E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2008

University of Malaya

E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

DISSERTATION SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF COMPUTER SCIENCE

FACULTY OF COMPUTER SCIENCE AND INFORMATION TECHNOLOGY
UNIVERSITY OF MALAYA
KUALA LUMPUR

2008

University of Malaya

ABSTRACT

In schools educational system, the advancing technologies in e-learning should not focus on the transition from conventional classroom teaching to self-pursue e-learning system, but instead how these technologies can be used to support the learning process. However, without careful considerations, students fail to acknowledge and benefit from the support systems and causes low level of satisfaction towards using them. The main objective of this study is to investigate and suggest solutions to the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and e-learning system towards educational pursuit among students. The results of the questionnaire analysis gives an insight on the problems which include the lack of time, lack of attention provided by the existing system and the lack for self-assessment. ESCA-Math which is a prototype that was developed based on the framework formulated from the analysis stage is a suggestion to address these problems using the study companion approach. In this approach, there will be no teacher presence, but the interaction between the system and the user alone. This way, students are able to carry out their learning process without any outside pressure, thus highlight on the meaning of the study companion. It emphasize on its ability to track students' progress and provide topics assessment scheme to guide students with their learning process. There is also an administrator account feature to allow future maintenance and addition to the content of the system in order to keep track with the changes by the educational system. To ensure ESCA-Math prototype is developed efficiently and effectively, the system model adapts from the waterfall model with prototyping to cover all aspect in system development life cycle. In the user acceptance testing, it shows that students are mostly satisfied with ESCA-Math and believe that it will benefit them as their study companion.

University of Malaya

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere gratitude to my supervisor, Pn. Suraya Hamid for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. Because of her, I had achieved things beyond my wildest dreams. If it were not for her, I would not be where I am now.

To my parents, En. Yusof Hamzah and Pn. Aini Abdul Aziz, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My one and only big sister, Nur Zuhailah Yusof, this little sister of yours had finally did it. Thanks for your patience and love that has got me this far. I am forever indebt with all of you.

These thanks go to all of the students and teachers in the three schools I went for survey and testing, SAMURA, SEDAR and SMKPB.

To my best cyberpals, Louise and Ashleigh, thanks for your undying support and wisdom in keeping me going. Thanks for letting me rant and rave; whine and weep when the going gets tough and convince me to be the tough one that gets going. Our friendship means a lot to me. May we stay mates to our old age.

Last but not least, this also goes to you – you know who you are. My sincerest thanks.

All the words in the world is not enough to thank you all. May Allah bless you with His Rahman and Rahim.

University of Malaya

~Do I Make You Proud~

I've never been the one to raise my hand
That was not me, and now that's who I am
Because of you, I am standing tall
My heart is full of endless gratitude
You were the one, the one to guide me through
Now I can see and I believe
It's only just beginning

This is what we dream about
But the only question with me now
Is do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?

Everybody needs to rise up
Everybody needs to be loved
To be loved

This is what we dream about
But the only question with me now
Is do I make you, do I make you proud?
There ain't no question, just do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?
Do I make you proud?

~Taylor Hicks

University of Malaya

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

University of Malaya

CHAPTER 2: LITERATURE REVIEW

University of Malaya

CHAPTER 3: METHODOLOGY

University of Malaya

CHAPTER 4: REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

University of Malaya

University of Malaya

CHAPTER 5: PROTOTYPE DEVELOPMENT

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND TESTING

University of Malaya

CHAPTER 7: CONCLUSION AND FUTURE WORK

APPENDICES

University of Malaya

University of Malaya

LIST OF FIGURES

FIGURES **PAGE**

University of Malaya

University of Malaya

LIST OF GRAPHS

GRAPHS **PAGE**

University of Malaya

LIST OF TABLES

TABLES **PAGE**

University of Malaya

University of Malaya

LIST OF ABBREVIATION

1. ICT – Information and Communication Technology
2. KBSM – *Kurikulum Baru Sekolah Menengah* or New Integrated Curriculum for Secondary School
3. MoE – Ministry of Education of Malaysia
4. MSC – Multimedia Super Corridor
5. NITC – National Information Technology Conference
6. RMK-8 – *Rancangan Malaysia ke-8* or Eighth Malaysia Plan (from year 2000 to 2005)
7. RMK-9 – *Rancangan Malaysia ke-9* or Ninth Malaysia Plan (from year 2006 to 2010)
8. SAMURA – *Sekolah Menengah Sains Muar*, one of the school picked to participate in the questionnaire analysis
9. SEDAR – *Sekolah Menengah Dato' Sri Amar Diraja*, one the school picked to participate in the questionnaire analysis
10. SMKPB – *Sekolah Menengah Kebangsaan Parit Bunga*, one of the school picked to participate in the questionnaire analysis
11. SPM – *Sijil Pelajaran Malaysia* or Malaysian Certificate of Education
12. TASA – Topic Assessment Algorithm
13. UNITAR – *Universiti Tun Abdul Razak*
14. UNITEM – *Universiti Terbuka Malaysia* or Open University of Malaysia
15. UPU – *Unit Permohonan Universiti* or University Application Unit

University of Malaya

E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF COMPUTER SCIENCE

FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

UNIVERSITY OF MALAYA

KUALA LUMPUR

APRIL 2008

University of Malaya

ABSTRACT

In schools educational system, the advancing technologies in e-learning should not focus on the transition from conventional classroom teaching to self-pursue e-learning system, but instead how these technologies can be used to support the learning process. However, without careful considerations, students fail to acknowledge and benefit from the support systems and causes low level of satisfaction towards using them. The main objective of this study is to investigate and suggest solutions to the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and e-learning system towards educational pursuit among students. The results of the questionnaire analysis gives an insight on the problems which include the lack of time, lack of attention provided by the existing system and the lack for self-assessment. ESCA-Math which is a prototype that was developed based on the framework formulated from the analysis stage is a suggestion to address these problems using the study companion approach. In this approach, there will be no teacher presence, but the interaction between the system and the user alone. This way, students are able to carry out their learning process without any outside pressure, thus highlight on the meaning of the study companion. It emphasize on its ability to track students' progress and provide topics assessment scheme to guide students with their learning process. There is also an administrator account feature to allow future maintenance and addition to the content of the system in order to keep track with the changes by the educational system. To ensure ESCA-Math prototype is developed efficiently and effectively, the system model adapts from the waterfall model with prototyping to cover all aspect in system development life cycle. In the user acceptance testing, it shows that students are mostly satisfied with ESCA-Math and believe that it will benefit them as their study companion.

University of Malaya

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere gratitude to my supervisor, Pn. Suraya Hamid for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. Because of her, I had achieved things beyond my wildest dreams. If it were not for her, I would not be where I am now.

To my parents, En. Yusof Hamzah and Pn. Aini Abdul Aziz, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My one and only big sister, Nur Zuhailah Yusof, this little sister of yours had finally did it. Thanks for your patience and love that has got me this far. I am forever indebt with all of you.

These thanks go to all of the students and teachers in the three schools I went for survey and testing, SAMURA, SEDAR and SMKPB.

To my best cyberpals, Louise and Ashleigh, thanks for your undying support and wisdom in keeping me going. Thanks for letting me rant and rave; whine and weep when the going gets tough and convince me to be the tough one that gets going. Our friendship means a lot to me. May we stay mates to our old age.

Last but not least, this also goes to you – you know who you are. My sincerest thanks.

All the words in the world is not enough to thank you all. May Allah bless you with His Rahman and Rahim.

University of Malaya

~Do I Make You Proud~

I've never been the one to raise my hand
That was not me, and now that's who I am
Because of you, I am standing tall
My heart is full of endless gratitude
You were the one, the one to guide me through
Now I can see and I believe
It's only just beginning

This is what we dream about
But the only question with me now
Is do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?

Everybody needs to rise up
Everybody needs to be loved
To be loved

This is what we dream about
But the only question with me now
Is do I make you, do I make you proud?
There ain't no question, just do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?
Do I make you proud?

~Taylor Hicks

University of Malaya

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

University of Malaya

CHAPTER 2: LITERATURE REVIEW

University of Malaya

CHAPTER 3: METHODOLOGY

University of Malaya

CHAPTER 4: REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

University of Malaya

University of Malaya

CHAPTER 5: PROTOTYPE DEVELOPMENT

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND TESTING

University of Malaya

CHAPTER 7: CONCLUSION AND FUTURE WORK

APPENDICES

University of Malaya

University of Malaya

LIST OF FIGURES

FIGURES **PAGE**

University of Malaya

University of Malaya

LIST OF GRAPHS

GRAPHS **PAGE**

University of Malaya

LIST OF TABLES

TABLES **PAGE**

University of Malaya

University of Malaya

LIST OF ABBREVIATION

1. ICT – Information and Communication Technology
2. KBSM – *Kurikulum Baru Sekolah Menengah* or New Integrated Curriculum for Secondary School
3. MoE – Ministry of Education of Malaysia
4. MSC – Multimedia Super Corridor
5. NITC – National Information Technology Conference
6. RMK-8 – *Rancangan Malaysia ke-8* or Eighth Malaysia Plan (from year 2000 to 2005)
7. RMK-9 – *Rancangan Malaysia ke-9* or Ninth Malaysia Plan (from year 2006 to 2010)
8. SAMURA – *Sekolah Menengah Sains Muar*, one of the school picked to participate in the questionnaire analysis
9. SEDAR – *Sekolah Menengah Dato' Sri Amar Diraja*, one the school picked to participate in the questionnaire analysis
10. SMKPB – *Sekolah Menengah Kebangsaan Parit Bunga*, one of the school picked to participate in the questionnaire analysis
11. SPM – *Sijil Pelajaran Malaysia* or Malaysian Certificate of Education
12. TASA – Topic Assessment Algorithm
13. UNITAR – *Universiti Tun Abdul Razak*
14. UNITEM – *Universiti Terbuka Malaysia* or Open University of Malaysia
15. UPU – *Unit Permohonan Universiti* or University Application Unit

University of Malaya

E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF COMPUTER SCIENCE

FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

UNIVERSITY OF MALAYA

KUALA LUMPUR

APRIL 2008

University of Malaya

ABSTRACT

In schools educational system, the advancing technologies in e-learning should not focus on the transition from conventional classroom teaching to self-pursue e-learning system, but instead how these technologies can be used to support the learning process. However, without careful considerations, students fail to acknowledge and benefit from the support systems and causes low level of satisfaction towards using them. The main objective of this study is to investigate and suggest solutions to the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and e-learning system towards educational pursuit among students. The results of the questionnaire analysis gives an insight on the problems which include the lack of time, lack of attention provided by the existing system and the lack for self-assessment. ESCA-Math which is a prototype that was developed based on the framework formulated from the analysis stage is a suggestion to address these problems using the study companion approach. In this approach, there will be no teacher presence, but the interaction between the system and the user alone. This way, students are able to carry out their learning process without any outside pressure, thus highlight on the meaning of the study companion. It emphasize on its ability to track students' progress and provide topics assessment scheme to guide students with their learning process. There is also an administrator account feature to allow future maintenance and addition to the content of the system in order to keep track with the changes by the educational system. To ensure ESCA-Math prototype is developed efficiently and effectively, the system model adapts from the waterfall model with prototyping to cover all aspect in system development life cycle. In the user acceptance testing, it shows that students are mostly satisfied with ESCA-Math and believe that it will benefit them as their study companion.

University of Malaya

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere gratitude to my supervisor, Pn. Suraya Hamid for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. Because of her, I had achieved things beyond my wildest dreams. If it were not for her, I would not be where I am now.

To my parents, En. Yusof Hamzah and Pn. Aini Abdul Aziz, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My one and only big sister, Nur Zuhailah Yusof, this little sister of yours had finally did it. Thanks for your patience and love that has got me this far. I am forever indebt with all of you.

These thanks go to all of the students and teachers in the three schools I went for survey and testing, SAMURA, SEDAR and SMKPB.

To my best cyberpals, Louise and Ashleigh, thanks for your undying support and wisdom in keeping me going. Thanks for letting me rant and rave; whine and weep when the going gets tough and convince me to be the tough one that gets going. Our friendship means a lot to me. May we stay mates to our old age.

Last but not least, this also goes to you – you know who you are. My sincerest thanks.

All the words in the world is not enough to thank you all. May Allah bless you with His Rahman and Rahim.

University of Malaya

~Do I Make You Proud~

I've never been the one to raise my hand
That was not me, and now that's who I am
Because of you, I am standing tall
My heart is full of endless gratitude
You were the one, the one to guide me through
Now I can see and I believe
It's only just beginning

This is what we dream about
But the only question with me now
Is do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?

Everybody needs to rise up
Everybody needs to be loved
To be loved

This is what we dream about
But the only question with me now
Is do I make you, do I make you proud?
There ain't no question, just do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?
Do I make you proud?

~Taylor Hicks

University of Malaya

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

University of Malaya

CHAPTER 2: LITERATURE REVIEW

University of Malaya

CHAPTER 3: METHODOLOGY

University of Malaya

CHAPTER 4: REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

University of Malaya

University of Malaya

CHAPTER 5: PROTOTYPE DEVELOPMENT

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND TESTING

University of Malaya

CHAPTER 7: CONCLUSION AND FUTURE WORK

APPENDICES

University of Malaya

University of Malaya

LIST OF FIGURES

FIGURES **PAGE**

University of Malaya

University of Malaya

LIST OF GRAPHS

GRAPHS **PAGE**

University of Malaya

LIST OF TABLES

TABLES **PAGE**

University of Malaya

University of Malaya

LIST OF ABBREVIATION

1. ICT – Information and Communication Technology
2. KBSM – *Kurikulum Baru Sekolah Menengah* or New Integrated Curriculum for Secondary School
3. MoE – Ministry of Education of Malaysia
4. MSC – Multimedia Super Corridor
5. NITC – National Information Technology Conference
6. RMK-8 – *Rancangan Malaysia ke-8* or Eighth Malaysia Plan (from year 2000 to 2005)
7. RMK-9 – *Rancangan Malaysia ke-9* or Ninth Malaysia Plan (from year 2006 to 2010)
8. SAMURA – *Sekolah Menengah Sains Muar*, one of the school picked to participate in the questionnaire analysis
9. SEDAR – *Sekolah Menengah Dato' Sri Amar Diraja*, one the school picked to participate in the questionnaire analysis
10. SMKPB – *Sekolah Menengah Kebangsaan Parit Bunga*, one of the school picked to participate in the questionnaire analysis
11. SPM – *Sijil Pelajaran Malaysia* or Malaysian Certificate of Education
12. TASA – Topic Assessment Algorithm
13. UNITAR – *Universiti Tun Abdul Razak*
14. UNITEM – *Universiti Terbuka Malaysia* or Open University of Malaysia
15. UPU – *Unit Permohonan Universiti* or University Application Unit

University of Malaya

E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF COMPUTER SCIENCE

FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

UNIVERSITY OF MALAYA

KUALA LUMPUR

APRIL 2008

University of Malaya

ABSTRACT

In schools educational system, the advancing technologies in e-learning should not focus on the transition from conventional classroom teaching to self-pursue e-learning system, but instead how these technologies can be used to support the learning process. However, without careful considerations, students fail to acknowledge and benefit from the support systems and causes low level of satisfaction towards using them. The main objective of this study is to investigate and suggest solutions to the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and e-learning system towards educational pursuit among students. The results of the questionnaire analysis gives an insight on the problems which include the lack of time, lack of attention provided by the existing system and the lack for self-assessment. ESCA-Math which is a prototype that was developed based on the framework formulated from the analysis stage is a suggestion to address these problems using the study companion approach. In this approach, there will be no teacher presence, but the interaction between the system and the user alone. This way, students are able to carry out their learning process without any outside pressure, thus highlight on the meaning of the study companion. It emphasize on its ability to track students' progress and provide topics assessment scheme to guide students with their learning process. There is also an administrator account feature to allow future maintenance and addition to the content of the system in order to keep track with the changes by the educational system. To ensure ESCA-Math prototype is developed efficiently and effectively, the system model adapts from the waterfall model with prototyping to cover all aspect in system development life cycle. In the user acceptance testing, it shows that students are mostly satisfied with ESCA-Math and believe that it will benefit them as their study companion.

University of Malaya

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere gratitude to my supervisor, Pn. Suraya Hamid for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. Because of her, I had achieved things beyond my wildest dreams. If it were not for her, I would not be where I am now.

To my parents, En. Yusof Hamzah and Pn. Aini Abdul Aziz, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My one and only big sister, Nur Zuhailah Yusof, this little sister of yours had finally did it. Thanks for your patience and love that has got me this far. I am forever indebt with all of you.

These thanks go to all of the students and teachers in the three schools I went for survey and testing, SAMURA, SEDAR and SMKPB.

To my best cyberpals, Louise and Ashleigh, thanks for your undying support and wisdom in keeping me going. Thanks for letting me rant and rave; whine and weep when the going gets tough and convince me to be the tough one that gets going. Our friendship means a lot to me. May we stay mates to our old age.

Last but not least, this also goes to you – you know who you are. My sincerest thanks.

All the words in the world is not enough to thank you all. May Allah bless you with His Rahman and Rahim.

University of Malaya

~Do I Make You Proud~

I've never been the one to raise my hand
That was not me, and now that's who I am
Because of you, I am standing tall
My heart is full of endless gratitude
You were the one, the one to guide me through
Now I can see and I believe
It's only just beginning

This is what we dream about
But the only question with me now
Is do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?

Everybody needs to rise up
Everybody needs to be loved
To be loved

This is what we dream about
But the only question with me now
Is do I make you, do I make you proud?
There ain't no question, just do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?
Do I make you proud?

~Taylor Hicks

University of Malaya

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

University of Malaya

CHAPTER 2: LITERATURE REVIEW

University of Malaya

CHAPTER 3: METHODOLOGY

University of Malaya

CHAPTER 4: REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

University of Malaya

University of Malaya

CHAPTER 5: PROTOTYPE DEVELOPMENT

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND TESTING

University of Malaya

CHAPTER 7: CONCLUSION AND FUTURE WORK

APPENDICES

University of Malaya

University of Malaya

LIST OF FIGURES

FIGURES **PAGE**

University of Malaya

University of Malaya

LIST OF GRAPHS

GRAPHS **PAGE**

University of Malaya

LIST OF TABLES

TABLES **PAGE**

University of Malaya

University of Malaya

LIST OF ABBREVIATION

1. ICT – Information and Communication Technology
2. KBSM – *Kurikulum Baru Sekolah Menengah* or New Integrated Curriculum for Secondary School
3. MoE – Ministry of Education of Malaysia
4. MSC – Multimedia Super Corridor
5. NITC – National Information Technology Conference
6. RMK-8 – *Rancangan Malaysia ke-8* or Eighth Malaysia Plan (from year 2000 to 2005)
7. RMK-9 – *Rancangan Malaysia ke-9* or Ninth Malaysia Plan (from year 2006 to 2010)
8. SAMURA – *Sekolah Menengah Sains Muar*, one of the school picked to participate in the questionnaire analysis
9. SEDAR – *Sekolah Menengah Dato' Sri Amar Diraja*, one the school picked to participate in the questionnaire analysis
10. SMKPB – *Sekolah Menengah Kebangsaan Parit Bunga*, one of the school picked to participate in the questionnaire analysis
11. SPM – *Sijil Pelajaran Malaysia* or Malaysian Certificate of Education
12. TASA – Topic Assessment Algorithm
13. UNITAR – *Universiti Tun Abdul Razak*
14. UNITEM – *Universiti Terbuka Malaysia* or Open University of Malaysia
15. UPU – *Unit Permohonan Universiti* or University Application Unit

University of Malaya

E-LEARNING USING THE STUDY COMPANION APPROACH FOR SECONDARY SCHOOL MATHEMATICS (ESCA-MATH)

NUR AZIZAN @ NUR AZYAN BT YUSOF

DISSERTATION SUBMITTED IN FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF COMPUTER SCIENCE

FACULTY OF COMPUTER SCIENCE & INFORMATION TECHNOLOGY

UNIVERSITY OF MALAYA

KUALA LUMPUR

APRIL 2008

University of Malaya

ABSTRACT

In schools educational system, the advancing technologies in e-learning should not focus on the transition from conventional classroom teaching to self-pursue e-learning system, but instead how these technologies can be used to support the learning process. However, without careful considerations, students fail to acknowledge and benefit from the support systems and causes low level of satisfaction towards using them. The main objective of this study is to investigate and suggest solutions to the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and e-learning system towards educational pursuit among students. The results of the questionnaire analysis gives an insight on the problems which include the lack of time, lack of attention provided by the existing system and the lack for self-assessment. ESCA-Math which is a prototype that was developed based on the framework formulated from the analysis stage is a suggestion to address these problems using the study companion approach. In this approach, there will be no teacher presence, but the interaction between the system and the user alone. This way, students are able to carry out their learning process without any outside pressure, thus highlight on the meaning of the study companion. It emphasize on its ability to track students' progress and provide topics assessment scheme to guide students with their learning process. There is also an administrator account feature to allow future maintenance and addition to the content of the system in order to keep track with the changes by the educational system. To ensure ESCA-Math prototype is developed efficiently and effectively, the system model adapts from the waterfall model with prototyping to cover all aspect in system development life cycle. In the user acceptance testing, it shows that students are mostly satisfied with ESCA-Math and believe that it will benefit them as their study companion.

University of Malaya

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere gratitude to my supervisor, Pn. Suraya Hamid for her extensive knowledge and exceptional guidance for this research. Thanks for believing and pushing me to go and outdo myself. Because of her, I had achieved things beyond my wildest dreams. If it were not for her, I would not be where I am now.

To my parents, En. Yusof Hamzah and Pn. Aini Abdul Aziz, my utmost respect and appreciation for believing and undeterred confidence in me, that I will complete this research. I will always cherish your love and support. My one and only big sister, Nur Zuhailah Yusof, this little sister of yours had finally did it. Thanks for your patience and love that has got me this far. I am forever indebt with all of you.

These thanks go to all of the students and teachers in the three schools I went for survey and testing, SAMURA, SEDAR and SMKPB.

To my best cyberpals, Louise and Ashleigh, thanks for your undying support and wisdom in keeping me going. Thanks for letting me rant and rave; whine and weep when the going gets tough and convince me to be the tough one that gets going. Our friendship means a lot to me. May we stay mates to our old age.

Last but not least, this also goes to you – you know who you are. My sincerest thanks.

All the words in the world is not enough to thank you all. May Allah bless you with His Rahman and Rahim.

University of Malaya

~Do I Make You Proud~

I've never been the one to raise my hand
That was not me, and now that's who I am
Because of you, I am standing tall
My heart is full of endless gratitude
You were the one, the one to guide me through
Now I can see and I believe
It's only just beginning

This is what we dream about
But the only question with me now
Is do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?

Everybody needs to rise up
Everybody needs to be loved
To be loved

This is what we dream about
But the only question with me now
Is do I make you, do I make you proud?
There ain't no question, just do I make you proud?
Stronger than I've ever been now
Never been afraid of standing out
But do I make you proud?
Do I make you proud?

