact on achievement of mathematics at secondary school level.

1.2 Statement of the Problem

In the last two decades, many schools in Malaysia are equipped with technology in Mathematics classroom. This trend came as a result of the recommendations by the Malaysian Ministry of Education (MMOE). The Malaysia Government had also allocated special budget for the training of Mathematics, Science and English teachers and they were given three types of training including English Language proficiency training, Curriculum Orientation and Pedagogy Course, and ICT Usage (Hishammudin, 2005, Sharifah, 2002). Such training or retraining is essential to give these teachers the confidence and necessary skills to enable them to use computers in the teaching and learning process in schools. Besides, the Malaysian Minister of Education declared on the on-going massive distribution of the IT tools to schools in 12 states and at present almost all schools are equipped with IT tools (Naresh, Raduan, & Jeffrey, 2008). Thus, teachers should be ready to adopt and use computers, and students should benefit and be geared towards the realization of Vision 2020.

Consequently, many research studies in Malaysia have been conducted to evaluate the impact of using technology on achievement and attitudes towards mathematics of the students in different levels of schooling (Mumtaz, 2000).
According to Usun (2004), nowadays, computers which are seen as the most effective interactive device and most effective individual learning technology entered to educational systems and compose new approaches to school systems and learning process, developed new dimensions to existence models supplying information transfer. Based on Chee, Horani and Daniel’s (2005) study, 49.5% of mathematics teachers use teaching courseware in class, 40.5% used ICT (Information and Communication Technology) as presentation tools, 8.1% used ICT as a graphical visualizing tool, 6.3% used ICT as an online demonstration tool, and 3.6% used ICT for other purposes in classroom. Most of the research findings conclude that technology has changed mathematics education in both the design of the curriculum and the teaching methods. Thus, there is a need to further investigate the use of GSP in the teaching and learning mathematics. This is required as to date, not many schools implemented the use of GSP in the mathematics classroom. Teoh and Fong (2005) further cautioned that teachers’ enthusiasm and willingness to use the software is still an issue to be addressed.

In the current trend of the teaching and learning of mathematics, it is no longer adequate to teach students with the traditional expository approach at the current age of knowledge explosion. In response to the foreseeable change of global knowledge economy, the teaching and learning of geometry utilizing dynamic geometry software have been explicitly indicated in the new Malaysian secondary school syllabus implemented in 2003 (Integrated Curriculum for Secondary Schools, 2003) and taught in English after 30 years being taught in the National Language (Bahasa Malaysia). In the syllabus, teachers have been recommended to utilize dynamic software and one such dynamic geometry software licensed to be used in the Malaysian schools is the Geometer’s Sketchpad (GSP) software, developed partly under the Geometry Visual Project conducted in Pennsylvania and sponsored by the National Science Foundation.

Affective factors have been central to the theoretical perspective taken by many researchers exploring gender and mathematics issues. The Fennema–Sherman