~Taylor Hicks

University of Malaya

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

University of Malaya

CHAPTER 2: LITERATURE REVIEW

University of Malaya

CHAPTER 3: METHODOLOGY

University of Malaya

CHAPTER 4: REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

University of Malaya

University of Malaya

CHAPTER 5: PROTOTYPE DEVELOPMENT

CHAPTER 6: PROTOTYPE IMPLEMENTATION AND TESTING

University of Malaya

CHAPTER 7: CONCLUSION AND FUTURE WORK

APPENDICES

University of Malaya

University of Malaya

LIST OF FIGURES

FIGURES **PAGE**

University of Malaya

University of Malaya

LIST OF GRAPHS

GRAPHS **PAGE**

University of Malaya

LIST OF TABLES

TABLES **PAGE**

University of Malaya

University of Malaya

LIST OF ABBREVIATION

1. ICT – Information and Communication Technology
2. KBSM – *Kurikulum Baru Sekolah Menengah* or New Integrated Curriculum for Secondary School
3. MoE – Ministry of Education of Malaysia
4. MSC – Multimedia Super Corridor
5. NITC – National Information Technology Conference
6. RMK-8 – *Rancangan Malaysia ke-8* or Eighth Malaysia Plan (from year 2000 to 2005)
7. RMK-9 – *Rancangan Malaysia ke-9* or Ninth Malaysia Plan (from year 2006 to 2010)
8. SAMURA – *Sekolah Menengah Sains Muar*, one of the school picked to participate in the questionnaire analysis
9. SEDAR – *Sekolah Menengah Dato' Sri Amar Diraja*, one the school picked to participate in the questionnaire analysis
10. SMKPB – *Sekolah Menengah Kebangsaan Parit Bunga*, one of the school picked to participate in the questionnaire analysis
11. SPM – *Sijil Pelajaran Malaysia* or Malaysian Certificate of Education
12. TASA – Topic Assessment Algorithm
13. UNITAR – *Universiti Tun Abdul Razak*
14. UNITEM – *Universiti Terbuka Malaysia* or Open University of Malaysia
15. UPU – *Unit Permohonan Universiti* or University Application Unit

University of Malaya

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

In the past 15 years, when the Ministry of Education (MoE) proposed the New Integrated Curriculum for Secondary Schools (KBSM), it stated that the new approach in teaching should be students-oriented (MoE 1991). Students are encouraged to progress at their own pace, and according to their varying capabilities, interests and needs. The students are also given greater responsibility for managing and directing their own learning. The focus is on students' searching, generating, and using knowledge with an emphasis on problem-solving and creativity. In this way, it is hoped that students will develop the critical skills and acquire the knowledge they need for effective lifelong learning and full functioning as citizens in a charging society (Chan 2003).

To realize this vision it is vital to have support from all means possible. With the recent growth of advance technologies in systems software and online learning applications, all advantages should be manipulated to enhance the learning process and to assist in fulfilling these ideas of transition.

A study companion will not replace the role of the teacher entirely. Malaysia is still in the beginning level of computer usage in the educational system. E-learning should not replace the teacher's role - yet, but it should act as a support towards the learning

University of Malaya

process. Students will have other ways besides the textbooks to turn to for revision and help with homework.

Mathematics is a vital component both for understanding and controlling today's technology. It is of vital importance that future generations have not only an understanding of basic mathematical operations but also the ability to apply them in a practical context (Kilpatrick 2001; Noraini 2004).

The main objective for Mathematics KBSM is to implant the problem solving skills and the ability to use the mathematics skills learned in order for a person to function in his daily live effectively and respectfully and to appreciate the importance of mathematics itself (MoE 2001).

In the past few decades we have also seen the increased use of quantitative techniques in many subject areas. For example, economics, biology and geography have all seen a vast increase in the use of mathematical analysis and the teaching of these subjects in school has reflected the increased use of mathematics. Besides that, it is a compulsory subject when applying for further studies in higher education at the universities. Stated by the UPU Online for the admission requirements to over 120 courses all over universities in Malaysia, they require students to achieve at least a compliment - grade '3B' to passing grade '6C' - in Mathematic (Ministry of Higher Education (MoHE) 2005). Realizing this, parents and teachers alike are very concerned with the development of student's achievement in Mathematics.

University of Malaya

1.2 PROBLEM STATEMENTS

Various technologies are emerging everyday focusing on enhancing the users experience on the Internet. The Internet has been used to assist the educational system for some years but students are yet to use them at its fullest capability. Most students, especially those in rural areas lack in computer skills competency and equipments. Thus it is very important to develop a system that would address this matter using the appropriate method carefully so it will be a system they will want to use.

The existing systems had several obvious drawbacks that can be improved as new technologies emerged. These drawbacks include the followings,

- **Lack of e-learning education website that are based in Malaysia**

  A study in Chapter 2 shows that there is a limited number of local website built to encompass the usage of online system among school student. This would discourage students from considering it as another choice of learning tool.

- **The available local websites are faced with several content issues.**

  The available local website does little to show the veritable capability of e-learning. Some of them, quite disappointingly, merely list out links to other websites and more often than always, these website are not based in Malaysia. An instantaneous intuition would see that by using these websites, the students are likely to slip from the school syllabus outlined for them. While it is true that knowledge knows no bound, the syllabus should be taken as the first priority before engaging in other extra curricular activities. Another attribute that can be seen in these websites is they inclined to adopt a 'book-turn-website' scenario

University of Malaya

where quite plainly they failed to present the real potency an e-learning can bring. By displaying a complex array of words, the user can be easily rendered bored by them. Furthermore, they often exhaust their user by displaying too much information in a single page.

- **The e-learning that are not based in Malaysia does not follow the KBSM syllabus**

  There are numerous e-learning websites developed by countries other than Malaysia. This is only to show that e-learning is gaining its popularity. While it is a good aspect when a student uses these websites as another learning tool besides books, the most important thing that should not be taken lightly is that the examination are based on a syllabus outlined by the Ministry of Education. It is very important for these students to master the syllabus first, before diving in other in-depth topics.

With the availability of today's advance technology, it is very important to find a way to address this problem because in the long run, it will be a tragic loss to the educational system if this concern is not tackled immediately.

University of Malaya

1.3 AIM OF THE PROJECT

The aim of this project is to develop an e-leaning prototype that will assist Form 4 and Form 5 students in acquiring and understanding the Mathematic subject in school based on the KBSM syllabus better, using the idea of a study companion instead of the usual e-learning.

1.4 OBJECTIVES OF THE PROJECT

This is a study to obtain and analyze the following,

i) To investigate the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet for educational pursuit such as e-learning among students.

ii) To create a viable framework based on the qualitative and quantitative research and analysis as a means of consideration in order to suggest for a solution to the problem.

iii) To develop a workable prototype based on the framework created which is called “E-learning using the Study Companion Approach: Mathematics (ESCA-Math)” that the user would use.

University of Malaya

1.5 RESEARCH QUESTIONS

In order to achieve the objectives defined above, the research questions identified are:

- **Could the low to moderate level of satisfaction in Internet usage for educational purpose due to impersonalized e-learning system or because students did not know how to get the best benefits out of e-learning?**

Internet had been around for several years and the Smart School project had selected several schools that will be endorsed with Internet connection along with computers equipment by the ministry. In addition to that, the Internet holds an extensively vast amount of information. One needs to only use the searching engine for any kind of information. This research will investigate how to increase students' level of satisfaction in e-learning particularly in Mathematics subjects. There is no doubt that there are a lot of e-learning websites around the Internet. So what could possibly the cause that resulted to the low to moderate level of satisfaction? Perhaps students do not regard the e-learning websites as a source for information, because these websites does not regard the students as an individual person but instead just any other person visiting it. Or perhaps, the facilities are all there, but they do not know how to gain from it. This research will investigate all these possibilities.

University of Malaya

- **Would an e-learning using the study companion approach that treats its user as an individual person instead of any typical user able to address this situation?**

If the above assumption that the students choose to shy away from e-learning websites because of unsatisfactory experience, then some things can be done to improve this situation. This research proposes the study companion idea as one of the way to address this deficiency. Perhaps with the welcoming feelings one gets with a personalized application able to diminish the alienated sensitivity from the past experience. By having an individually learning application, one will be able to advance based on one's own pace thus helps one from getting intimidated by extensive kind of exercises and sample questions.

1.6 SCOPE OF RESEARCH

Time and financial constraint does not allow for a larger sample to be studied and thus it has the following limitations,

i) The survey will be conducted and limited to students of Form 4 and 5 from secondary schools in Muar, Johor.

ii) The prototype that is to be built involves a few selected topics from Mathematic subject in Form 4 and Form 5. Other topics that could not be inserted in this prototype, can be added at a later time, since this prototype had enable administrator account. The administrator for ESCA-Math will be able to edit and add to the content of the system, thus allowing for future update and maintenance.

University of Malaya

1.7 SIGNIFICANCE OF RESEARCH

Below is the significance of this research that has been discovered:

- **Improving the usage of Internet for education among secondary school students.**

  This study will provide valuable information to improve the usage of Internet among students to enhance their knowledge, and as a start, in Mathematics subject. The Internet has been used to assist the educational system for some years but students are yet to use them at its fullest capability. This study will investigate the reason behind the reluctance of the targeted users in using the existing available systems.

- **By developing an e-learning system, it will also assist students in mastering the English language as the medium of instruction.**

  The decision of the Ministry of Education to implement the teaching and learning of Mathematics and Science subjects in English is seen as an effort to improve students' efficiency in the said subject. It is a long-term undertaking to visualize Malaysia as an economic powerhouse country. With the availability of advance technology of the Internet and multimedia authoring tools, it is high time for these technologies aim to support the educational system as part of the drive towards the Vision 2020.

- **More quality time for the teachers for other activities in class related to teaching Mathematics.**

University of Malaya

Teachers will also benefit from ESCA-Math by providing them with more time in class for other social activities since the revision can be done by the students themselves at their own pace.

1.8 ORGANIZATION OF RESEARCH REPORT

This project is organized in seven related chapters. This chapter (Chapter 1) presents the introduction of this project. It starts by presenting the overview of the research, research problem statements, aim of the project, objectives of the project, research questions, scope of the research, significance of the project and the organization of the project. The last section is the summary for Chapter 1.

Chapter 2 of this project provides literature review about e-learning, the study companion approach, mathematics and personalized account are studied and use as a guidance towards advancing with the research. Resources are gathered from journals, published articles, books, papers and magazines and online resources.

Chapter 3 of this project discusses the methodology used to develop the prototype. It consists of system methodology and research design. It also explained the sample and location of the respondents who participated in this research.

Chapter 4 explained the requirement analysis and the system design. It laid out the results and data analysis to the questionnaire undertaken as part of the requirement analysis. Another analysis undergone is the research on the frequently Internet-accessed location. Project scope and requirements that followed next outlined the types of user determined for the project, system framework, functional requirements

University of Malaya

and non-functional requirements. This chapter also described the system design of this project which outlined the system architecture, system flowchart, web development tools and the proposed storyboard.

Chapter 5 explained the system development which comprises of the system modules and the algorithm used in the system.

Chapter 6 discussed the system implementation and testing. System implementation consists of environment preparation while testing involves unit testing, integration testing, system testing and user acceptance testing.

Chapter 7 concludes the research report by providing the research contributions, research publications, strength and limitations of the ESCA-Math prototype, objectives achieved and the future enhancement that can be carried out.

1.9 SUMMARY

When Vision 2020 was laid out in1991, there have been numerous efforts to support in making these visions a reality. One of these visions includes having technologically literate and critically thinking workforce prepared to participate fully in the global economy of the 21st century. Transition needs supports from all means possible and this research is aimed to cater for that purpose.

This chapter is written to outline the problem statement, the aim of the project, the objectives of the project, its research questions, scope of the research and the significance of the research.

University of Malaya

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this chapter, previous researches on topics of e-learning which includes a brief overview, the initiatives in Malaysia, key factors, benefits and challenges in implementing it, the design and presentation issues, and evaluation of the existing system is gathered and studied. There are also previous researches on the study companion approach, mathematics and personalized account. This information will be used as guidance towards advancing with the research. Resources are gathered from journals, published articles, books and online resources.

2.2 E-LEARNING IN AN OVERVIEW

The end of 20th century sees a rapid growth in computer and information technology. Businesses are undergoing a period of sustained, rapid transformation, brought about by the competitive pressures of globalization and the revolution in information and communications technology (Robiah & Nor Sakinah 2004). To survive and be successful, businesses actively need to embrace and promote change within their organizations; find new ways to produce existing products and services and to develop new ones; as well as finding new routes to market. Thus, this urgency calls for a way to manage the people within the organization, polishing their skills and competence in order for them to reach those goals (Asirvatham 2003). Exploiting what the computer and information age can offer, e-learning came into view.

University of Malaya

2.2.1 E-Learning definition

There has been various definition of e-learning (abbreviated from 'electronic learning') over the past few years since its implementation. According to Rosenberg (2001), "E-learning refers to the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance", while Yusuf and Razmah (2001) defined it as "learning and teaching approach using the digital media and computer technology that enable the information to be transmitted via networks and can be access regardless of time and places".

These various definitions may even overlap with one another but it can be summarized that e-learning is the using of Internet technology and networks towards assisting, simplifying, boosting and accelerating the educational processes.

2.3 E-LEARNING KEY FACTORS

It has been noted that it is expensive to develop and employ e-learning in the educational system (Pittard 2004; Ng & Gunstone 2003). Hence, a systematic study and research into the benefits of computer-enriched environment is important to establish if the investment is justified and deciding the key factors to focus on in order to ensure that e-learning in education is not simply just another passing fad. Based on the researches and findings, the following key factors are discovered. These key factors are outlined in **Figure 2.1**.

University of Malaya

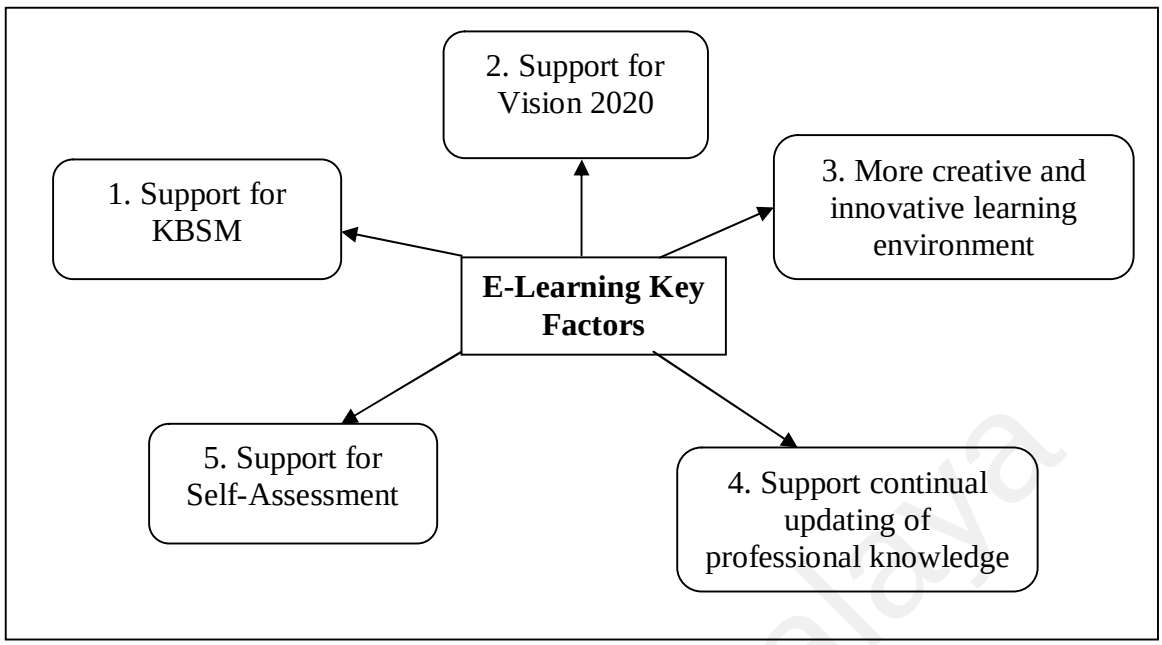


Figure 2.1
E-Learning Key Factors

2.3.1 Support for KBSM

E-learning can be an alternative to support the New Integrated Curriculum for Secondary School (KBSM). The latest legislation that was documented stated several modules that have been formulated. One of them is to encourage the self-access learning, where students are able to carry out the teaching and learning process based on their own capability pace and according to their own time schedule using the arranged materials and devices provided to them (Curriculum Development Center (CDC) 2002). As such, the philosophical logics behind this proposed type of learning are to produce independent and responsible students who have the initiative and the ability to make enquiries, research and self-assessment.

University of Malaya

Apart from that, the urgency lies in generating students who are self-provoked in gaining knowledge outside the walls of the classroom and later applying them in problem-solving situation in their everyday lives (MoE 2004).

2.3.2 Support the Vision 2020

E-learning can be used as another means to support the Vision 2020. The text contains nine challenges that need to be addressed before Malaysia can become a fully-developed country by the year 2020. Stated in the sixth challenge is, "to establish a scientific and progressive society, a society that is innovative and forward-looking, one that is not only a consumer of technology but also a contributor to the scientific and technological civilization of the future" (Mahathir 1991). The children of today are the society of tomorrow. Thus, in order for them to not only become a consumer to the technology but also a contributor, they have to first and foremost, become comfortable with computer technology. One of the ways to achieve this is to introduce e-learning in the educational system.

2.3.3 Creative and Innovative Learning Environment

E-Learning can be used as a means to produce a more creative and innovative learning environment in the educational system. Students of the current era relate to computers as part of their upbringing and, in the homes of an increasing number of students, computers play an essential role in their recreation and learning activities (Ng & Gunstone 2003). A study that was conducted by Polyzou (2005) on five language teachers on use of computer and multimedia elements in classrooms concluded that teaching with multimedia authoring tools generated a context of practice within which new

University of Malaya

pedagogical assumptions about learning evolved and thus helped them to escape from their routines of practice. Learning with multimedia elements brings out new means of knowledge acquiring. Music, games and animation are some of the elements that manage to capture students' interest compared to stagnant and formal form of textbooks.

2.3.4 Continual updating of professional knowledge

E-Learning can be seen as a challenge to develop a system which supports continual updating of professional knowledge (Ng & Gunstone 2003) which will further increase the level of confidence and computer literacy (Asirvatham 2003). The availability of vast amounts of up-to-date information on the Internet is important in the teaching and learning in the sense that new findings are emerging rapidly where books would become obsolete before long. Thus, it is easier to keep up with information by accessing the Internet. For example, Ng and Gunstone (2003) noted that several senior teachers in biology interviewed, agreed that science of biology technology is a rapidly emerging sector and thus new information can be access immediately easily by way of Internet rather than books which are effortlessly becoming out of date before long. By using the computer and incidentally the Internet, computer literacy in the general community and students specifically can be increased.

2.3.5 Supports for Self-Assessment

Self-assessment can be done in many ways. It can be achieved by taking self-test from exercises and revision books, or by enrolling to a tuition class. Undeniably, both ways can be costly. One of the alternatives to this is by signing up to an e-learning system that is able to track students' progress from

University of Malaya

time to time as they undertake tests that are provided. This would also reduce the examination stress by outlining their weak and strong topics for their further action. Ultimately, students are more prepared and confident for the crucial examination before they embark towards higher level of education.

It has been mentioned by many researchers (Polyzou 2005; Minaidi & Hlapanis 2005; Pittard 2004; Chan 2003; Maor 2003; Asirvatham 2003) that even with the availability of resources and technology, one should not eagerly jump into the bandwagon after seeing the accomplishment of other countries, especially the developed ones without knowing the full consequences of implementing e-learning in their educational system. What these researchers agreed upon is not without solid arguments; however, one important aspect that should not be taken lightly in this matter is that every effort undertaken to proceed with e-learning, is an effort to empower lives and most importantly the children of the future with the latest technology available.

2.4 E-LEARNING DESIGN AND PRESENTATION ISSUES

Sadik and Reisman (2004) outline four issues relating to delivering learning material on the Internet. These issues are based on a collective research on the 'lessons learned' design and development of an e-learning system. These four issues are as follows:

a) Providing a rich-learning environment;

b) Understanding the spectrum of interaction;

c) Developing the presentation environment;

d) Cost required.

University of Malaya

These issues will be used when evaluating existing system in **Section 2.5.6.**

2.4.1 Rich-Learning Environment

Web-based learning is an instructional delivery mode that has evolved from traditional instructional delivery environment; hence, many online materials have been derived from traditional instructional materials typically textbooks. Unfortunately, converting textbooks to Web pages can result in digital versions of textbooks that provide no incremental benefit for students. Thus, e-learning instructions need to provide rich e-learning experience with activities that are necessary to support and reinforce student learning which includes the following criteria:

- **Content design**

It is very essential to insert course objectives within the system because not only do they help instructors plan the structure of a course, develop learning activities and assessment methodologies (Berge et al 2000), it also provide students the capabilities of the system and what it plans to address and achieve.

- **Learning support activities**

This issue is related to the availability of the e-learning system to provide an ideal environment in which to implement the principles of the constructivist learning (Smith-Gratto 2000). Constructivist concerns with students to construct their own learning in meaningful ways when they take part in individual and social activities encounter and solve problems and evaluate their understanding.

University of Malaya

- **Learning materials and resources**

This issue concerns with the way learning materials is being organized within the system and how it is delivered. Each module should be easy enough for the student to understand the flow of the learning facility provided. For instance, before presenting the user with self-test and topic evaluation, they should be presented with the topic resources first followed by further examples and exercises. The interaction and purposes of each module should be clear.

- **Web resources**

Most e-learning system would include a section where a list of outside resources in a form of links. While this can provide learners with limitless information resources, one important aspect that should not be forgotten is the appropriateness of age group of targeted users. For secondary school students, information should be within the confine of the syllabus. Web resources that provide in-depth information on certain topics should be highlighted that they are meant for additional information to avoid 'information overloading' to happen to them.

2.4.2 Spectrum of interactions

Interaction within the e-learning relies heavily on the main purpose of the system. Integrating interactions in e-learning depends on how high the level of interactions is needed. For distance learning, for instance, interaction is very high on the list and should be implemented fully because the main platform for the learner and instructor to communicate is the system itself. However, for a system that is not entirely replacing the role of a teacher, the interaction can be

University of Malaya

limited to the basic need such as the interaction between the student and the system itself. Two types of interactions have been outlined namely, the interaction with course content and discussion board.

- **Interaction with course content**

The design and development of the content is very important, not only to facilitate student-content interaction but also to direct and foster other type of Web-based interactions, which are vital for the success of learning. Student-content interaction is realized when the students are not only able to read the content in short and visually attractive chunks, but also they are able to explore, browse, and choose before reading throughout the lesson. Students were able to choose and link among chunks or even to visit back previous lessons or support materials and receive auto-feedback.

- **Discussion board**

Discussion board is a place where internet users discuss certain topics or issues by posting after one another, usually the discussion starts when a person post the first message, in a facility that holds all of these postings together. Admittedly, discussion board can benefit the learner by allowing interaction through computer screens, but careful consideration should be made when implementing it in an online system for 16 to 17 years old students. Most research (Muilenburg & Berge 2005; Li 2003; Vonderwall & Zachariah 2005) that had proven the effectiveness of discussion board are essentially on older group of students, for instance, undergraduates.

University of Malaya

An observation on discussion board implemented in an e-learning for K-12 student group, shows that the average number of postings was very low (one message per student per two weeks). Many students are found to prefer to 'lurk' and posted fewer than three messages for 12 discussions topics. Students commented that they did not participate because,

1) They could not post 'correct answer' that would add meaningful value to discussions,
2) They had nothing to say,
3) They did not consider discussions to be as important as conventional tasks.

Other than that, Flotternesch (2000) reported that students rarely interact via discussion boards because of a lack of opportunity to develop peer relations and/or because of the intimidation about using new technology.

Aside from that, the quality of the messages posted appeared to be very low, where they tend to;

1) Repeat information from other's messages without additional explanation,
2) Support or reject other's opinion without adding personal comments or providing clear evidence,
3) Offer solutions without providing clear interpretation,
4) Provide solutions directly depicted from the text, and not from external Web resources or self-experience, and
5) Ask a question that was not directly related to the discussion topics (Sadik & Reisman 2004).

University of Malaya

This shows that embedding discussion board in an e-learning is not a significant factor in determining student's academic success unless there is a sufficient quantity of relevant, motivating, and content-related messages passing between and among correspondents. In other perspectives, little educational effectiveness can be gained from involving students in group discussion if they are unable to carry out in-depth processing of discussion problems, are not interested in group-based learning, or do not have the necessary skills, time, and experience to participate in such activities.

2.4.3 Presentation Environment

This is in fact the most important aspect when developing an e-learning. Obviously, by embedding multimedia elements, the presentation environment holds quite an advantage over traditional instruction. However, it is very important to realize that careful consideration on the development is vital to ensure the expected benefits are successfully delivered to the students. Below are the criteria for this issue;

- **User experience and training**

One issue that can affect student learning in Web-based environment is students' previous computer and Internet experience. Thus, it is important that the learning environment be designed to reduce the effect of that experience on the learning that is to take place. This can be ensured by providing help in one click away and roll-over functions that provide caption and labels to further assist them.

University of Malaya

- **Information presentation**

A good practice of a well-designed user interface is by developing the starting page as a crossroad or origin point to guide learners toward exploring, understanding, and navigating through the site. Presenting information and learning material in other than text-based form such as animation, or audio or video might not be as effective and they took longer time to download.

- **Ensuring quality**

An important consideration pertaining to information is that of quality. Providing information of high-quality is important to ensure users get the most accurate and reliable information for their use. According to Norma and Normadiah (2002), to reflect the quality of information, the following attributes must be found in the information provided.

1) Accuracy (error free)

Ensure that there is no debugging error, spelling error or broken links.

2) Reliability

Ensure that the content or learning materials are accompanied with subject syllabus to prove its reliability with what being taught at school.

3) Precision and consistency

Ensure that the information they are viewing comes from the latest source of information by providing the date of last update.

2.4.4 Cost required

Internet was always decided as the technologies to reach wide population of learners which incurred less cost than those of traditional instructional

University of Malaya

strategies (Inglis 1999). However, without realizing the element included into the e-learning system, these cost might offset the benefit it provides to the students. The cost needed to set up the Internet connection might not be an issue since school's computer laboratories and personal computer at home were not initially installed for the sole purpose of using e-learning system. But there are other costs involved such as the fees students need to pay in order to use the full package provided by the e-learning system.

As a conclusion, e-learning is not about digital technologies anymore than classroom teaching is about blackboards. E-learning should be about creating and deploying technology systems that support the improvement of teaching and learning. There are several ways to help with this process,

1) By investigating the previous existing system (*see* **Section 2.5**),
2) By analyzing the data collected in Chapter 4 and,
3) By studying the pros and cons in previous researches.

2.5 EXISTING E-LEARNING SYSTEM

When e-learning was first introduced in the educational system, the first objection was from the body of teaching profession. The first argument was educational concept such as the pedagogy of classroom teaching is not as easy to be mapped to computer screen because of the lack of role of physical teacher. The technology-skilled people then were excitedly racing to build computer systems claiming to facilitate the educational process the way that human cannot.

As Janieki and Liegle (2001) stated, Web-based courses were developed by people skilled in Web authoring but who are not necessarily knowledgeable about

University of Malaya

educational concepts. E-learning should meet many instructional, structural, and technical principles of design and development to be more than information 'dumping', and to avoid eye-strain from endless text screens, confusing navigation, and long download times (Spitzer 2001). Thus, it is very important to continue with evaluation of existing systems to further define the practical guides, good practices and lessons learned to ensure that future development of e-learning is an enhancement rather than a repetition.

Table 2.1
List of Existing System

No	Name	Vendor's Name	URL Address
1	'Portal Pendidikan Bestari'	Utusan Melayu (M) Berhad Kuala Lumpur	www.tutor.com.my
2	Score A Programme	Kenshido International Sdn Bhd	http://www.scorea.com/eng/index.cfm
3	Online Learning @ Maxis	Maxis Communication Berhad	www.maxis.communities.com.my/page.cfm?name=Online_Learning_2004&sid=17
4	Math Forum	Drexel School of Education	www.mathforum.com
5	MathisFun	MathIsFun.com	www.mathisfun.com

From the table above, it can be seen that three of them are local e-learning website and two are international and they have been chosen for this evaluation.

University of Malaya

2.5.1 'Portal Pendidikan Bestari'

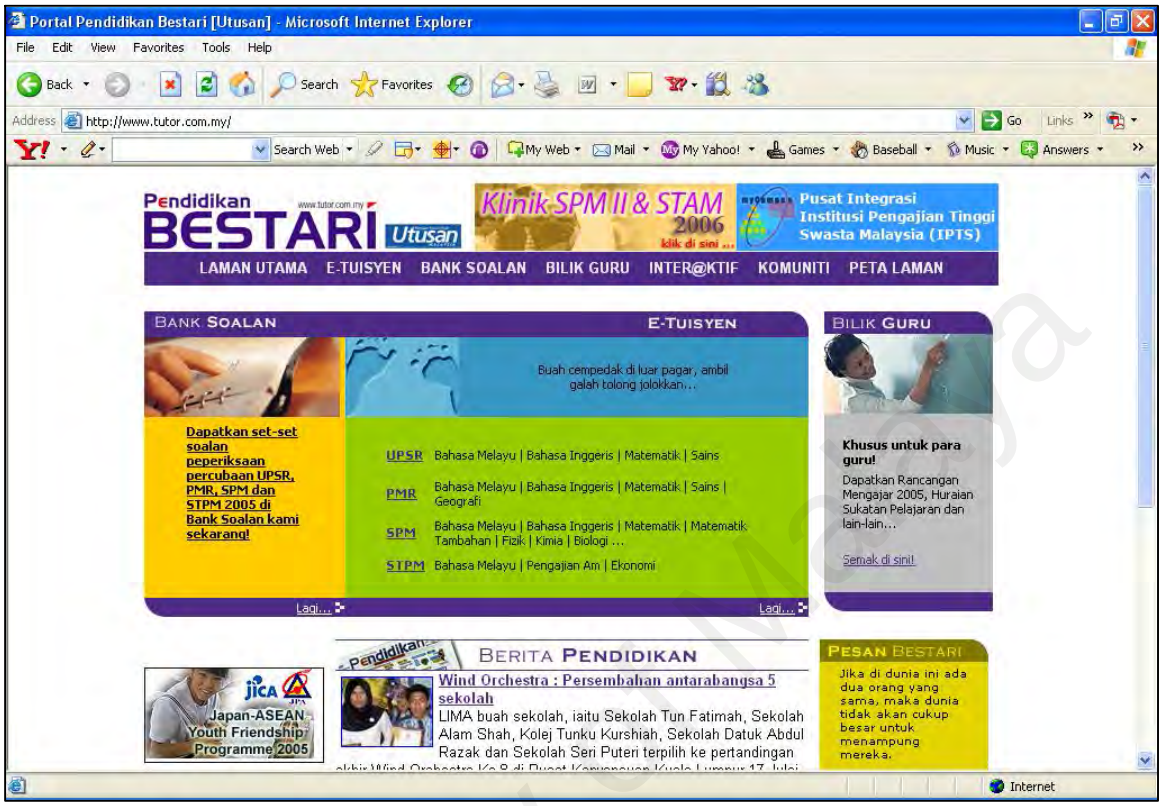


Figure 2.2
'Portal Pendidikan Bestari'

Portal Pendidikan Utusan (Bestari) was developed, managed and administered by Unit Pendidikan Utusan, Jabatan Pengarang, Utusan Melayu (M) Berhad, one of the top publication company in Malaysia. It was successfully launched in July 2001 and some of the early initiatives are explained below:

- Providing information on school's curriculum and syllabus for students, teachers and as well as parents;
- Creating learning modules covering notes, exercises, references, examination tips and questions bank for students sitting for the Ujian Pencapaian Sekolah Rendah (UPSR), Penilaian Menengah Rendah

University of Malaya

(PMR), Sijil Pelajaran Malaysia (SPM), and Sijil Tinggi Pelajaran Malaysia (STPM);

- Providing the latest news about educational system;
- Providing the search engine and links to other related websites;
- Providing the information about the college and universities in Malaysia.

2.5.2 'Score A Programme'

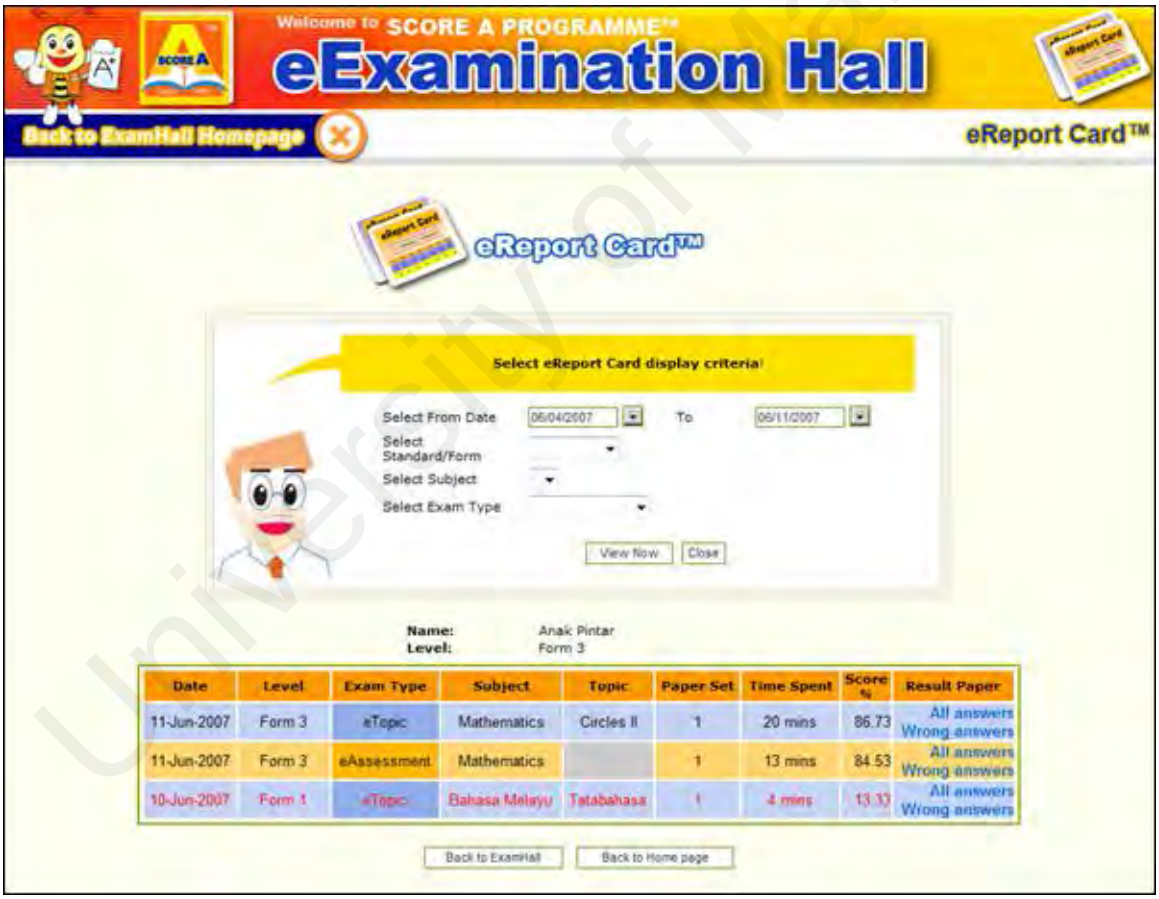


Figure 2.3
'Score A Programme'

ScoreA is an interactive programme runs by Edu-2U Sdn Bhd and it introduces the concept of Output Learning which is the ability to retrieve and

University of Malaya

apply what the students have studied or learnt. Input Learning is where students read, study, memorize and listen which enabled them to achieve average marks. Some of the features are listed below:

- Providing another login account which is the parents as well as students to include participation from the parents' side in determining their children's success in school;
- Suitable for students sitting for the Ujian Pencapaian Sekolah Rendah (UPSR), Penilaian Menengah Rendah (PMR), and Sijil Pelajaran Malaysia (SPM);
- Providing ePast Year Exam for past year examination paper collection set;
- Providing eTrial Exam for sample paper set;
- Providing eAssessment for collective topic assessment paper set;
- Providing eTopic for specific topic assessment paper set; and
- Providing eReport Card a collective records of previous assessment done within the system.

University of Malaya

2.5.3 'Online Learning @ Maxis'

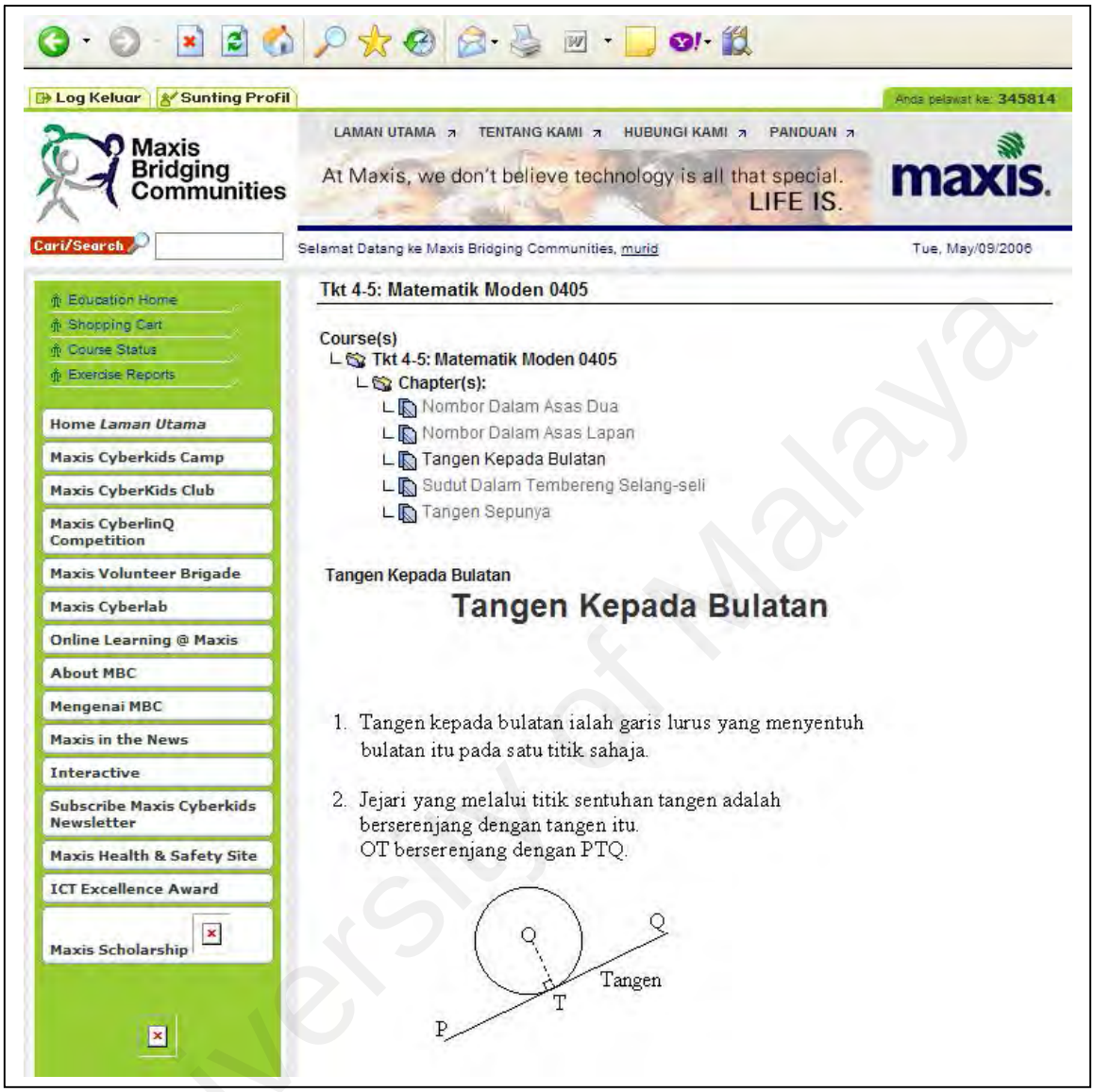


Figure 2.4
'Online Learning @ Maxis'

This is one of the private sector's experimental offerings of learning support to the students. Titled 'Maxis Bridging Communities', it shows an initiative from the private sector to use technology for educational purpose. There are many reasons why but perhaps one of them is because Maxis is one of the top companies in communication, and hence, with the need to show its effort

University of Malaya

properly, all Mathematics topics are available online. Some of the features include;

- Providing free login ID and password for guest to log-in and view the learning materials
- Providing learning notes, sample questions and answers, followed with a set of questions to test ones understanding on the concept.

2.5.4 'Math Forum'

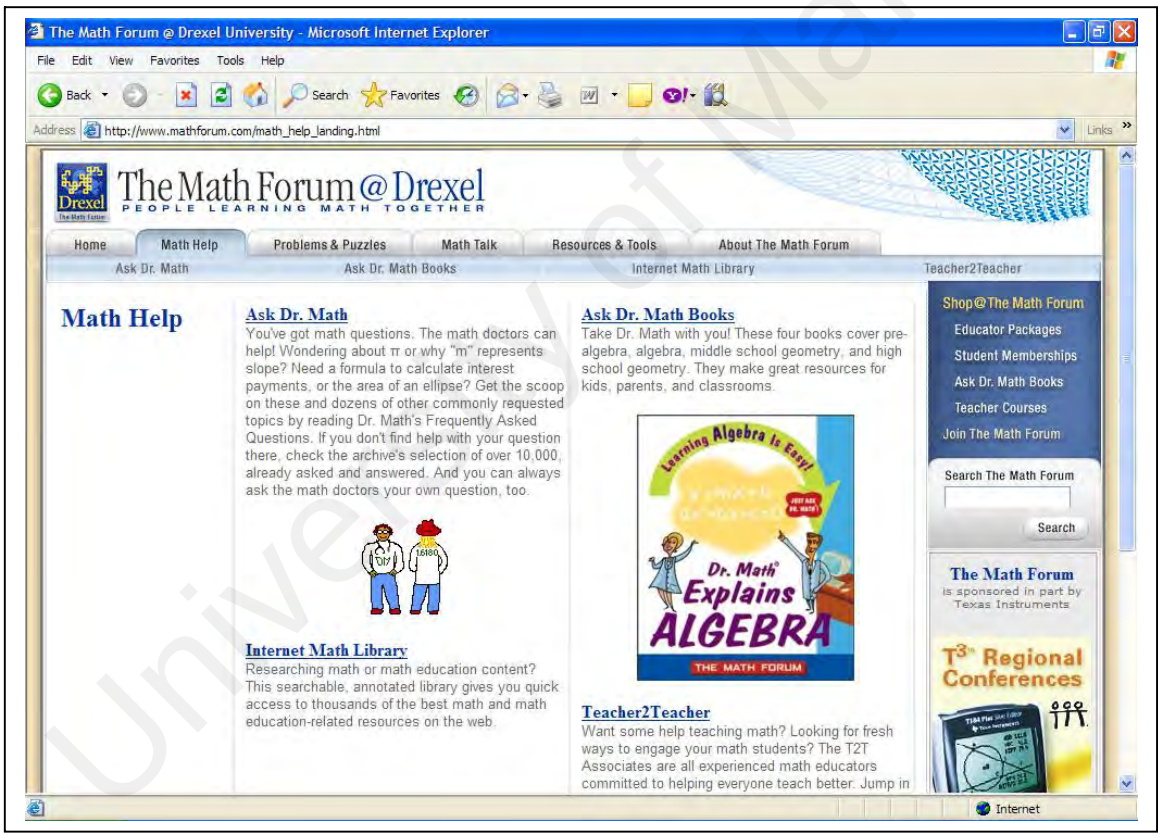


Figure 2.5
'Math Forum'

The Math Forum is a leading center for mathematics and mathematics education on the Internet and it is probably the best mathematics resources over the Internet. Operating under Drexel's School of Education, this website

has been developed over the years to further improve the quality of the website. Not only does it provide high quality of mathematics educational content, it also assists in making mathematics-related web resources more accessible. Some of the features include;

- Providing resources, materials, activities, person-to-person interactions, and educational products and services that enrich and support teaching and learning in an increasingly technological world;
- Encouraging communication throughout the mathematical community by having three type of discussion board which is Teacher's Lounge, Bridging Research and Practice and Discussions;
- Providing many other features such as 'Ask Dr. Math', which consist of volunteer 'math experts' to help students with any mathematical problem and an archive for all past questions; 'Math Tools', the website's community digital library supporting the use and development of software for mathematics education; and the 'Mathematics Library', which covers math and math education Web sites in depth.
- Providing a 'Help' and 'Site Map' section for those who might get concerned about the amount of information on that website that might cause 'information overload' to the users;
- Providing a feedback form for users to inform the administrator whenever they found a broken link or incorrect information.

University of Malaya

2.5.5 'Math is Fun'

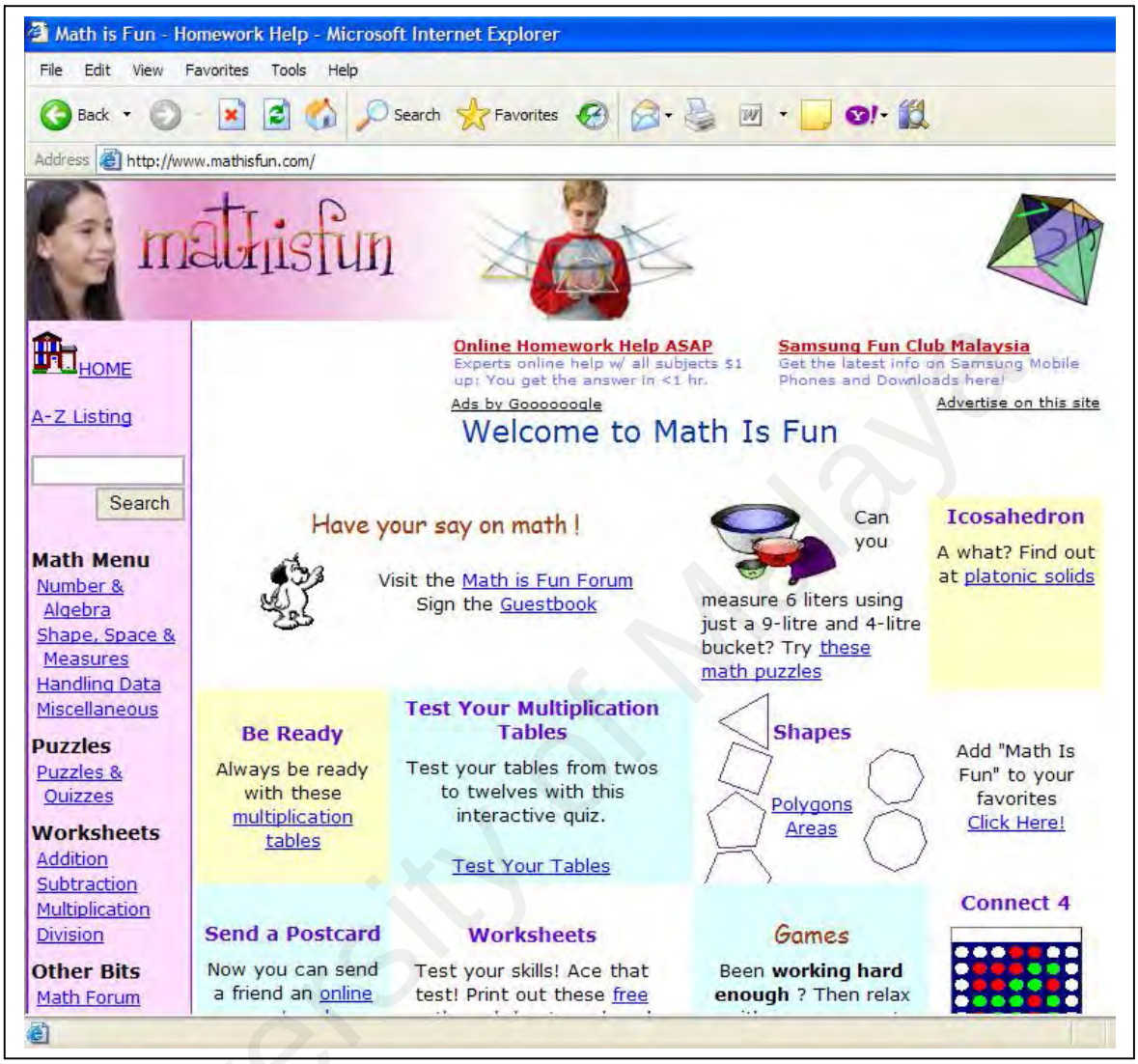


Figure 2.6
'Math is Fun'

The idea behind the site is to offer mathematics as well as some fun bits, and to combine the two wherever possible. MathsIsFun.com is developed and maintained by Rod Pierce, who hopes that by developing such website as this one, he could reduce the level of mathematics anxiety among students. The main content of the site is aimed at basic math skills but there is some complex stuff available as well. Some of the features include;

University of Malaya

- Providing extensive learning modules in colorful presentation to depict an enjoyable environment of learning;
- Providing printable and customizable worksheet to sharpen mathematics skills;
- Providing a search engine within site facility to assist student to look for specific information;
- Providing puzzles and games for recreational activities;
- Providing additional learning facilities such as illustrated mathematics dictionaries, mathematics forums, and printable time tables.

2.5.6 Evaluation of existing system

The evaluation of the existing system is based on the issues discussed in **Section 2.4.** These existing system are those listed in **Table 2.1** which are; Portal Pendidikan Bestari, Score A Programme, Online Learning @ Maxis, MathForums and MathisFun. The issues used in this evaluation are based on Sadik and Reisman (2004) and they are as the following:

A) Providing a rich-learning environment;

1. Content design
2. Learning support activities
3. Learning materials and resources
4. Web resources

B) Understanding the spectrum of interaction;

1. Interaction with course content
2. Discussion board

University of Malaya

C) Developing the presentation environment.

1. User experience and training
2. Information presentation
3. Ensuring quality

D) Cost requirement

From the evaluation summary, it can be concluded that the limitations of these system are as the following:

i) Course and learning objective not always clear.

Course and learning objective is very important because it shows the structure of the system and provides the students with the idea of how the e-learning may help them in their learning process. Without course and learning objective present, students may simply browse around without any intention to take in the content and learn. They will consider the e-learning system like any other website they are visiting without any significant purpose.

ii) Does not contain learning support activities.

An e-learning should not only contain examination paper set, but must also provide notes and examples to assist the students prior to taking the paper set.

iii) Incomplete learning materials and resources

For school students, it is essential for the e-learning to follow with the syllabus outlined by the MoE before any in-depth resource is developed for the topics. The international e-learning system concerns with this issue. Being international website, the syllabus for mathematics subject clearly does not

University of Malaya

based on the syllabus outlined by the MoE in Malaysia. However, based on observation, the e-learning systems in Malaysia do not provide complete learning materials because they are often combined with other subjects as well.

iv) Does not provide a guidance for student's learning process

This is almost like the learning objective issue above. Since e-learning focuses on students' one-on-one experience with the system, it is very essential that the system gives an origin point and guide students on how to proceed with their learning activities. Students still have the freedom to choose what to learn and the speed of their progress, but this does not mean that the e-learning system should not provide some guidance to show students what they can benefit and how to gain them from the system.

v) Incurred fees

Many of the e-learning system require the students' to pay in order to use the system to the fullest. Bear in mind that payment online often requires credit card. This would prove an inconvenience to them since students rarely own one. Even if they have allowance, educational fees could still be a burden to them.

Table 2.2 shows the summary evaluation of these five existing systems.

University of Malaya

Table 2.2
Evaluation of existing systems

Website/Issues	Portal Pendidikan Bestari	Score A Programme	Online Learning @ Maxis	MathForum.com	MathisFun.com
A) Rich-Learning Environment					
1. Content design	Not available	Available	Not available	Available	Available
2. Learning support activities	Extensively available but does not specific to mathematics only	Available	Not available	Extensively available	Available
3. Learning materials and resources	Incomplete; however in examination papers provide links to resources	Complete; focus on examination papers but provide links to resources	Incomplete; providing notes but no assessment questions	Complete and provide in-depth resources on mathematics topics	Focus on basic mathematics skill
4. Web resources	None	Limited	None	Extensive list	None
B) Spectrum of interaction					
1. Interaction with course content	Good; provide search-in-site and site map	Good; provide search-in-site and site map	Poor; it is a book-turn-website interaction.	Good; provide search-in-site and site map	Good; provide search-in-site and site map
2. Discussion board	Available	None	None	Available	None
C) Presentation environment					
1. User experience and training	Good; maintain consistency, basic user experience and training needed	Good; provide overall map of the system, basic user experience and training needed	Poor; little help provided, user might get lost within the system	Good; maintain consistency, basic user experience and training needed	Good; maintain consistency, basic user experience and training needed
2. Information presentation	Poor; learning notes and explanation is not easy to find	Good; provide origin point for guidance to student's learning process	Very poor; notes is divided into months instead of topics makes it hard to choose.	Good; provide resources for all level of user. Notes can be determined based on education level.	Good; provide origin point for guidance to student's learning process
3. Ensuring quality	Frequently updated	Frequently updated	No update assurance	Frequently updated	Frequently updated
D) Cost requirement					
Fees	Require fees	Require fees	Free	Free; but provide paid package	Free

University of Malaya

2.6 STUDY COMPANION CONCEPT

An e-learning with the study companion approach will not replace the role of the teacher entirely. Malaysia is still in the beginning level of computer usage in the educational system. E-learning should not replace the teacher's role - yet, but it should act as a support and companion towards the learning process. Students will have other ways besides the textbooks to turn to for revision and help with homework.

In the traditional instruction, several researches indicate that competition can lead to negative attitudes and affective responses (Lancaster 1988; Brown et al 1989). This kind of competition may exist in classroom in the form of peer-pressure between students. Van Eck (2006) stated that, 'those who are not good at content, or who cannot beat other players with faster reaction times may consistently 'lose', leading to disaffection'. Using that concept in classroom environment, when the students are not sorted by their performance level, there will be a few star students who are constantly at the top of their class and this will increase the peer-pressure on the less excellent students. This would affect their motivation level and lead to negative attitudes. This type of competition can result in confounding emotional responses such as refusing to revise or study and accept the fact that they cannot do well in studies.

On the other hand, on the perspective of the star students, competition does promote motivation, performance, and learning, but it is enough for them to perform at less than their maximum level due to noncompetitive conditions (Van Eck 2006). Thus, competition is less likely to produce large improvement (Thompson 1972) and this would mislead these students in the long run. Imagine when they are accepted to a higher

University of Malaya

education institution where everyone is as excellent as they are. Their habit of putting little effort in studying might not work this time and they would be left behind because of changes in the competition environment.

For competition to work, it has to be in a situation where the students are expected to an 'uncertain outcome' but not so much that they begin to doubt their ability to accomplish (Malone 1981). In other words, to avoid competitive environment which can invoke negative attitudes, students would gain more benefit by competing with their own self. This is where a study companion concept plays a role in ESCA-Math.

2.7 JUSTIFICATION FOR A STUDY COMPANION SYSTEM

Well-designed e-learning system can provide learning opportunities for students, both at school and at home. Students who use appropriate tutorials, especially when completing homework assignments, have higher achievement than those who use traditional methods only (Sasser 1991). Research shows that an e-learning system developed using the study companion approach may benefit the students based on the following statement;

2.7.1 Assisting in Implementing Self-Assessment

Self-assessment refers to performance establishment (Shaharom 2003), which is done by the students themselves. This type of assessment benefits the students as well as the teachers by being,

- Student-friendly as it reduces the learning stress where the student can continuously track their progress before the Sijil Pelajaran Malaysia (SPM) examination at the end of Form 5. But having the ability to

University of Malaya

constantly track their progress will ease their anxiety about the outcomes possibility and their readiness for the exam.

- Flexible (Shaharom 2003), where students are able to go back to whatever weak topics they have for further revision. A later assessment would ensure them that they had managed to grasp the concept on that topic.
- Immediate with feedback as online self-assessment saves a lot of time and the student would be able to get a quick feedback on their performance for further appropriate action.

E-learning enables self-assessment to be implemented efficiently. The students are free to choose the time, content, and direction of their learning (Iverson 2005). They may also choose to repeat certain difficult topic as many times as they like until they are satisfied that they have mastered the concept. A well-developed e-learning system will be able to keep their progress and track them for a more efficient learning and to produce systematic report for the students' future reference.

2.7.2 Wide range of diversity and performance level of students

Every teacher would at least had face this kind of situation at one point; while some students have already solved the given mathematical problem and are asking for further challenges, others have not even taken up their pencil. Some students are trying to solve new mathematical problems with enthusiasm and creativity, others cannot even start working and do not even have any confidence in their own capabilities. This kind of diversity affects the smoothness of teaching process

University of Malaya

and will require longer time to address the whole class (Prediger 2005). E-learning using the study companion approach which supports students learning process is able to cater for these diversities and learning abilities.

2.7.3 More active learning environment

E-Learning empowers its learners by means of enabling a more active learning environment. A concept of constructivism stated that it is a learning theory approach which relates to those of cognitive psychology where it focuses on students ability to develop meaning and establish their learning system (Burns et al 1998). Thus, constructivism is very appropriate to be linked with e-learning since it encourages students-oriented approach of teaching and learning (Faisal et al 2002). In other words, it encourages an active learning environment. Furthermore, a view from constructivism body of opinions had noted that the learning process can be improved when the students are actively involved and there are sufficient equipments and environment provided to them (Yusuf 2000). This concept had been mentioned in the KBSM document where it is one of the visions of the educational system to shift the learning process from students *receiving information* to them *looking* for relevant information.

2.7.4 Feedback

One of the most important features of emerging technology is the capability for interactivity and opportunity for feedback. There is much research on the varied amounts of support (Hannafin & Scott 1998), interactivity, feedback, pacing and individualization, which may significantly improve achievement. Feedback is

University of Malaya

particularly important for enhancing achievement especially in terms of immediacy, amount of information provided, and the type of task involved.

2.7.5 Improving Quality of Interaction

By relieving the teacher from keeping a progress record of each and every of their students, it will provide them with more time in class for other social activities. One of the major challenges in mathematics classroom is the diversity of students' capability (Prediger 2005). It is important to realize that students do not only vary in their pace of work and their proficiency level but in many dimensions, for instance, their prior experiences, conceptions, motivations and strategies (Iverson et al 2005). And this should not be seen as a difficulty, but instead as a chance for a more quality classroom interaction. One important condition to be considered is to break away from deficit oriented consideration of students ability (by asking, 'Who is still not be able to do…?) in favor of competence oriented considerations (by asking, 'What are they *able* to do…?)

2.7.6 Ensure Privacy and Peer-pressure Free Environment

Slow and shy learners would always be hesitant to answer questions in class for fear that their peers would ridicule them should they answer wrongly or even to put up their hand to ask for fear to be thought as dense or backward. However, computers can provide privacy to these students. It does not matter how long they took to answer questions or how many times they need to revise any topic, it will not judge them with any remarks. So, an e-learning using the study companion is

University of Malaya

crucial in helping them develop their skills and gain knowledge (Gyöngyösi 2002).

2.7.7 Providing a Student-oriented Learning Environment

In conventional classroom, it would take quite an effort for a teacher to set a close attention on an average of 30 students per class. Teachers are overburdened with many curricular activities and they are also pressured to finish the syllabus by the end of the year. Once they had finished the syllabus for a certain topic, they will proceed to the next topic. According to Cobb et al (1992) mathematics teaching in the classroom should provide sufficient time for critical thought and the connection with everyday life. By allowing the user to proceed with the learning process in their pace, e-learning provides a student-oriented learning environment.

2.8 DEVELOPING ISSUES FOR ESCA-MATH

Better technology does not equate to better learning (Iverson et al 2005). Online developers should not assume that students will learn better from technology-based delivery system. Rather, they should focus on instructional design strategies, regardless of the medium they choose. Below are the best practices that have been discovered for developing ESCA-Math prototype and they are separated by different issues as follows:

2.8.1 Targeted User's Age Group

The scope of this research is to develop an e-learning prototype for students in Form 4 and Form 5, which is between 16 to 17 years old. This age group is chosen because of these reasons below,

University of Malaya

- The students are in their last two years of school. At this age, being near to the end of teenagers' period of life, the students are more responsible and mature about their learning. They know how costly it is to not succeed in SPM.

- At the end of Form 5, the students will face the most crucial examination of schools education. Their result will determine their position whether they are acceptable to advance in any higher education institution. Not only that, most job applications required applicants to at least have an SPM certificate. So succeeding in this examination proved to be the turning point of their life.

- In addition to all the above reason, schools give them a priority in using computer laboratories over other lower age group.

- **Table 2.3** shows the percentage of distribution of household users of the Internet by age group in an Internet Survey in 2005.

University of Malaya

Table 2.3
Distribution of Household Users of the Internet by Age Category

Age Group	Percentage
Below 15 years old	6.5
15- 19	**18.6**
20-24	17.2
25-29	12.5
30-34	12.2
35-39	9.9
40-44	9.6
45-49	5.1
Above 50	8.4

Source: Asirvatham et al (2005)

From the table above, it shows that users within 15 to 19 years old are the top user of the Internet which is 18.6 per cent. Admittedly, these young adult might be using the Internet for e-mail, visiting chat rooms and online-gaming, but it just gives more reason to provide them something that is beneficial to their learning process. At least, they would not be intimidated with using computers for the first time when they advance their education in higher institution. Furthermore, by fulfilling their time spent using ESCA-Math; it would decrease their Internet usage in other less beneficial purpose.

2.8.2 Targeted User's Requirement

Below are the best practices in developing ESCA-Math prototype for the targeted user's requirement.

University of Malaya

2.8.2.1 Tracking Progress Record

As a student learns, ESCA-Math will continually evaluate his/her progress. Every time the student logs-in to ESCA-Math, it will show a progress chart with weak and strong topics and recommending the direction of learning. Along with these, it will also encourage the students with words of wisdom and phrases of motivation. This would reduce their level of mathematics anxiety and relieve the teachers off some burden to remember each and every progress of their students. And this is also how ESCA-Math helps the students to revise their own learning pace.

2.8.2.2 Facility Requirement

By developing ESCA-Math prototype, it would mean that not only will the students be required to have a computer but also Internet connection with them. In the recent report of the Ninth Malaysia Plan, it was stated that an approximate 96 per cent of schools have already been connected to broadband and RM2.1 billion has been allocated to further increase the quality of education in schools (Utusan Malaysia 2006).

Apart from that, a survey on the household use of Internet, shows that users spent 46.8 per cent of the Internet activity on educations and research purposes (*see* **Table 2.4**) and 36.5 per cent of them are students (*see* **Table 2.5**). This shows that the Malaysian society are in the comfortable zone of Internet usage and what is probably keeping the students from using it to a more educational purpose is the lack of well-developed learning system.

University of Malaya

Table 2.4
Distribution of Household Users of the Internet by Activity

Activity	Percentage
E-mail	73.7
Educations/research activities	**46.8**
Finding information about goods and services	40.5
Chat rooms	25.9
Reading/downloading online newspapers/news/magazines	20.2
Playing/downloading games, software, music	19.9
Getting information from/interacting with government	12.7
Online banking/financial services	12.2
Other entertainment/pleasure	7.0
Purchasing/ordering goods or services	2.4
Others	1.3

Source: Asirvatham et al (2005)

Table 2.5
Distribution of Household Users of the Internet by Employment Status

Employment Status	Percentage
Employer	5.0
Employed	37.7
Self Employed	8.8
Unemployed	12.0
Student	**36.5**

Source: Asirvatham et al (2005)

2.9 JUSTIFICATION ON MATHEMATICS AS THE CHOSEN SUBJECT

Upper secondary school students (Form 4 and Form 5) are required to take six compulsory subjects with at least another two of elective subjects where they will be tested at the end of their Form 5 year in SPM. Out of all of the elective and compulsory

University of Malaya

subjects, Mathematics has been chosen for this e-learning research and below is the reasons why.

2.9.1 Benefits to the Largest Group of Students

Educational system enables upper secondary students to choose whatever subjects they wish to register provided they include six of the compulsory subjects in the list. One of these subjects is Mathematics.

An analysis from the Ninth Malaysia Plan reveals that the numbers of students' enrolment to the upper secondary level had increased from 707, 835 in 2000 to 763, 618 in 2005 and this number will keep increasing by the year 2010, which is forecast to be 881, 247. By choosing a subject from one of the compulsory category, that would mean that it can benefit up to that large number of participation which is larger compared to any elective subjects.

2.9.2 Mathematics Anxiety

According to Lampert (1990), many students appear to hold a lot of naïve and incorrect beliefs about Mathematics. If this happen, it would jeopardize the whole idea of learning mathematics and eventually will create slackness in the midst of preparing people in the era of information technology. This kind of phobia is called 'Mathematics Anxiety' or 'Math Anxiety'.

University of Malaya

Mathematics anxiety can be defined as an "irrational dread of mathematics that interferes with manipulating numbers and solving mathematical problems within a variety of everyday life and academic situations" (Buckley & Ribordy 1982).

There are many reasons contributing this attitude such as the following:

1. Negative predisposition may result if a child's parents have a negative attitude toward or limited experience with mathematics. Lower socio-economic status may mean that the family has not had sufficient exposure to the kind of education and experience that would more likely promote a positive feeling about math.

2. A statistical study (Lazim et al 2004) on students' belief about mathematics shows that teachers play a big part on students' interest in the subject. The study concluded that if the mathematics teacher is not showing his/her equal interest in teaching, the students would not likely to be interested in mathematics as well. This issue intensified since the transformation of teaching and learning mathematics and science in English. This was stated by Marzita (2003) that teachers, who do not demonstrate confidence when teaching mathematics due to their own English imperfection, may cost their students interest on the subject along.

This is also supported by Perry (2004) where students can immediately recall any 'horror previous experience of a single insensitive mathematics teacher

University of Malaya

that can create a recurring anxiety problem which may be difficult to overcome'.

3. Teaching techniques in some schools have the punishment for misbehavior or assigning activity in detention class with mathematics problems. It gives an impression to the students that if they want to be averted from answering mathematics problems, all they have to do is to behave themselves. Equating mathematics problems with punishment is not a good way to decrease mathematics anxiety in students. Calling out students to answer questions is a poor way of reducing the dreaded feeling of mathematics class either. Since mathematical problems usually have one outcome, obviously there is only one acceptable answer even if there are many ways to solve it.

These type of information need to be made known to the students, so they may realize that their fear towards mathematics probably had nothing to do with their ability in succeeding in the subject but was influenced by many outside factors. One way to spread is by including it in ESCA-Math prototype for it to reach many students. Students must overcome any fears of mathematics and be challenged to take higher level of mathematics courses; otherwise, their career choices may be affected.

2.9.3 Test Anxiety

Furthermore, mathematics anxiety is said to be connected with test anxiety (Anton & Klisch 1995). Sarason (1987) stated that mathematics anxiety, like test anxiety,

University of Malaya

may be driven by cognitive concerns about performance and emotional reactions to stress. Test anxiety can be caused by other factors like poor test preparations and test-taking strategies, psychological pressures, and poor health habits (such as sleeping late the night before the test and unhealthy diet). Whatever the reasons may be, they will only heighten the justification of choosing mathematics. By having a learning support such as ESCA-Math, students can prepare themselves for tests and reduce their test anxiety level. It would then increased their confidence level when they achieve good results and later further reduce their mathematics anxiety level along the way.

2.10 SUMMARY

The literature review process provides a lot of valuable information as guidance to carry on with the research. The difference between traditional learning and e-learning shows that, both types of instruction hold advantage over the other. Perhaps, if e-learning is not developed to replace the role of teacher but to provide a learning support, students can gain more benefits out of the two kinds. The investigation shows that both instructions actually complement one another towards a more effective teaching and learning process.

An investigation on the existing e-learning systems shows that there is not many mathematics e-learning system around that are based in Malaysia. Most e-learning systems provide assistance to other subjects as well and there is yet a specific system focusing on assisting secondary students in mathematics subjects. Although there are quiet a number of non-local mathematics online system in the Internet, it may cause

University of Malaya

confusion or ‘information overload’ to the students since the inconsistencies with the syllabus as outlined by the educational system.

Best practices are as much an important findings because e-learning system is not simply turning textbooks to digital versions of textbooks. E-learning system should focus on its strength and that is the rich-learning environment and presentations. All of the best practices in both aspects has been noted and taken into consideration when ESCA-Math prototype is being developed. One of the interesting aspects of practices is the suitability of embedding discussion board into the prototype. In has been decided that discussion board will not be employed in ESCA-Math prototype because of the main objective, which is to provide a learning support. Students will not be cut off from interaction with their teacher at school; hence the disregarding of discussion board as it is not a priority for this system. Furthermore, studies shows that discussion board is not a significant factor in determining student’s academic success unless there is a sufficient quantity of relevant, motivating, and content-related message passing between correspondents. With the amount of homework and other extra-curricular activities for these students, time is not a luxury they have to ensure such quality messages.

E-learning proved to benefit the students in their learning process, but without careful consideration, it may turn fruitless because better technology does not guarantee a better application.

University of Malaya

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter contains an explanation on system development methodology that was used in ESCA-Math prototype to plan, manage, control and evaluate the project. It follows by research design which will examine the information gathering techniques that have been used for the purpose of data collection. Sample and location of respondents described the details of the respondents chosen for this research.

3.2 PROTOTYPE METHODOLOGY

Methodology acts as the backbone that provides guidance on how a system should be developed and the proper activities to be done (Pfleeger 1999). It ensures that a consistent and reproducible approach is used from the first activity of the prototype development process until the prototype is completed. It also helps in reducing the risk of omitting important activities and producing consistent documentation.

The waterfall model and prototyping focus on combining two models namely; the waterfall model and the prototyping model. It is chosen as the system methodology for ESCA-Math prototype because where waterfall model emphasis on one stage to be followed by the completion of the stage before it, the waterfall with prototyping model allows all or part of the system to be constructed quickly in order to identify or understand issues that may arise.

University of Malaya

Prototyping act as a sub process; a prototype is a partially developed product that enables users and developers to examine some aspect of the proposed system and decide if it is suitable or inappropriate for the finished product. **Figure 3.1** illustrates the waterfall model with prototyping.

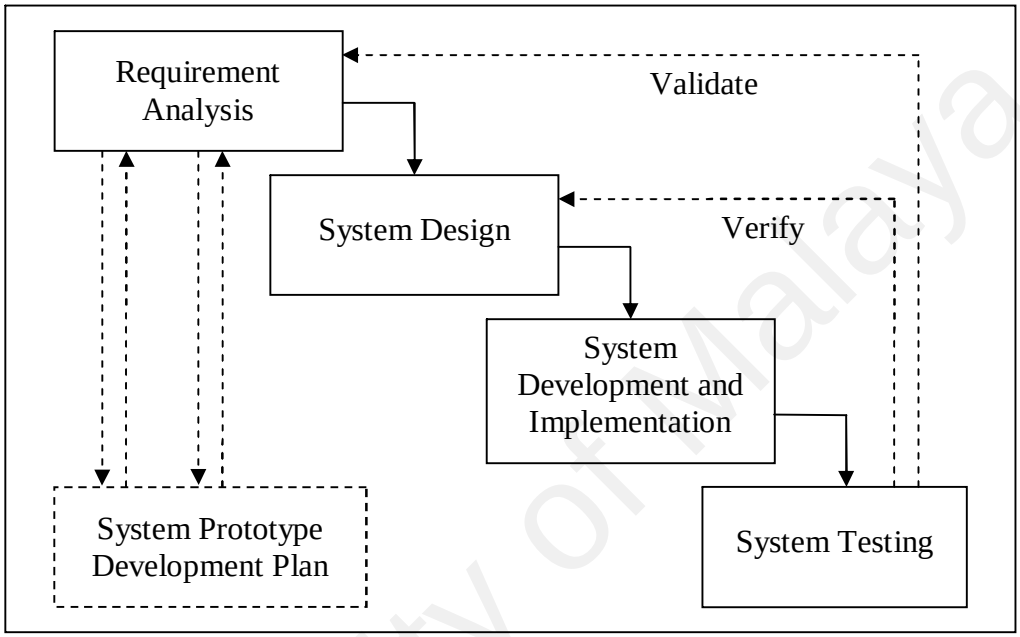


Figure 3.1
The Waterfall Model with Prototyping
Source: Pfleeger (1999)

The addition of prototyping to the waterfall model enhances the understanding level between the user and the developers.

3.3 ESCA-MATH PROTOTYPE MODEL

During the development of this project, the waterfall model with prototyping model is selected since it allows all or parts of the prototype to be constructed quickly to understand or clarify prototype needs. Prototype development generally passes through series of phases or stages.

University of Malaya

Several activities can occur simultaneously and activities may be repeated. It suggests the sequence of events that should be expected to encounter. The objective of using this model is to come out with a complete prototype with all the criteria needed by the user. In order to reach the objective, a prototype on requirement analysis and system design will be made and it will be shown to the user for testing purposes and for getting their feedback. With this feedback, some modification will be made to the prototype in order to fulfil user's need. Other than that, prototype testing will also verify prototype design and validate requirement analysis to make sure that the entire requirement has been fulfil before it is delivered to the user. Each of the stage is discussed below.

University of Malaya

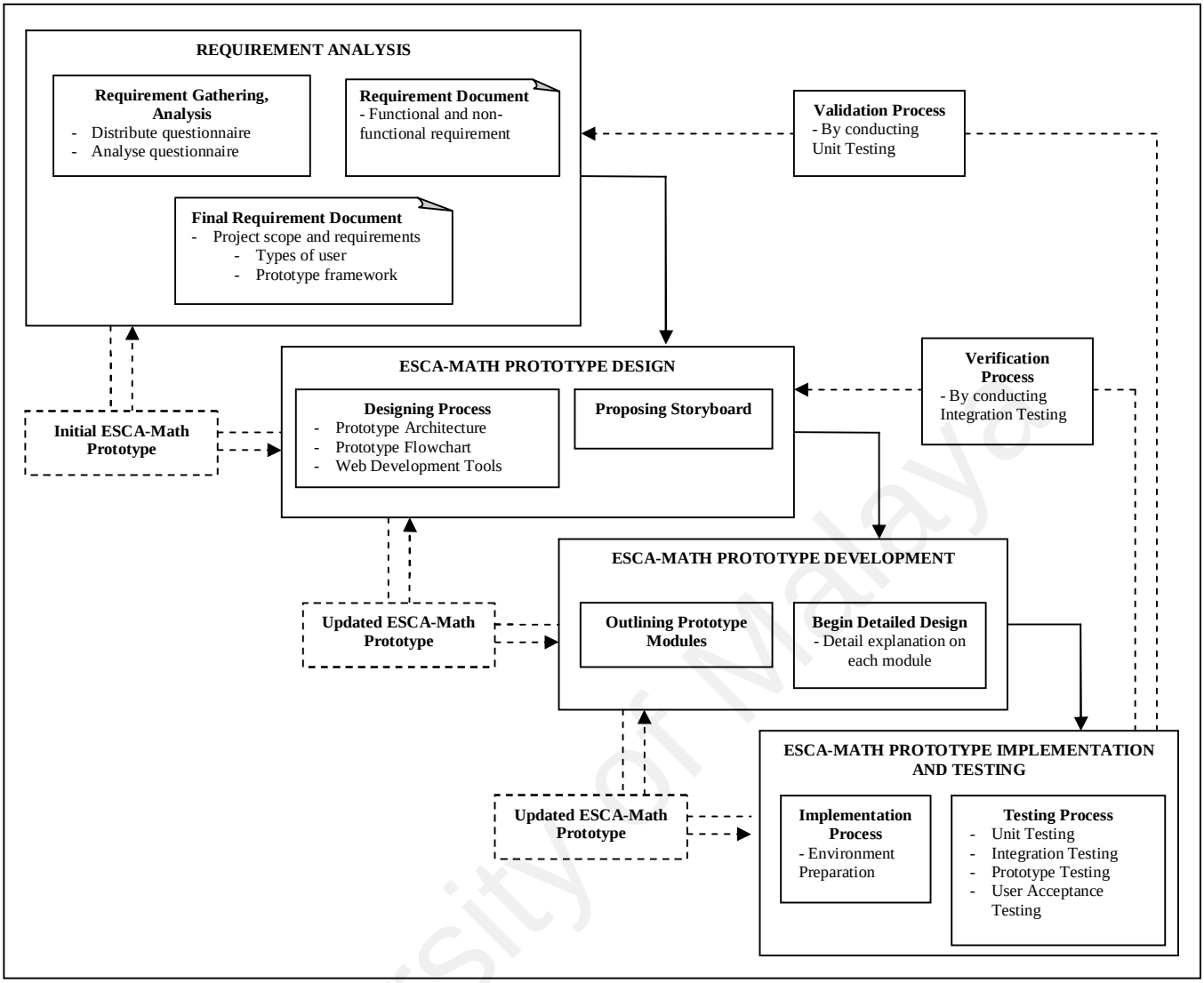


Figure 3.2
ESCA-Math Prototype Model

a) Requirement Analysis

This phase is the most crucial part of this project. In this phase, the following methods are applied:

i. Gathering and analysing user's requirement through the feedback collected from the questionnaire distributed. Conclusion will then be derived from the data and results collected.

ii. Functional and non-functional requirements are defined as part of the requirement document.

University of Malaya

iii. Finally, to complete the requirement document, project scope and requirements are determined. This includes determining types of user and the prototype framework for ESCA-Math.

An initial ESCA-Math prototype is developed based on the information found at this stage and it will be forwarded to the prototype design to further develope it.

b) ESCA-Math Prototype Design

The design phase builds on the knowledge obtained from the analysis phase for which all of the acquired prototype requirements are translated into a 'blueprint' for the software construction. The blueprint depicts a holistic view of the software. Analysis and design is a crucial phase in the entire development cycle. Any glitch in the design phase could be very expensive to solve at the later stage of the software development.

In this phase, the following methods are applied:

i. Designing process – in this section, prototype architecture and prototype flowchart diagram gives an overview of how the prototype works and connected to other peripherals involved and the work flow from start to the end. It will also outline the web development tools used in developing ESCA-Math prototype.

ii. Proposed storyboard – storyboard for all modules of ESCA-Math prototype will be defined.

ESCA-Math prototype is updated with the information gathered in prototype design and it will be forwarded to the prototype development phase.

University of Malaya

c) ESCA-Math Prototype Development

This phase concerns with converting the prototype design into a workable prototype. The methods applied are:

i. Outlining prototype modules – modules for ESCA-Math prototype that will be developed as students' study companion will be outlined in this section.

ii. Detailed design – the main modules such as tracking student's progress and other supporting modules to enhance ESCA-Math as the study companion will be outlined in this section.

ESCA-Math prototype is updated with the information gathered in prototype development and it will be forwarded in the prototype implementation and testing next.

d) ESCA-Math Prototype Implementation and Testing

Testing is the critical step in assuring the quality of the developed prototype. In this phase, the following method is applied:

i. Implementation process – this involves the environment preparation prior to user acceptance testing. It is to setup the ESCA-Math prototype so that it will be ready to be tested by the respondents.

ii. Testing process – this process involves four types of testing namely;

- Unit testing – to verify each prototype module. The testing on the rule package will be particularly difficult as there will be lots of unexpected results produced.

University of Malaya

- Integration testing – to integrate unit-testing program modules and conduct tests that uncover errors or bugs associated with the interfacing of those modules. Validation test succeeds when the prototype functions performed as expected.
- Prototype testing – Prototype testing will evaluate the functional and non-functional requirements listed in the prototype design.
- User acceptance testing – User acceptance testing will be conducted by distributing questionnaire to a group of user who had used ESCA-Math prototype. An analysis of user acceptance testing is evaluated and critical summary is reported based on testing.

3.4 RESEARCH DESIGN

At the core of prototype analysis is the collection of information. Problems, opportunities, constraints and terminology of the information systems that are currently being used are discovered. There are many ways to get this information using the fact-finding techniques. Common methods include reviews on documentation, questionnaires, interviewing, participant-observation, naturalistic enquiry and good old-fashioned research.

For the purpose of this project, qualitative and quantitative research and analysis have been used in order to gather all required information. Qualitative research had been performed to obtain information and news on latest and technologies through:

a) Computer trade journals and citations

b) Latest periodicals and books

University of Malaya

c) Sites through the internet

Quantitative research is gathered through requirement analysis and it is a process where raw data is collected to be analyzed. The objective of this phase is to further understand the current situation of the study companion system in the educational system and to further define the detailed prototype requirement that must be fulfilled in order to develop a workable design that relates to users and information system.

Quantitative research had been performed through:

a) Questionnaire

b) Research on the Frequently Internet-accessed Location

3.4.1 Computer trade journals and citations

Computer trade journals and citations provide information on previous researches especially on how others have solved similar problems. Most white papers or publications of the journals and citations which are related to this project are obtained from IEEE Xplore, ACM and CITESEER websites.

IEEE Xplore is one of the most popular online delivery system that provides full text access to the world's highest quality technical literature in electrical engineering, computer science and electronics. IEEE Xplore contains full text documents from IEEE journals, transactions, magazines, letters, conference proceedings, standards and IEE (Institution of Electrical Engineers) publications. Users are permitted to view, download, and print content found in IEEE Xplore for personal use. To access IEEE Xplore, users must use the

University of Malaya

IEEE Xplore URL which includes the IEEE domain name *http://www.ieee.org/ieeexplore* or *http://www.ieeexplore.ieee.org/*.

Other source for the journals and citations can be found in the portal of ACM. The fundamental components of the ACM Portal are an enhanced version of the ACM Digital Library plus an extended bibliographic database, consisting initially of more than a quarter-million citations of core works in computing. These works are of all types such as journals, proceedings, books, technical reports, theses and they are from all the major publishers in the discipline. The ACM Portal thus provides an Online Guide to Computing Literature and a "reading room" for ACM's own literature in the ACM Digital Library.

Meanwhile, there are scientific literature digital library and search engine that focuses primarily on the literature in computer and information science, which are called Citeseer.IST (Scientific Literature Digital Library). Rather than creating just another digital library, CiteSeer provides algorithms, metadata, services, techniques and software that can be used in other digital libraries. CiteSeer indexes PostScript and PDF research articles on the Web. CiteSeer is capable to show the context of citations to a given paper, allows to quickly and easily seeing on what other researchers have to say about an article of interest.

University of Malaya

3.4.2 Latest periodicals and books

To get an in-depth understanding on the prototype engineering and prototype maintenance itself, developer must refer to the latest periodicals and books. All relevant materials can be found in the University Malaya's Library. To get more information about the library, they are suggested to browse the given url: *www.umlib.um.edu.my*. A lot of readings have been performed on the theory of prototype engineering by much emphasis given on the theoretical aspects of development process and maintenance tools as well as the theory and the example of possible scenarios available.

3.4.3 Sites through the internet

Some extensive researches on areas relevant to the ESCA-Math prototype project have been done by attending to the online tutorials or guided tour found on web sites that serves as well known search engines for example Yahoo.com, Google.com and Altavista.com.

3.4.4 Questionnaire

This method is use to gather statistical value from a large number of respondents. An approximate 200 students from 3 schools have been picked as respondents from the sampling technique cited in **Section 3.5** below. The questionnaire (*see* **Appendix B**) is set out to cover several issues concerning the prototype development process. To ensure smoothness in answering, the questionnaire is organized into 4 parts and they are as the following:

1. Demographic Data – the objective of this section is to gather some background information of the respondents.

University of Malaya

2. Internet Experiences – the objective of this section is to gather some insight on student's experience with Internet.
3. E-learning Experience – the objective of this section is to gather some insight on student's experience with using the e- learning.
4. Personal opinion on e-learning – the objective of this section is to gather some insight pertaining to student's mindset on e-learning, student's judgement on facility and equipment to access the Internet, student's impression from past experience of e-learning, student's perception between the traditional learning and e-learning and their insight on mathematics subject.

3.4.5 Research on the Frequently Internet-accessed Location

Location research was conducted in all of the school involved in the analysis. The result in **Graph 4.6** (*see* **Section 4.2.2.1**) above showed that students most frequently accessed Internet at their school computer's laboratory. Thus, it is crucial to investigate the condition of these computers, especially when determining the minimum requirement for the proposed system.

University of Malaya

3.5 SAMPLE AND LOCATION OF RESPONDENTS

The targeted users of the proposed system are Form 4 and Form 5 students. There are 35 schools (*see* **Appendix C**) with this educational level within the scope of research defined in Chapter 1 which is focusing in Muar, Johor.

Muar, Johor is randomly selected as the location for the survey because of the following reasons;

- ESCA-Math is aimed to be used by students all over Malaysia. It is important to pick a location that is neither a metropolitan city nor a small rural area town. By picking either location, it will produce a biased result such as lifestyle, culture and mindset aspect based on where these students stay.
- Muar is currently a city status with a population of 330, 334 and 35 secondary schools and it is seen as the suitable location for this survey.
- The schools encompass three types which are fully residential schools, daily urban-area schools and daily rural-area schools. One school from each category will be picked randomly to become the respondents to increase the result credibility.

This research uses the stratified sampling technique where the population of respondents is further divided into particular groups called strata. One of the questionnaire concerns is the availability of Internet and the mindset of students. This factor can be summarized as demographic difference among possible respondents. Thus, all of the schools have been separated into three groups which are, 'urban-area' daily schools, 'rural-area' daily schools and fully residential schools. One from each

University of Malaya

group will be picked out randomly as the targeted respondents and they will represent the other schools in their category. The schools that has been picked are as follows,

Table 3.1: Three Secondary Schools Picked To Be Participated in Questionnaire

No.	School's Name	School's Type
1	Sek Men. Sains Muar, Johor (SAMURA)	Fully residential school
2	Sek Men. Dato' Sri Amar Diraja, Muar, Johor.(SEDAR)	'Urban-area' daily school
3	Sek. Men. Parit Bunga, Muar, Johor.(SMKPB)	'Rural-area' daily school

3.6 SUMMARY

A prototype development methodology is a very formal and precise prototype development process that defines a set of activities, methods and deliverables to develop a required prototype. Relevant methodology assists in planning, managing, controlling and evaluating the needed information for the project.

Waterfall model with prototype has been chosen to develop ESCA-Math prototype. Research design defined the various researches and analysis methods to collect data and it is divided into qualitative and quantitative research and analysis.

University of Malaya

CHAPTER 4

REQUIREMENT ANALYSIS AND PROTOTYPE DESIGN

4.1 INTRODUCTION

ESCA-Math prototype is developed through the waterfall model with prototyping as elaborated in Chapter 3. The requirement analysis concerns with the finding in quantitative analysis and this project had undergone the following methods:

i. Questionnaire

ii. Research on the Frequently Internet-accessed Location

In prototype design phase, the overall design analysis of the ESCA-Math will be laid out. It includes the project scope and requirements, prototype architecture, prototype flowchart, web development tools and the proposed storyboard.

4.2 QUESTIONNAIRE

This method is use to gather statistical value from a large number of respondents. An approximate 200 students from 3 schools have been picked as respondents from the sampling technique cited above. The questionnaire (*see* **Appendix B**) is set out to cover several issues concerning the prototype development process. To ensure smoothness in answering, the questionnaire is organized into 4 parts and they are as the following:

1. Demographic Data
2. Internet Experiences
3. E-learning Experience

University of Malaya

4. Personal opinion on e-learning

The analysis of the feedback by respondents was done based on each of the categories above. The results are discussed as follows:

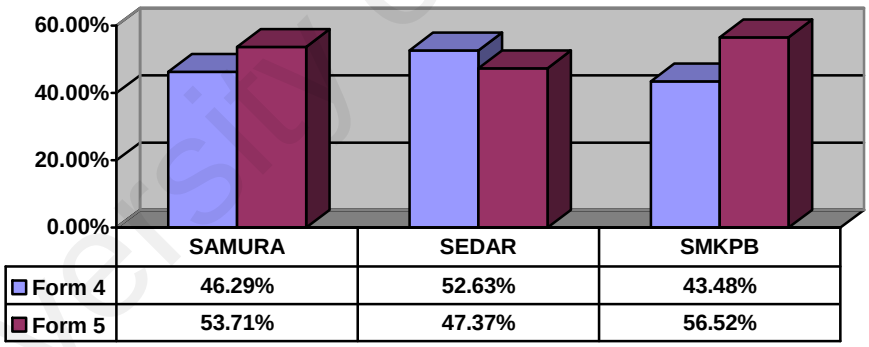
1. Results and analysis of these results.
2. Discussion from the analysis.

4.2.1 Demographic Data

This part is to enable some background information to be gathered.

4.2.1.1 Results and Data Analysis

Below are the result and analysis for demographic data.

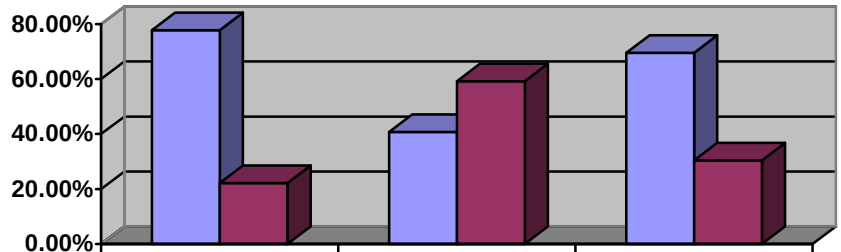


	SAMURA	SEDAR	SMKPB
Form 4	46.29%	52.63%	43.48%
Form 5	53.71%	47.37%	56.52%

Graph 4.1
Percentage of Respondent by Education Level

Graph 4.1 shows the percentage of respondents separated by their education level. From the graphs, it can be seen that all three schools have participated evenly from each educational level, which is Form 4 or Form 5. From this graph, an overall 47.46% of the participants are Form 4 while the other 52.54% are Form 5.

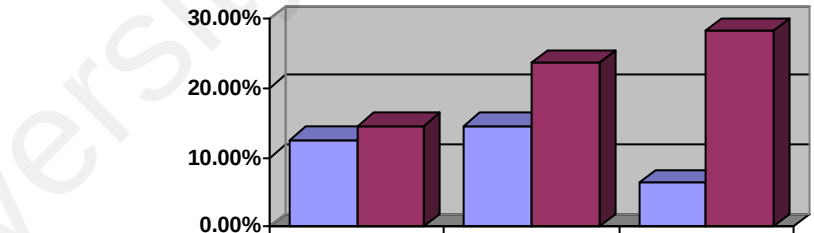
University of Malaya



	SAMURA	SEDAR	SMKPB
Girls	77.78%	40.79%	69.57%
Boys	22.22%	59.21%	30.43%

Graph 4.2
Percentage of Respondents by Genders

Graph 4.2 shows the percentage of students between different schools separated by genders. From the graph, an average of all schools shows 62.71% of participant as girls while the other 37.29% are boys.



	SAMURA	SEDAR	SMKPB
Has Internet at home	12.56%	14.57%	6.53%
No Internet at home	14.57%	23.62%	28.14%

Graph 4.3
Percentage of Internet Availability of Respondents At Home

Graph 4.3 shows the percentage of Internet availability of these students at home. A distinctive pattern can be seen among these schools. SAMURA students show a well-balance between those who have Internet at home (12.56%) and those who do not (14.57%). SEDAR students shows a

University of Malaya

slightly less percentage for those who have Internet at home (14.57%) compared to those who do not (23.62%). SMKPB students show a rather large difference between those who have Internet at home (6.53%) and those who do not (28.14%). From this graph, a total of 33.67% of these respondents have Internet installed at their home.

4.2.1.2 Discussion

When the survey was taken, the top class is picked from Form 4 and 5 classes in each school to ensure the quality of answers given. The gender difference between respondents is resulted by the boys and girls ratio in each class. Since there is rarely a 1:1 ratio of boys and girls in one class (especially in fully residential school where girls are more successful than boys, thus had caused a larger quota of enrolment to be filled by girls), boys are fewer than girls in top classes. However, what is important is the level of mindset of these students and more often than always, students in top classes have a better view of the current on-goings than others. This means, gender difference should not affect the results of the survey.

The second graph concerns with the Internet penetration in the household of these respondents. From the graph, it can be seen that one third of them has Internet installed. Apart from showing that at least one third of respondents have the flexibility of Internet to use at home, it also means that the other two third of them have to use it elsewhere and one of the option is at their school. This weighs up the importance of careful consideration when deciding the minimum requirement for ESCA-Math

University of Malaya

prototype to run smoothly. This will be investigated in **Section 4.3**. One of the factors is the specification of the computers provided in school. Another aspect concerns with the choice between personalized account and using cookies. Seeing as how most students have to use shared computers, personalized account will ensure the privacy the students need when using ESCA-Math.

Other than that, the graph also shows that there are, even in a small percentage, of students with Internet installed at their home that lives in the rural area. This provides an insight that people in this area are beginning to realize the importance of Internet and how it can benefit them. This is without a doubt a good sign.

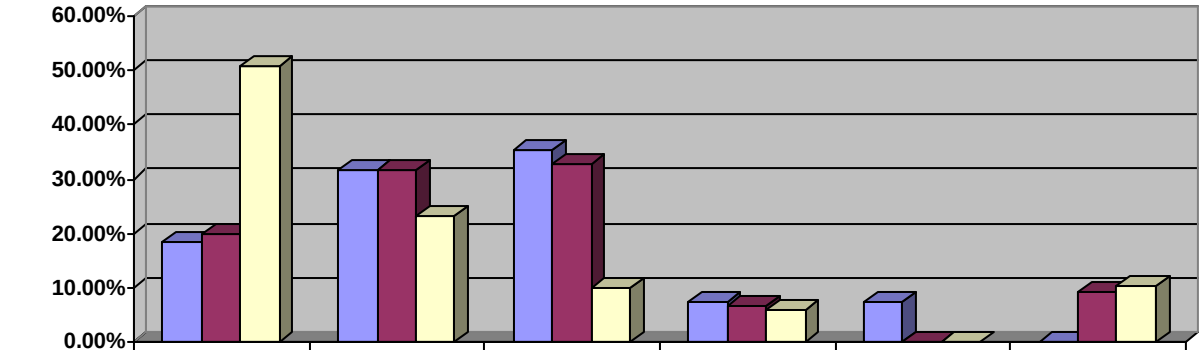
4.2.2 Internet Experiences

This part is to gather some insight on students' experience with Internet. Seven questions are set out in this part with one of them, a linked-question to a 'yes-no' question (*see* **Appendix B**, *question 1.7*). All of the graphs that had been drawn from this part are as follows:

4.2.2.1 Results and Data Analysis

Below are the result and analysis for participants' Internet experiences.

University of Malaya



	1 - 2 years	3 - 4 years	5 - 6 years	7 - 8 years	> 8 years	Never before
SAMURA	18.50%	31.50%	35.20%	7.40%	7.40%	0.00%
SEDAR	19.70%	31.60%	32.90%	6.60%	0.00%	9.21%
SMKPB	50.70%	23.20%	10.10%	5.80%	0.00%	10.15%

Graph 4.4
Internet Usage among Students

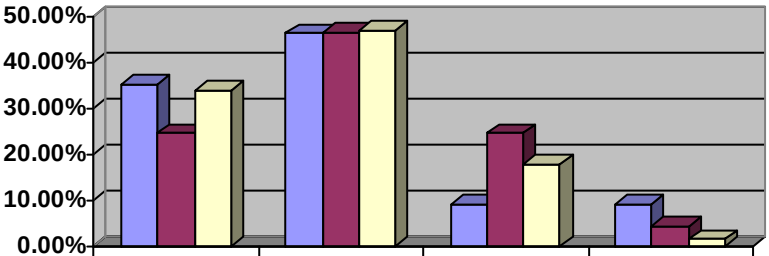
Graph 4.4 shows the percentage of students who have used the Internet before and how long they have been an Internet user. From the graph, a distinctive pattern can be seen where the students from fully residential school (with a cumulative count from 1 to 6 years of 85.2%) and daily urban area school (with a cumulative count from 1 to 6 years of 84.2%) had been using the Internet mostly for up to 6 years while the students from daily rural area school had only been using it most for 1 to 2 years ago, which is 50.7%. This could be contributed by the government initiatives to install Internet in all schools including in the rural area for the past five years (during Eighth Malaysia Plan – RMK-8). The integration of converting all schools to Smart School might also play a big part here. During the Ninth Malaysia Plan (RMK-9) speech on Ministry of Education allocation budget by the Minister of Education, YB Dato' Sri Hishammuddin Tun Hussein stated that as of 15 April 2006, 9320 schools all over Malaysia have been provided with computers and connected with the Internet.

University of Malaya

The graph also shows a higher percentage among the rural area students who had never used Internet before than the other two schools, although it is not an alarming rate as the number is quite small which is 10.1% (SMKPB) and an average of 7.1% from all students. Among the reasons are; 'no skills required to use it', 'no sufficient facility' and 'high cost'. Malaysia is flourishing and since the introduction of broadband Internet connection, it has increasingly become a necessity as opposed to a luxury years ago. These students who had never used Internet before, if they are selected to further their studies, they are likely to be a user sooner or later.

Apart from that, it is also worth to note that the there are students from the fully residential school who had been using the Internet for more than 8 years which is equivalent to 7.4%. This fully residential school enrolled students from all over the country and these students could probably come from big cities (such as the capital Kuala Lumpur or Johor Bahru) or from professional-career parents where the Internet is crucial at home.

University of Malaya

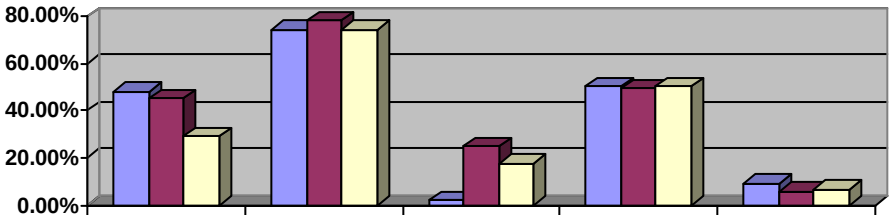


	< 1 hour	1 - 5 hours	5 - 10 hours	> 10 hours
SAMURA	35.20%	46.30%	9.30%	9.30%
SEDAR	24.60%	46.40%	24.60%	4.30%
SMKPB	33.90%	46.80%	17.70%	1.60%

Graph 4.5
Internet Usage among Students in a Week

The above graph shows the amount of time these students spent on the Internet in a week. From the graph, a pattern can be seen where most students used the Internet for around 1 to 5 hours per week. This could be contributed by their other extra curricular activities apart from getting ready for the most critical examination in school life, SPM. Some of these activities assist them in the preparation, such as tuition classes and homework, while others are not so, such as sports, swimming classes, martial arts training (just to mention a few) but still as much important. Either way, it is a good sign anyhow, that they do allocate some time to go online.

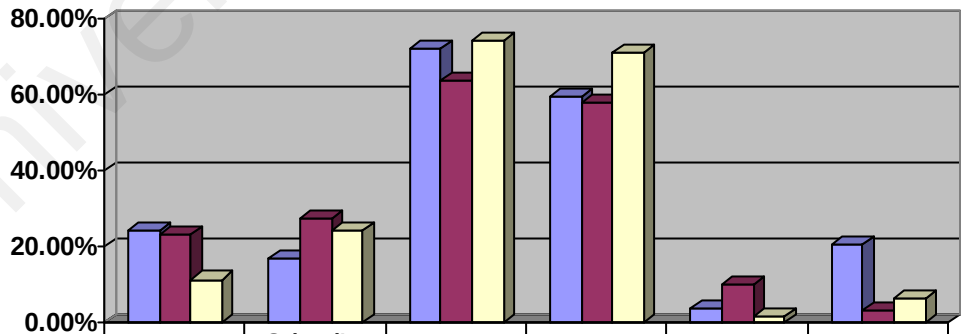
University of Malaya



	Home	School's Comp. Lab	Friend's House	Cyber Café	Others
SAMURA	48.10%	74.10%	1.90%	50.00%	9.30%
SEDAR	44.90%	78.30%	24.60%	49.30%	5.80%
SMKPB	29.00%	74.20%	17.70%	50.00%	6.50%

Graph 4.6
Places from Where the Students Are Accessing the Internet

The above graph shows the places where these students are accessing the Internet. From the graph, it can be seen that the school's computer lab earns the highest rate which is 74.59% on the average. Cyber café is the second mostly used with an average of 49.73%. This showed the effort of the students to go online since cyber café is not a free facility. 'Others' includes parents' workplace, immediate family's house and public library.

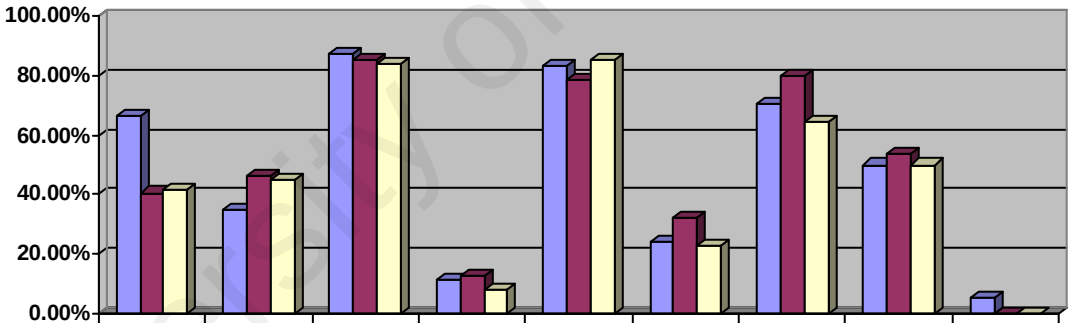


	Parents	School's comp. courses	Friends	Self-taught	Outside agency's	Others
SAMURA	24.10%	16.70%	72.20%	59.30%	3.70%	20.40%
SEDAR	23.20%	27.50%	63.80%	58.00%	10.10%	2.90%
SMKPB	11.30%	24.20%	74.20%	71.00%	1.60%	6.50%

Graph 4.7
Sources from Where the Students Learnt How to Use the Internet

University of Malaya

Graph 4.7 shows the sources from where the students learnt how to use the Internet. 'Friends' and 'Self-taught' received the highest percentage, with an average of 70.1% and 62.7% respectively. This is a very good sign because it shows that the students are quite ready in terms of mindset where they are willing to take the effort to acquire the skills themselves or asked from friends. It is also worth to note that there are parents who taught their children to use the Internet, with an average of 19.5%. This shows the openness of these parents to provide the skills to their children so that they are being kept abreast with the technology. 'Others', which consist of 9.9%, includes the student's older siblings.



	E-mail	Chatting	Online Learning	Online Forums	Educa-tional	Online Gaming	Enter-tainment	General Infor-mation	Others
SAMURA	66.70%	35.20%	87.00%	11.10%	83.30%	24.10%	70.40%	50.00%	5.6%
SEDAR	40.60%	46.40%	85.50%	13.00%	78.30%	31.90%	79.70%	53.60%	0.0%
SMKPB	41.90%	45.20%	83.90%	8.10%	85.50%	22.60%	64.50%	50.00%	0.0%

Graph 4.8
Purposes of Internet Usage

The above graph shows the percentage of purposes of Internet usage among students. From the graph, it can be seen that students mostly used the Internet for educational and entertainment purposes, with an average of 82.4% and 71.5% respectively. E-mail received quite a large vote as well,

University of Malaya

with an average of 49.7%. Relating back to the Internet Survey which was mentioned in Chapter 2 *(see* **Section 2.11.2.2***)*, the survey shows most people use the Internet to use the 'E-mail service' and 'Educations or research activities' comes second. But bear in mind, that survey included all ages, while this one concentrates on 16 to 17 years old students only. This means, it is very reassuring when 'educational activities' received the highest percentage among them.

4.2.2.2 Discussion

All of the questions in this section contribute some insight on the pattern of Internet usage among students. This pattern will be considered when developing the prototype. The first three questions, which are the percentage of Internet exposure to the students, shed some light when setting the level of proficiency to use the prototype. The graph shows that more than half of the students (65.9%) had been an Internet user for up to 4 years. Using this information in the development of the prototype, it can be derived that most of the targeted user are in the intermediate level. A comprehensive 'Help' function should be included to assist the students in systems application.

Apart from that, this section also covers the amount of time students spend online. **Graph 4.5** shows the result of Internet usage among students in a week. It is important as it gives some insight on how much time a student has to visit a website in one session. The result shows that more than two thirds of these students or, 77.30%, has up to 5 hours a week to spend on

University of Malaya

the Internet. Other extra curricular activities have been scheduled by schools and parents that influenced their allocation of time. This would mean that, besides having a web system simple enough to be used by inexperienced or little experience user, it should also be developed in such a way that the students are able to use it in a short time, preferably one hour per sitting.

Another issue this section covers is the places where these students have access to the Internet. **Graph 4.6** compares all of the options where students may access the Internet. From the graph, it can be seen that students mostly access the Internet at their school computer's laboratory and cyber cafes. This information will be fed when determining the minimum requirement of the prototype. Since the two most used places for accessing the Internet are public computers, ESCA-Math will only be beneficial to the students if they can have their own account where they are able to login before using it. Using cookies to track which user they are will be inaccurate since the computers are shared among a lot of students.

Next result shows the sources from where these students learn how to use the Internet. From the result showed in **Graph 4.7**, it can be seen that students are mostly self-taught or learned it from their friends. This shows an important aspect in terms of mind-set. When they learned it by themselves, it shows their effort to gain the skills rather than to wait for other means to spoon-feed them. Internet skills may not seem critical at this stage but it will be when they further their studies at the university.

University of Malaya

But by learning to use it now, it shows the will to empower oneself on the technology. Further more, it will facilitate them later and they will be comfortable around computers when they do proceed to higher learning. In terms of this research, it will assist the introduction of the prototype considering that they are motivated to learn by themselves.

The last result provides an insight on what these students mostly used the Internet for. The result shows that e-learning and other educational purposes receive the highest rate and this shows a promising prospect for the students to use the Internet to assist them in acquiring knowledge. Part of this may be influenced by the fact that most students access the Internet at school and thus there are certain boundaries to which websites these students are allowed to access. Nevertheless, this would only show that these students realize that there are other means on medium that they could turn to in order to help them with their school work besides the textbooks and teachers.

4.2.3 E-Learning Experience

This part is to gather some insight on students' experience with using e-learning. The result feeds directly to prototype design because of the reasons discussed below.

University of Malaya

4.2.3.1 Results and Data Analysis

Below are the result and analysis for respondents' e-learning experience. As can be seen, the results are no longer divided into three schools. This is due to no significance difference of the results between these schools.

Table 4.1
Visited Websites by Students and the Amount of Time in a Week

Hours (%) / Websites	<1	1 – 5	5 – 10	> 10
Portal Pendidikan Bestari	18.59%	26.63%	5.03%	-
Score A Programme	14.07%	13.07%	3.52%	-
Online Learning @ Maxis	5.03%	5.03%	4.02%	-
Math Forums	1.01%	0.50%	0.50%	-
MathisFun	3.02%	3.52%	0.50%	-
Others	7.04%	7.54%	1.01%	-
Average (%)	36.68%	36.68%	5.53%	-
Never visited one before	21.11%			

The table above shows a very high percentage of students who had experienced with e-learning before, with an average of 78.89%. The other 21.11% includes those who have never used the Internet before. From the table it can be seen that there is an equal amount of percentage between students who use them less than one hour per week and one to five hours per week which is 36.68%.

University of Malaya

Table 4.2
Specific Purpose in Visiting the Above Stated Websites

No	Reasons	%
1.	Help with homework and revision	59.87
2.	Curiosity	52.87
3.	To get the latest news fast	49.04
4.	Free additional tutorial and exercises	41.40
5.	Keeping abreast with the latest available technology in education	40.13
6.	Free past year questions	38.85
7.	More resources to grasp a better understanding on certain particular subject	36.94
8.	To experience an enjoyable learning process	33.76
9.	Fail-proof study tips	33.76
10.	More resources to understand complex formulas	26.11
11.	To share information with other cyber pals	22.93
12.	Others	0.64

The table above shows the percentage of specific purposes these students have when visiting the e-learning websites and it is arranged in descending order. 59.87% of these students use e-learning to get help with their homework and revision and is the highest percentage among all of them. While 0.64% have other reasons besides the one listed for purposes of using e-learning websites which includes as a means to pass time.

4.2.3.2 Discussion

The single fact that almost 80% of these students have been using e-learning before has made it easier to introduce the ESCA-Math. Using the result in **Table 4.1**, ESCA-Math should be developed in such a way that it

University of Malaya

is easy enough for these students to use and able to gain a lot of benefits even if they spend as little as half an hour in one session. This will consequently affect the minimum specifications, the downloadable time for each page and the quantity of pages to go through for a student to get to their desired page.

In the next result, it shows that apparently, most of these students use e-learning for help with their homework and revision. This will be considered as a priority when the prototype modules are being developed. From **Table 4.2,** the percentage of students 'using e-learning to share knowledge with other people' is another proof, statistically, that students rarely visit discussion forums or any knowledge sharing tool as stated in Chapter 2 **(***see* **Section 2.7.2)**. In the studies as stated in that section, it shows that messages posted in discussion board are both low in quantity and in quality and thus concluded that it is not an effective tool when the users are mostly school students.

4.2.4 Perception on E-learning and Mathematics

In this section, twenty-five statements are being developed to address five issues of e-learning that has been pre-determined. These issues includes students' mindset on e-learning, students' judgment on facility and equipment to access the Internet, students' impression from past experience of e-learning, students' perception on traditional learning method and e-learning and lastly their insight on Mathematics subject.

University of Malaya

It is important to note here, that all twenty-five statements are randomly arranged between one another to hide their true nature of issue which might influenced students' answer. To these students, they are answering twenty-five statements where in fact they are from five main issues.

These statements are presented measuring their perspective in score of a five point Likert-scale from 1 (strongly disagree) to 5 (strongly agree). A basic statistical analysis was performed on all of the statements and the results are being presented below. These statements can be viewed in **Section D** of the questionnaire in **Appendix B**.

4.2.4.1 Results and Data Analysis

The results are being presented according to their own issues. Mean (M) and standard deviation (SD) is being calculated for further analysis. Mean is chosen as one of the measurement method to see what the average opinion of these students is; meanwhile standard deviation will be able to reveal the distribution of students' answer between themselves. The lower the standard deviation for each of these statements, the more harmonious like-minded agreement of these students between one another. This section will also show combined results for all three schools because of the similarities in the results between them.

Issue 1: Students' mindset on e-learning

This is to investigate the level of mindset among secondary school students about using technology - e-learning in particular – to assist them in

University of Malaya

achieving good result in school. This section contains 6 statements to see their personal interest in e-learning, ranging from general statements to more specific ones. The statements positions from within the questionnaire *(see* **Appendix B***)* are placed in brackets and below (in **Table 4.3**) are the results.

Table 4.3
Results for Students' Mindset on E-Learning

Statements	Mean (M)	Standard Deviation (SD)
1. I will continue using e-learning for revision in the future. (2.5)	3.770	0.890
2. If there are facilities to learn Mathematics easier on the Internet, I will use that opportunity to the fullest. (2.10)	3.879	0.742
3. E-learning gives a lot of benefits to students. (2.13)	3.799	0.791
4. I will take computer courses if that is what is required to use the e-learning effectively. (2.18)	3.920	0.825
5. In my opinion, students should take all opportunity provided by technology and Internet if that would increase their performance in Mathematics. (2.21)	**4.317**	**0.775**
6. I will only surf websites developed and available in Bahasa Melayu. (2.25)	2.216	1.004

From the above result, it can be seen that the statement with the highest vote is 'in my opinion, students should take all opportunity provided by technology and Internet if that would increase their performance in Mathematics', which is 4.317. And the standard deviation (SD) does not vary too far either with only 0.775, which is second to the lowest shown. This score comes between 'agree' and 'strongly agree' and it is a very firm position and this is further assured by the low SD which means the answers given by students does not vary too much from one another.

University of Malaya

The next highest mean is 'I will take computer courses if that is what is required to use the e-learning effectively' with 3.920. However the SD is slightly higher than the previous one which is 0.825. The other statements that follow closely by is 'if there are facilities to learn Mathematics easier on the Internet, I will use that opportunity to the fullest', 'e-learning gives a lot of benefits to students' and 'I will continue using the e-learning for revision in the future'. These scores are between 'agree' and 'not sure' but by having them more than 3.5 show that they are leaning towards 'agree'.

It is worth to note that the lowest score of SD is 0.742 for the second statement, where it received a 3.879 score. By having the lowest SD it shows that the answers do not go far from one another which means students basically agree that the would use the facilities to learn Mathematics on the Internet if it is available to them.

The lowest score of mean belongs to 'I will only surf websites developed and available in Bahasa Melayu' with a 2.216. Even though it received the lowest score, it does not mean a bad thing because the statement itself is in a negative approach. By having a score close to 'disagree', it shows that students will not only surf websites that were developed and available in Bahasa Melayu. However, it is worth to note that this statement gets the highest SD, which means it is the most varied answers from one another but on the average (by calculating the mean) most students 'disagree' with the statement.

University of Malaya

Issue 2: Facility and equipment to access Internet

The second issue is developed to investigate the facility and equipment for these students to access the Internet. Included are statements pertaining to their competence and skills in order to use the Internet at the maximum level and another regarding language barrier which is the widely used English. Below (in **Table 4.4**) are the results,

Table 4.4
Result for Students' Judgment on Facility and Equipment to Access the Internet

Statements	Mean (M)	Standard Deviation (SD)
1. School has provided computer courses towards a better and effective Internet usage. (2.6)	3.800	1.010
2. School has provided enough computers for all students to use. (2.9)	3.020	1.200
3. I have the facility and do not have any problem to access the Internet. (2.14)	3.101	1.235
4. I have all the necessary skills to use the Internet effectively. (2.20)	3.236	0.979
5. English is not an obstacle for me to using the Internet smoothly. (2.26)	**3.950**	**0.833**

The highest mean in this issue is 'English is not an obstacle for me to using the Internet smoothly' with 3.950 and it receives the lowest score of SD with 0.833. This shows that students are mostly leaning towards 'agree' that English should not be a problem to them when using the Internet.

The lowest mean received is on 'school has provided enough computers for all students to use', with 3.020 and to follow closely by 'I have the facility and do not have any problem to access the Internet' with 3.101. The SD for both of these statements is also quite high which are 1.200 and

University of Malaya

1.235 respectively. At a glance, it can be seen that most students still feel that the facility and equipment to access the Internet at a moderate level. Looking at the highest score, they do not feel that English is an obstacle for them to use the Internet and this is a good thing especially when further affirmed by a low amount of SD. But as for the other statements, most students seem to have problems with the quantity of school's computers which further influence their ability towards accessing the Internet as shown in statement 4.

Issue 3: Past experience of e-learning

This third issue is developed to investigate the students past experience of using e-learning. Through these statements, the fact of whether they are satisfied with e-learning thus far will be revealed. One of the obvious advantages of e-learning is assisting with homework and revision, so this statement is included as well to see if these students agree. The third statement is in the form of 'what-if' and is based on opinion. If these students had used an e-learning site before, they would have formed certain opinion on this matter and so it is crucial to find out. Below (in **Table 4.5**) are the results,

University of Malaya

Table 4.5
Results for Students' Impression from Past Experience of E-Learning

Statements	Mean (M)	Standard Deviation (SD)
1. E-learning assists me in my homework and revision. (2.4)	3.700	0.920
2. I will recommend the website I've been visiting to my teachers. (2.17)	3.206	0.799
3. If I am highly skilled in using Internet, it would give me more benefits when using the e-learning. (2.22)	**4.352**	**0.763**
4. I will recommend the website I've been visiting to my friends and classmates. (2.27)	3.794	0.706
5. I am satisfied with the advantages gain from e-learning thus far. (2.28)	3.688	0.867

The highest mean in the above table if statement no. 3 which played with the 'what-if' situation and that is 'if I am highly skilled in using Internet, it would give me more benefits when using the e-learning' with a 4.352. The SD for this statement is low which is also the second lowest in this issue, which is 0.763. It means that most students agreed that to gain the most benefits from e-learning, they need to be highly skilled with using the Internet. The second highest is 'I will recommend the website I've been visiting to my friends and classmates' which incidentally received the lowest SD among all. Comparing to the other similar statement, 'I will recommend the website I've been visiting to my teachers'; the latter received a lower score, and incidentally the lowest mean among all and a slightly higher SD. This could probably be contributed by the gap of communication between students and their teachers.

University of Malaya

Issue 4: Perception between traditional learning method and e-learning

This fourth issue was developed to investigate their opinion on traditional learning method as well as the e-learning method. Smart school has been implemented for more than 6 years and the most publicized e-learning site, 'Portal Pendidikan Bestari' had been around since 2002. This would also mean that e-learning has been exposed to these students for several years that they would be able to differentiate between traditional method and the e-learning method. Below (in **Table 4.6**) are the statements and results.

Table 4.6
Results for Students' Perception on the Traditional Learning Method and E-Learning

Statements	Mean (M)	Standard Deviation (SD)
1. Multimedia elements (e.g.: graphics, audio, video, animation) that are used in e-learning make the Mathematic learning process easier than simply using textbooks and blackboard. (2.7)	**4.010**	**1.040**
2. I always hesitate to put up my hand when I do not understand anything taught in class for fear of being considered a slow learner. (2.12)	3.020	1.227
3. My interest in Mathematics is heavily influenced by my teacher. (2.15)	3.945	0.996
4. I always hesitate to give my answer in class for fear of giving a wrong one. (2.19)	3.226	1.182
5. I always hesitate to put up my hand to ask in class for fear of asking stupid question. (2.24)	2.824	1.152

The highest mean in the above result received by students' agreement that 'multimedia elements in e-learning make it easier to learn Mathematic than simply with textbooks and blackboard'. This means that even though students would mostly agreed with that statement, there are some of them who do not, but it is only a small number because the mean shows that it

University of Malaya

had passed over the 'agree' notch by having it more than 4. The second highest mean is the statement that said 'their interest in Mathematics is heavily influenced by the teacher who teaches that subject' which received the lowest measure of SD in this issue. The other three statements are in fact quite similar with one another where they depicted the scenario in a classroom and the action the students would take if faced with the situation. These statements are 'I always hesitate to give my answer in class for fear of giving a wrong one', 'I always hesitate to put up my hand when I don't understand anything taught in class for fear of being considered a slow learner' and 'I always hesitate to put up my hand to ask in class for fear of asking stupid question'. But they are also calculated to have the highest SD among all of the statements in the issue, which means that the answers given vary with quite a large gap between one another.

Issue 5: Opinion on mathematics subject

The last issue being developed is to gain some insights on students' opinion about the mathematics subject. Being dubbed as the 'haunted' subject at school, some of the students had developed 'math-anxiety' even before they started learning this subject. Be that as it may, mathematics is one of the important subjects to further studies at the universities. One of the statements is addressing this concern, to see whether these students realized what is at stake if they fail or did miserably in this subject. The statements and results are as follows, in **Table 4.7**:

University of Malaya

Table 4.7
Results for Students' Insight on Mathematics Subject

Statements	Mean (M)	Standard Deviation (SD)
1. Mathematic is an important subject that opens up a wider option when applying for higher education. (2.8)	4.500	0.650
2. 'Drill and practice' is an effective way to master mathematics. (2.11)	**4.704**	**0.510**
3. Mastering mathematics gives me confidence to master other subject as well. (2.16)	3.920	0.872
4. Mathematics is a challenging subject. (2.23)	2.693	1.129

The highest mean in the above result is shown in the second statement which is ''Drill and practice' is an effective way to master mathematics' with a 4.704, consequently, the highest among all twenty-five statements and further affirm by the lowest SD among all as well, with a 0.510. This shows that mostly students are leaning heavily towards 'strongly agree' that drill and practice is effective. The second highest mean is in 'Mathematic is an important subject that opens up a wider option when applying for higher education' with a 4.500 and an SD of 0.650, which incidentally is also the second highest mean and lowest SD for all twenty-five statements. In the statement 'mastering mathematics gives me confidence to master in other subjects as well', students mostly 'agree' that they would gain confidence to master other subjects if they excel in mathematics and the answers do not vary too far from one another seeing that the SD for this statement is only 0.872. However, in the statement 'Mathematics is a challenging subject', mostly students are in between of 'not sure' and 'disagree' with the saying that mathematics is a challenging subject. This means they believe that mathematics is not that challenging

University of Malaya

but it may vary from one student to the other as the SD is quite high with this one with a 1.129.

4.2.4.2 Discussion

The first issue which addressed the level of students' mindset on e-learning shows a positive result. By having one of the statement past over the 'agree' point (4.317), and all of the other statements leaning towards the 'agree' point, it shows that students are quite ready to accept e-learning as part of the education method. By having a very low score on the 'I will only use websites in Bahasa Melayu', it shows that they are aware that English is the prime language around the Internet and if they continue to choose only those in the native language they will be missing a lot from all other websites.

The second issue investigated the facility and equipment as another tool in terms of calculating the level of readiness of implementing e-learning in the educational system. From the result, it can be seen that most students agreed that the facility available to them is at moderate level. However, based on the Ninth Malaysia Plan it can be seen that the government realized this shortcoming and had set aside part of the allocated RM2.1 billion for education system to further enrich schools with more computers.

In the third issue, most students are mostly leaning towards the 'agree' point that they are satisfied with e-learning so far. However, they believe

University of Malaya

that if they are highly skilled to use the Internet, they will gain much more than in the present condition. This is clearly shown by that statement to receive the highest mean. Overall, the answers between the students do not vary too far based on the low number of standard deviation.

The fourth issue which covers students' perception between e-learning and the traditional method of learning shows that mostly students agreed that multimedia elements will help them with learning mathematics better. ESCA-Math is a support system for alternative assistant in the learning process and the other four statements show that ESCA-Math can benefit the students when it has fully operated. For instance, consider the statement where 'students' interest in mathematics are heavily influenced with who teaches them'. If they are blessed by good teachers, who are able to successfully explain the concepts, then their interest in this subject will follow along but if otherwise, they might be the victim to the situation. This is why it is important to present to these students that there are other alternatives to learning where they can benefit from it. The other three statements show a moderate level of confidence of these students in class. This will further increase the significance of the proposed system since these students shall have other means of learning if they are hesitating to ask in class.

The last issue is addressing with students' perception towards mathematics. Mostly students agreed the importance of mathematics and when accompanying with the first issue of level of students' mindset, this

University of Malaya

shows a very good sign of acceptance to ESCA-Math when it is ready to be used. Seeing that 'drill and practice' received the highest vote and further assured by the lowest standard deviation, this method will be implemented as one of the modules in ESCA-Math prototype.

4.3 RESEARCH ON THE FREQUENTLY INTERNET-ACCESSED LOCATION

Research of the location was conducted in all of the school involved in the analysis. The result in **Graph 4.6** (*see* **Section 4.2.2.1**) above showed that students most frequently accessed Internet at their school computer's laboratory. Thus, it is crucial to investigate the condition of these computers, especially when determining the minimum requirement for ESCA-Math prototype.

The research reveals the below results (in **Table 4.8** and **Table 4.9**):

Table 4.8
Result from the Research of the Location

Criteria	SAMURA	SEDAR	SMKPB
Total of computers	76	45	22
Students who have access to these computers	All students (which comprises of Form 4 and Form 5)	All students (which comprises of Form 1 to Form 5)	Form 4, Form 5 and Form 6 students only.
Operating system used	Windows XP and Windows 98	Windows XP	Windows XP
Flash player installed?	Yes	Yes	Yes

University of Malaya

Table 4.9
Procedure of Computers Usage

No	School	Procedures of using them
1	SAMURA	- Students may use them with permission / supervision of teachers. - They may also use during evening 'prep' (preparation).
2	SEDAR	- Students may use during non-school session (in the morning for evening session students and in the evening for the morning session students. - They may also use them during school sessions if they received permission from their teacher or accompanied by them. - There are several restrictions to Internet usage which are no chatting, online gaming or downloads allowed. These students however are allowed to use Internet for e-mail purpose.
3	SMKPB	- Priority is given to Form 4 and Form 5 students. - The usage is restricted to certain subjects only and fortunately, Mathematics for Form 4 and Form 5 are amongst them.

The most crucial criteria from the above results are whether these computers had Flash player installed since ESCA-Math is developed by Macromedia Flash Professional 8 and thus will need for the player to be installed in order to run ESCA-Math. All of the others criteria are to see the level of accessibility of these students to the Internet and whether they are restriction to outside websites.

Since the prototype that is to be developed is considered for educational purpose, students should not have any problem accessing them at schools.

University of Malaya

4.4 PROJECT SCOPE AND REQUIREMENTS

ESCA-Math aims to provide a study companion to Form 4 and Form 5 students. Administrator control feature exists in order to ensure ESCA-Math is maintainable and updatable for future maintenance. Through project scope and requirements, prototype framework, functional and non-functional requirements is determined.

4.4.1 Types of User Determination

Being a study companion e-learning system, ESCA-Math mainly concentrates on students only. Administrator is considered as another user of the system since their job is to maintain and update the system contents. The following table (in **Table 4.10**) outlines the types of user, their activities and access right:

Table 4.10
Types of ESCA-Math Users

Type of user	Activities	Access Right
Students	• Revising mathematics subjects • Looking for help with homework • Assessing topics understanding through sets of questions papers • Associating in recreational activities provided	All modules provided in the system namely: • User Profile • Topics Help • Question Bank • Quick References • Fun and Games
Administrator	• Maintaining system contents • Adding to content updates	Unlimited access right

University of Malaya

4.4.2 ESCA-Math Prototype Framework

Below is the ESCA-Math prototype framework as formulated from the analysis stage.

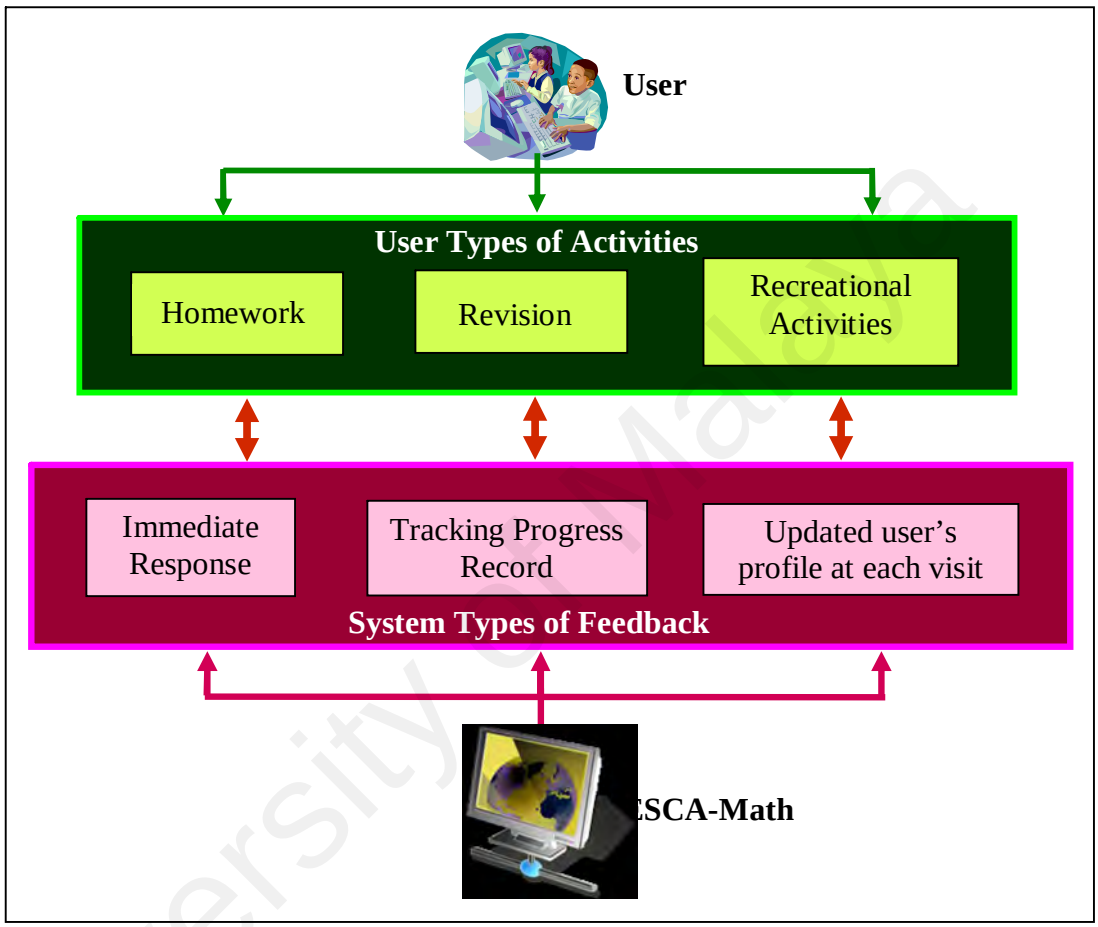


Figure 4.1
ESCA-Math Prototype Framework

From the framework in **Figure 4.1** above, we can see that the prototype interact with the user only. There will be no interaction between the students and their teachers through the prototype. This is based from the following reasons.

1. Students need to know that their activities are being watched and continually assessed by the prototype only. Adding their teacher into

University of Malaya

the picture will nullify the alternative to the solution of anxiety in class. Results in the requirement analysis shows that students are still having difficulties putting up their hands in class either to ask a question or to answer one. This prototype will provide a place where the students can carry on with their revision without the feeling of such anxiety. Furthermore, the result also shows that teachers influenced students' interest towards this subject. If their teacher does not positively influenced the students' interest, giving teachers access to ESCA-Math will prove fruitless because students will not likely to use it anyway.

2. ESCA-Math does not replace the teacher's role entirely. Students will still meet their teachers in classes. In that aspect, the students-teacher interaction still exist but not through the prototype.

Students main activities while on ESCA-Math are to look for help for their homework and as another alternative to revise this subject. Apart from that, they can even use the system as a place for recreational activities. These activities include games, fun facts, riddles and study tips. Result from the analysis shows that students do not use the Internet for educational purpose only but also for entertainment. As much as this might sounds like wasting time, they might do so as part of recreational activities. And this can be grouped together along with watching television or reading story books. In that aspect, this system will provide such activities so they can take a break after a studying session.

University of Malaya

Administrator uses the system to maintain the content inside. In order to uphold the good quality of the content, this feature will enable them to edit and update these contents to match the syllabus all the time.

ESCA-Math will be made in the online environment to allow a greater number of people to use it simultaneously. Whatever changes or addition by the admin will affect the whole system promptly and thus the students are able to experience these changes as immediate as they login. Offline materials takes a long time to distribute and not to mention are quite costly. With online environment students need only to have a computer with an Internet connection to experience it.

4.4.3 Functional Requirements

The functional requirements for this prototype describe what ESCA-Math must do. This would include the processes and the interfaces with users. Below are the functional requirements for this prototype.

1. The user log-in into the prototype using their own user ID and password. The prototype will produce their progress record as the display on first page.
2. This progress record consists of progress graph – which shows their improvement or otherwise as they use the prototype, and weak and strong topics from the tests they have taken so far.
3. With the weak topics, ESCA-Math will suggest that they take more time revising those topics.

University of Malaya

4. After each time a user had completed a test or an examination paper, their points will be recorded and added to the progress graph.
5. The prototype will follow the syllabus of Mathematics for Form 4 and Form 5 as had been outlined by the Ministry of Education to ensure its quality in content.
6. Administrator may change or add to the contents of the prototype.

4.4.4 Non-functional Requirements

The non-functional requirements for the prototype, concerns with how well the prototype performs. This would include the response times, page downloads times and security considerations. Below are the non-functional requirements for this prototype.

1. The prototype has the login feature which consists of user ID and password for the security purpose.
2. The prototype is simple and easy to use.
3. The prototype is reliable and shall not cause unnecessary or unplanned downtime of the overall environment. It does not produce dangerous or costly failure when it is used in a reasonable manner.
4. The prototype is easy to maintain and expand for future use.

University of Malaya

4.5 PROTOTYPE DESIGN

Below is the prototype design for this research. It consists of prototype architecture, prototype flowchart and web development tools.

4.5.1 ESCA-Math Prototype Architecture

Below is the prototype architecture for this research.

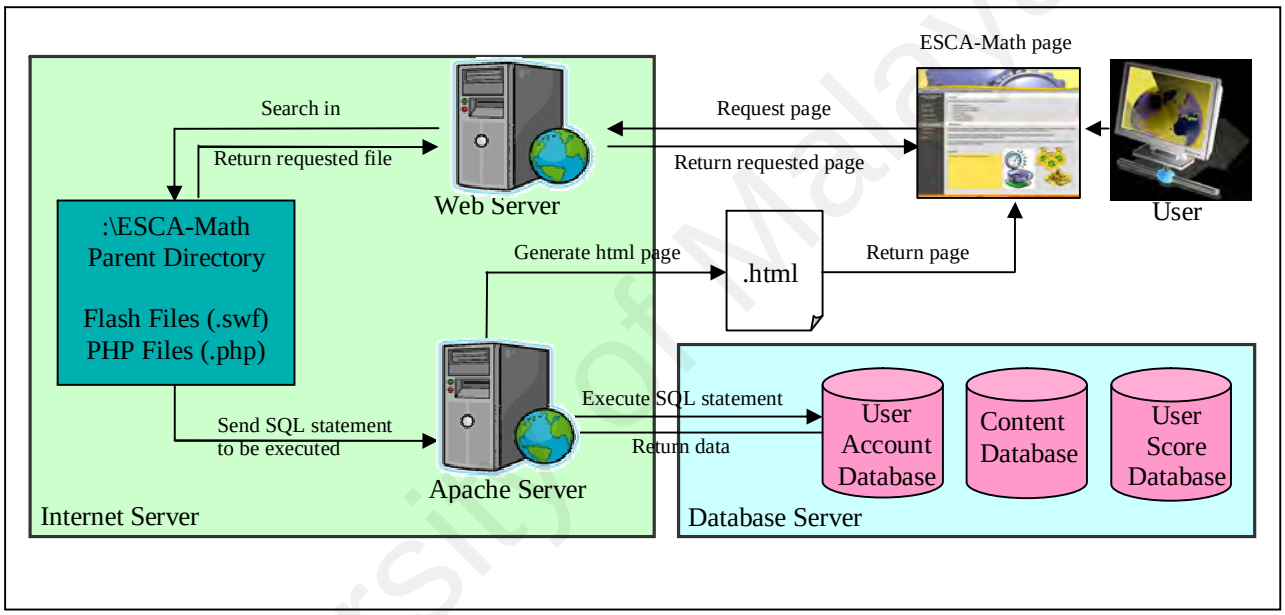


Figure 4.2
ESCA-Math Prototype Architecture

In **Figure 4.2**, the process started when a user request for a page from the main ESCA-Math page. Since the most challenging issue when delivering contents online is the long amount of time to download, ESCA-Math have been divided into small 'chunks' of files and these files will only be loaded upon request. There are two types of files which are the Flash files itself and the PHP files, which are used to communicate with the database.

University of Malaya

When a user requested for a Flash file, the web server will look for the file in the parent directory of ESCA-Math and upon finding that file, it will be returned back to the main page. However, when there is a request for data, PHP files will be invoked. When this happens, the file will be sent to the Apache Server for the SQL statements to be executed. The data will be searched from within the appropriate databases.

Once the data is found, it will be returned back to the Apache Server and a new html file will be generated to be returned to the main page. ESCA-Math will extract the data returned in the new generated file and display it on the screen.

4.5.2 ESCA-Math Prototype Flowchart

Below is the prototype flowchart for this research.

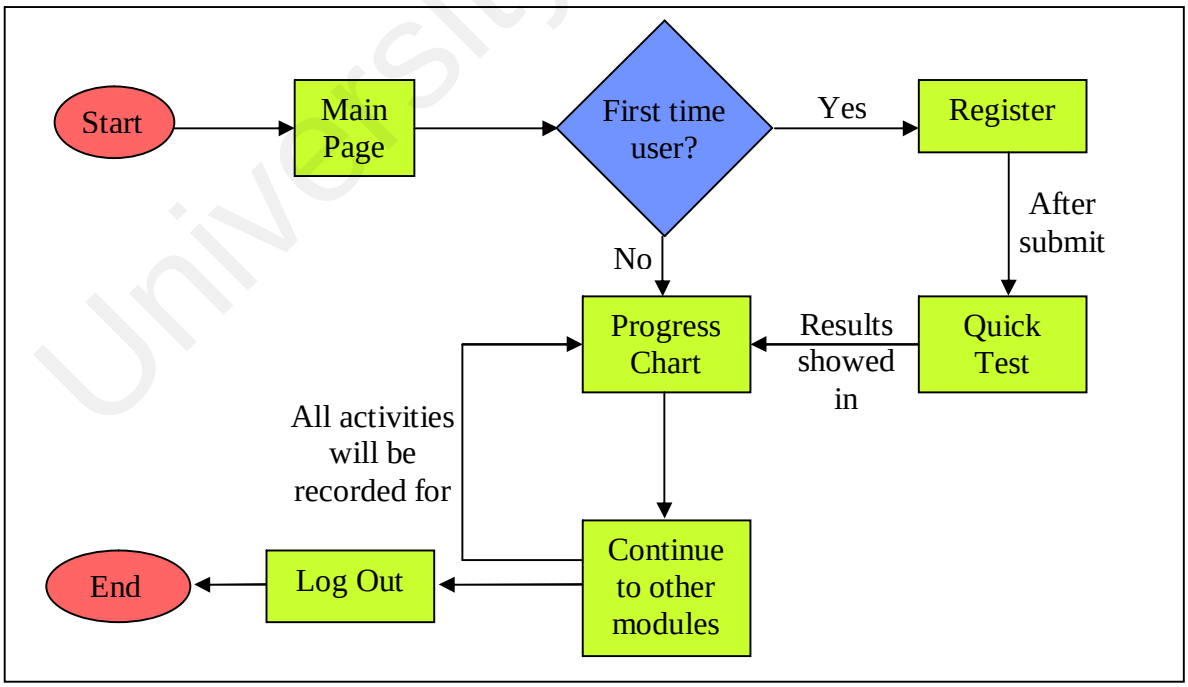


Figure 4.3
ESCA-Math Prototype Flowchart

University of Malaya

The above flowchart provides a roadmap of events for the prototype. Upon entering the website, they will come to the Main Page where it will be determined whether they are a registered user or a new comer. If they are a new visitor, they will be asked to register to receive the full benefits of the prototype. Clicking on the registering button, the prototype will take them to a Register page. Here, they will fill in the details as requested. After they have submitted their registration, they will have to take a quick test where they will have to answer some questions to set their progress chart. When they finished, they will be taken to their first display of progress chart. A registered user who had successfully logged in to the prototype will be taken to their own progress chart which will show them their performance level up to their last visit.

After they had finished viewing their progress chart, they may continue to the other modules within ESCA-Math. These modules provide their learning and revision process. If they had taken any tests or examination on the prototype, their results will be recorded and it will be added to their progress chart when they logged-in to ESCA-Math in their next visit. After they had finished with their learning session, they will click on the log-out button and that marks their end session with the prototype.

4.5.3 Web Development Tools

Web development tools explained the software tools used to develop ESCA-Math.

University of Malaya

4.5.3.1 Macromedia Flash Professional 8

Macromedia Flash Professional 8 is used as ESCA-Math authoring tool using Actionscript as the programming language. Since ESCA-Math is developed to be viewed online, some issues on slow connection long delivering time might cause problems. To address that, ESCA-Math will be divided into small files or 'chunks' and these files will only be uploaded upon request from the user. The basic main page of ESCA-Math will be small in size to allow faster content delivery.

4.5.3.2 Adobe Photoshop CS

This is the image editor software for images in ESCA-Math. All images will be saved as either Joint Photographic Experts Group – JPEG (*.jpeg) or Graphic Interchange Format – GIF (*.gif) to ensure the small sizes and less download page time.

4.5.3.3 MySQL

MySQL is used to generate SQL statements and codes to allow communication between the prototype and the database. The database contains users' profile information and their history of visits to the prototype. SQL statements have to be embedded inside another file extension in order to allow Flash to communicate with it. In this case, SQL statements will be created within PHP files. The result generated from the query will then be accessed by Flash files to be used inside ESCA-Math.

University of Malaya

4.5.3.4 PHPMyAdmin

PHPMyAdmin is a tool written in PHP intended to handle the administration of MySQL over the Web. It is chosen because the interface is straightforward and easy to use. It will monitor and managed these queries between files.

4.5.3.5 Macromedia Dreamweaver MX

Macromedia Dreamweaver can be used to handle a lot of programming language and cross-platform interchange between these languages. The coding editor window provides different colors for different language command, so detecting error is easy with this software. ESCA-Math uses Flash files and PHP coding. Dreamweaver is the perfect software to speed up the designing and developing with the interchanges between these two types of file.

4.6 PROPOSED STORYBOARD

The following are the storyboards for this prototype. There are 9 types of screens altogether.

4.6.1 Main Page Storyboard (Screen 1 of 9)

In the **Figure 4.4** below, it shows the Main Page storyboard and **Table 4.11** provide the description of the item in the storyboard.

University of Malaya

Screen Description: This is the main page of the prototype. Upon arriving in this e-learning prototype, this will be the first page a visitor will see.

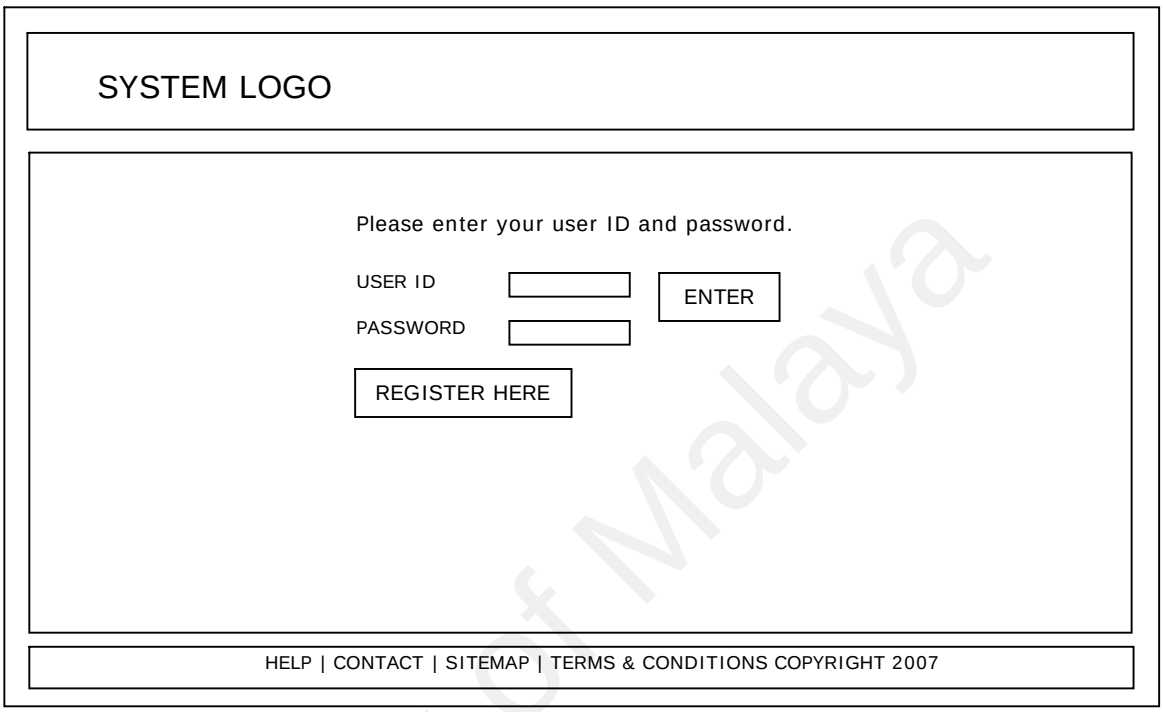


Figure 4.4
Main Page Storyboard

University of Malaya

Table 4.11
Main Page Storyboard Description

Item	Description
Narration	As this is the front page of the prototype, each visitor will be asked to fill in their user ID and password to login into the prototype. For an unregistered user, they may register by clicking on the 'Register Here' button placed underneath the log-in boxes.
User Interaction	There are two types of interaction from users in this page, which are from a registered user and an unregistered user. After filling in the details, upon clicking the 'Enter' button, they will be taken to their recent 'Progress Chart' page. An unregistered user clicks on the 'Register Here' button and they will be taken to the 'Register' page.
Placement	1. Graphics: Graphics should be limited to the necessary ones to allow a faster download time especially for a dial-up modem user. There will be a logo for the system on the top of the screen and a large graphic for background. 2. Buttons: 'Enter' button takes the user to the 'Progress Chart' page and 'Register Here' button takes them to the 'Register' page.
Colors	Limited to three colors to avoid it to become too colorful. ESCA-Math uses a combination of three main colors which are orange, grey and blue.
Text	There is a welcoming text at the top of the page and instruction to fill in the user ID and password.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There is no animation in this page.
Links from screen(s)	Since this is the first page, there is no links from any other screens.
Links to screen(s)	Since this is a closed prototype, content will only be available for registered user. There are however, general links that are listed on the bottom bar of the page, namely, 'Help, 'Contact', 'Sitemap' and 'Terms & Conditions'.

University of Malaya

4.6.2 Registration Page Storyboard (Screen 2 of 9)

In the **Figure 4.5** below, it shows the Registration Page storyboard and **Table 4.12** provide the description of the item in the storyboard.

Screen Description: This is the registration page for a new user to create a new account.

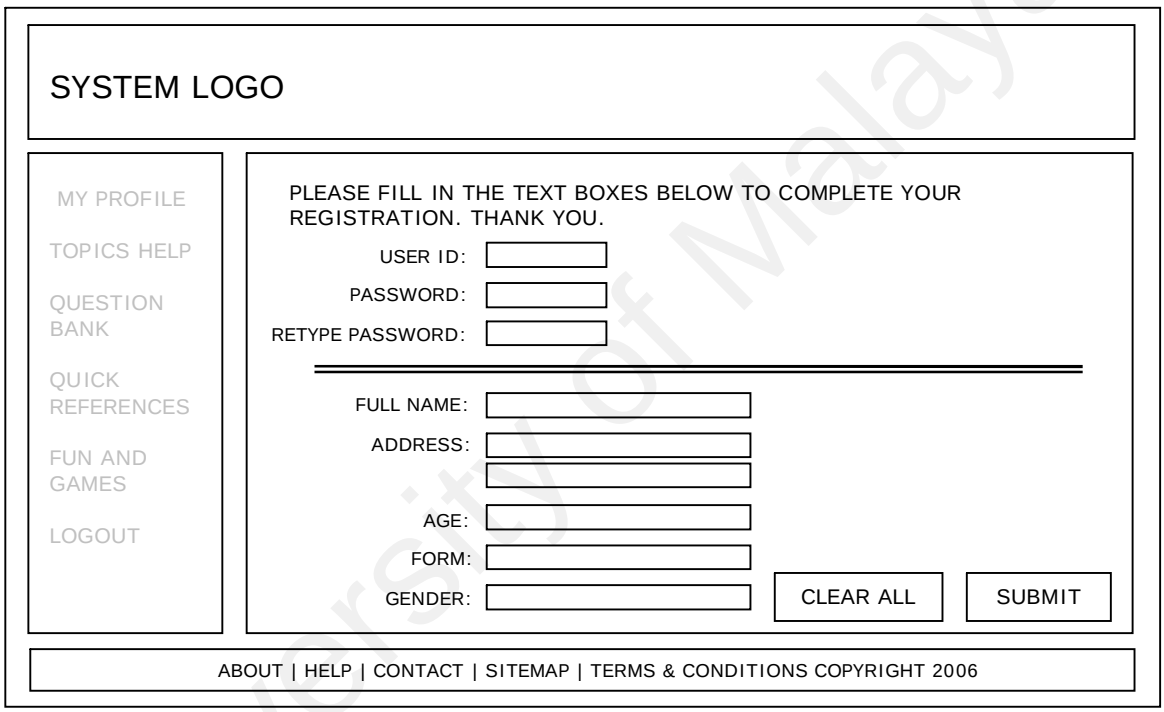


Figure 4.5
Registration Page Storyboard

University of Malaya

Table 4.12
Registration Page Storyboard Description

Item	Description
Narration	In this page, a user has to fill in all of the required details as listed out in the page.
User Interaction	This page requires a total user input using keyboard and mouse as the input devices. Upon clicking on the 'Submit' button, the prototype will take them to the next page.
Placement	1. Graphics: There is no need for any graphic in this page except the logo to keep on to the consistency of pages. 2. Buttons: There are two functional buttons for this page which is a 'Submit' button to submit the completed form to the system's database and a 'Clear All' button to clear the form and start filling all over again.
Colors	Limited to three colors to avoid it to become too colorful. ESCA-Math uses a combination of three main colors which are orange, grey and blue.
Text	There is an instruction page at the top of form to assist the user in filling the details up.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There is no animation in this page.
Links from screen(s)	This page is a direct link from the main page when a user clicked on the 'Register' button.
Links to screen(s)	After clicking on the 'Submit' button, the prototype will direct them to a 'Quick Test' page for the next process in registering. There are however, general links that are listed on the bottom bar of the page, namely, 'About', 'Help, 'Contact', 'Sitemap' and 'Terms & Conditions'.

University of Malaya

4.6.3 Quick Test Storyboard (Screen 3 of 9)

In the **Figure 4.6** below, it shows the Quick Test storyboard and **Table 4.13** provide the description of the item in the storyboard.

Screen Description: This is a quick test page to complete a registration process.

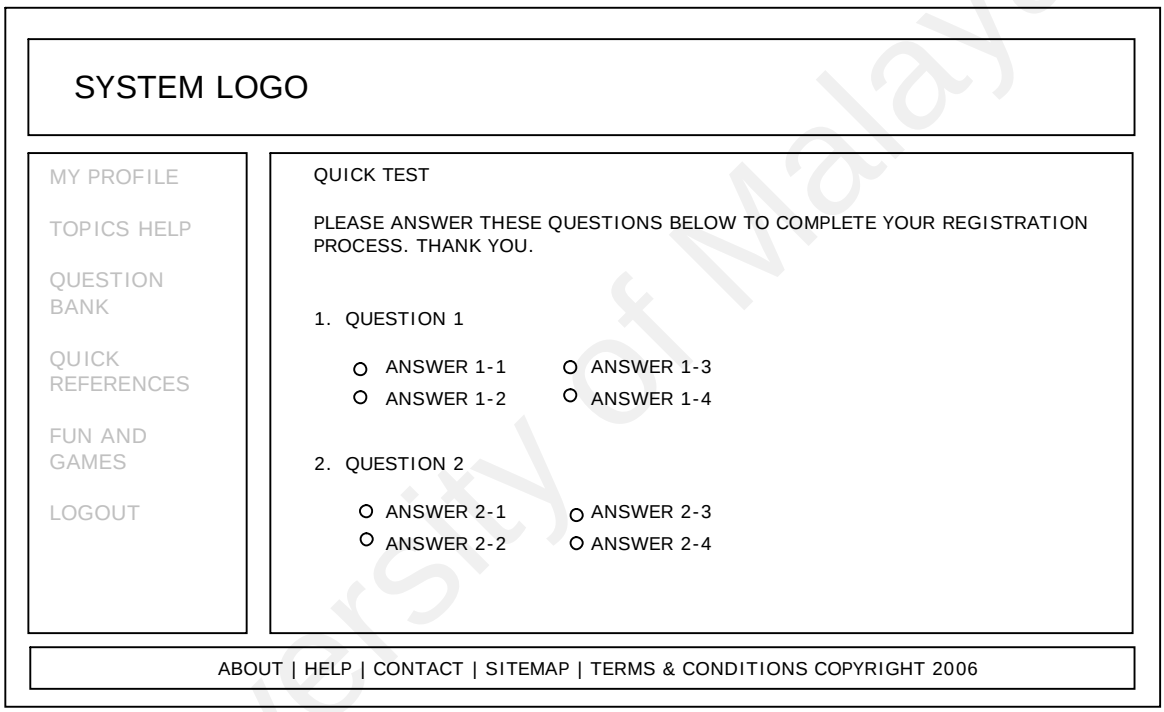


Figure 4.6
Quick Test Storyboard

University of Malaya

Table 4.13
Quick Test Storyboard Description

Item	Description
Narration	In this page, a user needs to take a quick test on several topics in Mathematics subject to complete their registration process. This test is necessary to create users' progress chart.
User Interaction	All of the questions are in multiple-choices form, so they only need to use their mouse to click on the right answers for all questions. When they had finished they will clicked on the 'Submit' button to submit their answers to be evaluated by the system.
Placement	1. Graphics: There may be some graphics present in the questions that are displayed. Other than that, the logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Buttons: There are two types of buttons in this page; radio buttons as choices to the answers and a 'Submit' button to feed in the answers to the system.
Colors	Limited to three colors to avoid it to become too colorful. ESCA-Math uses a combination of three main colors which are orange, grey and blue.
Text	There is an instruction page at the top of the screen to guide users on what to do and how to complete the test.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There is no animation in this page.
Links from screen(s)	This page is directly linked from the registration page. A user cannot access this screen unless they were from that page.
Links to screen(s)	Upon clicking the 'Submit' button, it will take them to their progress chart page where they can find out how well they did on the test and thus marked their first progress record.

University of Malaya

4.6.4 My Profile Storyboard (Screen 4 of 9)

In the **Figure 4.7** below, it shows the My Profile storyboard and **Table 4.14** provide the description of the item in the storyboard.

Screen Description: This is users' profile which contains their progress chart.

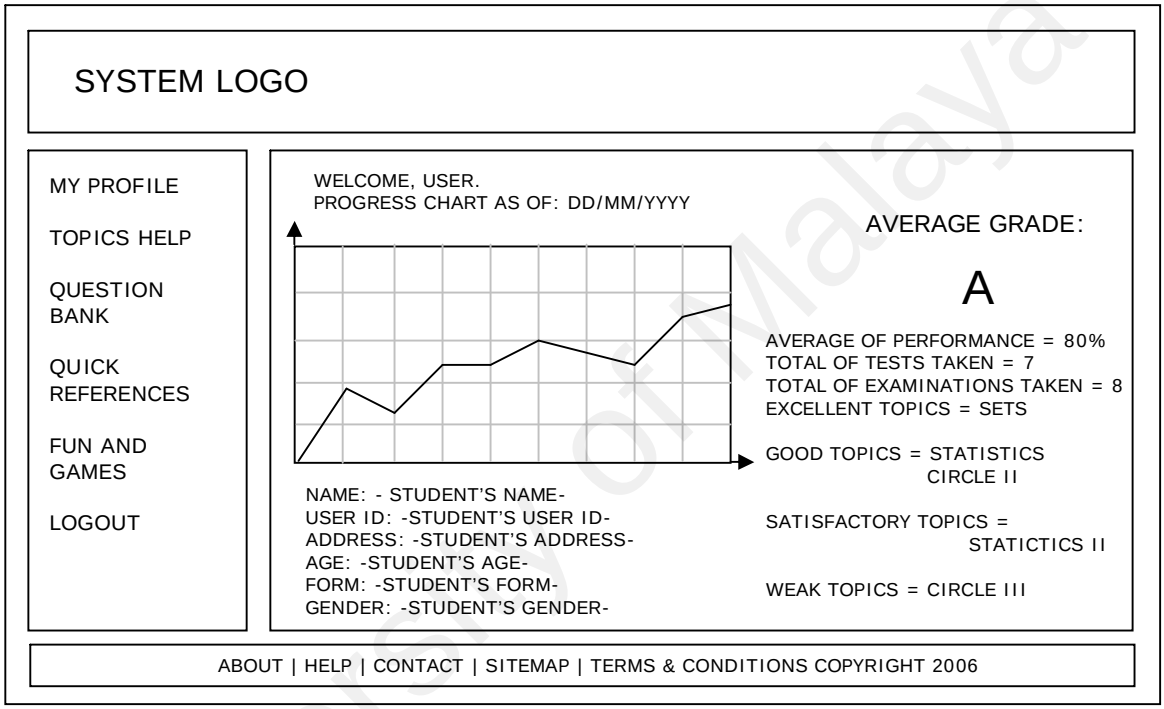


Figure 4.7
My Profile Storyboard

University of Malaya

Table 4.14
My Profile Storyboard Description

Item	Description
Narration	Each time a user logged in into ESCA-Math, it will take them to their progress chart to show their performance level up to the last time they used the prototype.
User Interaction	This page is to be viewed by the user for guidance to the direction of their next revision session. For example, by reviewing their weak topics, users realized that they should provide more time to revise on said topics. User may continue with the session by clicking on the links on the left side menu.
Placement	1. Graphics: A progress chart at the center of the screen to show user's level of performance. Other than that, the logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Buttons: There is no button present in this page.
Colors	Limited to three colors to avoid it to become too colorful. ESCA-Math uses a combination of three main colors which are orange, grey and blue.
Text	There is a welcoming text at the top of the page and their last visit date to confirm that the chart is based on that last visit. There is a record in the form of a list to further details the history of user's past visits such as 'Average of performance', 'Total of tests taken', 'Total of examination papers taken', 'Excellent topics', 'Good Topics', 'Satisfactory Topics' and 'Weak Topics'.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There is a simple animation on the progress graph when the page first loads.
Links from screen(s)	This page is directly accessed whenever a user logs in into the prototype. They may also access this page from the left-side menu at anytime of their visit.
Links to screen(s)	This page does not directly link to any particular page except that logically, users would choose any link on the left-side of the page to continue on with the learning session.

University of Malaya

4.6.5 Topics Help Storyboard (Screen 5 of 9)

In the **Figure 4.8** below, it shows the Topics Help storyboard and **Table 4.15** provide the description of the item in the storyboard.

Screen Description: This is the page where users may revise on mathematics topics.

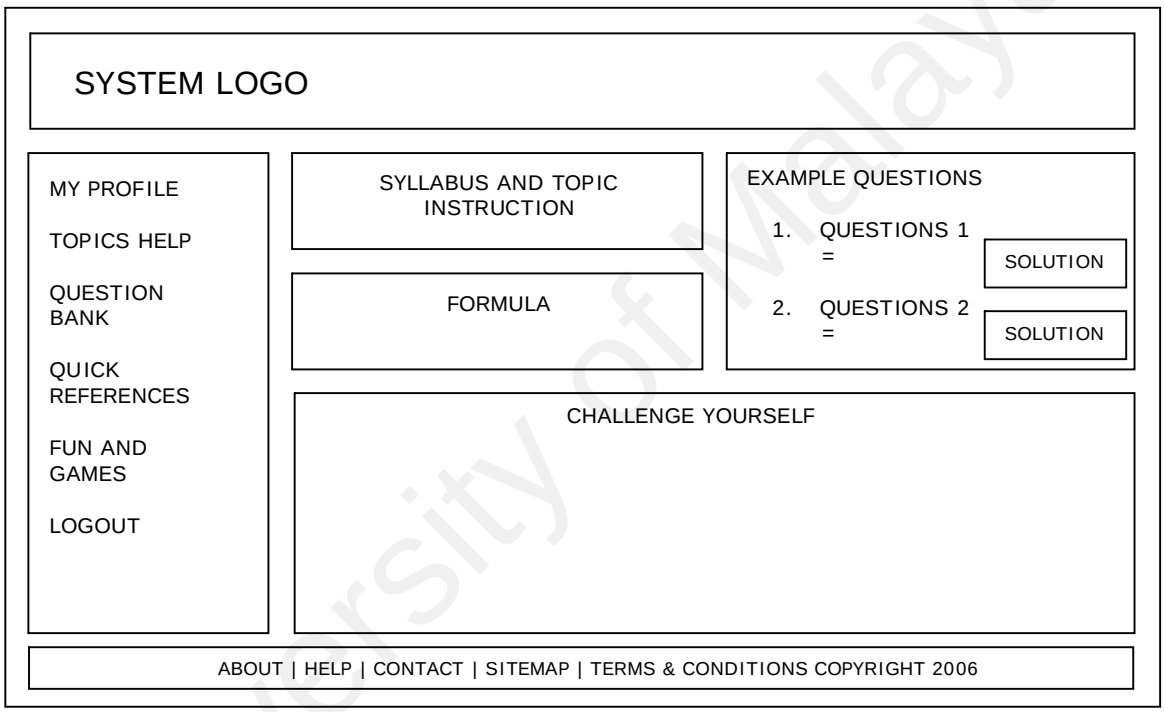


Figure 4.8
Topics Help Storyboard

University of Malaya

Table 4.15
Topics Help Storyboard Description

Item	Description
Narration	In this page, users will find a comprehensive guidance to each of the topic in the syllabus. There is the syllabus and topics instruction where it outlined what users are supposed to learn and a checklist at the end of the topic's lesson to summarize what each particular topic is about. Important formulas are available in animated format to help users to remember how to work it out. There is also the example of questions and answers to show what kind of questions that might come out from each particular topic. Lastly, there is the 'challenge yourself' section with lots of exercises aim to test users' understanding for each of the specific topic.
User Interaction	Important formulas come in two forms; the static plain one and the animated ones, to give users options especially to those with slow Internet connection. If they clicked on the animated ones, it will bring up another smaller window for that said animation. Example questions come without a solution when the page first loads to give users a chance to try them out first. Upon clicking on the 'Solution' button, the answer will be displayed underneath each of them for users to check.
Placement	1. Graphics: The logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Buttons: 'Solution' button will reveal the answer to each example question. 3.
Colors	There will probably more than three colors involved here to highlight different areas between the four sections.
Text	From the top of the screen, there is the title of the topic, followed by what users should learn from that topic, important formulas is next and then, the example of questions and veiled answers with tips and tricks. At the end of the topic lesson, there is a collection of exercise for the users to test their understanding.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	Animation comes in the form of the optional animated formulas.
Links from screen(s)	This page is linked from all other pages which originated from the left-side menu.
Links to screen(s)	Users may choose on any links on the left-side of the page to continue on with the learning session.

University of Malaya

4.6.6 Question Bank Storyboard (Screen 6 of 9)

In the **Figure 4.9** below, it shows the Question Bank storyboard and **Table 4.16** provide the description of the item in the storyboard.

Screen Description: This is the page where users may test their understanding by trying out the questions paper set.

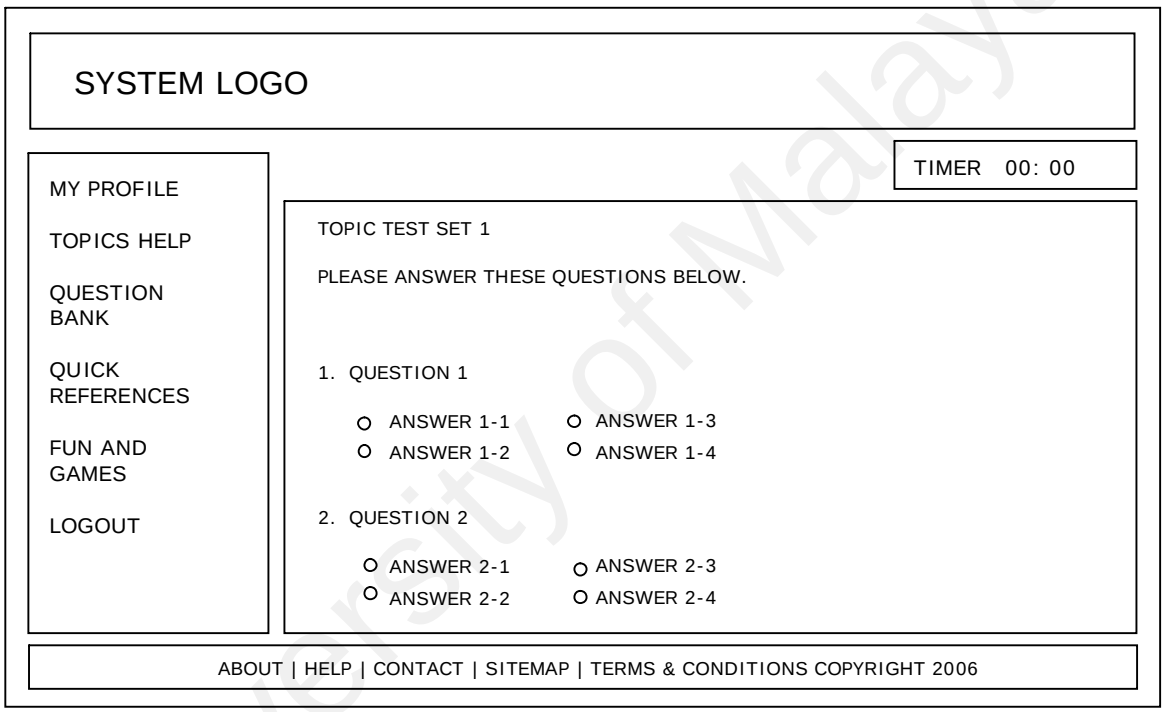


Figure 4.9
Question Bank Storyboard

University of Malaya

Table 4.16
Question Bank Storyboard Description

Item	Description
Narration	In this questions bank storyboard, all examinations, tests and exercises can be found here. User may try from any of the three types of paper set; examinations set – a set of questions based on SPM Mathematics examinations paper; test set – a set of various questions from all mathematics topics but less than examinations set; or exercise set – a set of questions on specific mathematics topics. All results from this section will be recorded in user's progress record.
User Interaction	User may pick by clicking on any type of paper set. From there they may try out the questions presented to them. A timer will be provided for them to track how much times have passed. This timer can be paused and restart later.
Placement	1. Graphics: The logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Other graphics and texts will be based on the questions accordingly.
Colors	There will probably be more than three colors involved here to highlight different areas between the four sections.
Text	An instruction text will be placed at the start of paper set. Other text is according to the questions presented.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There will be no animation in this module.
Links from screen(s)	This page is linked from all other pages which originated from the left-side menu.
Links to screen(s)	When user clicked on the 'Submit' button, the prototype will evaluate and present user's result on the Result screen.

University of Malaya

4.6.7 Quick References Storyboard (Screen 7 of 9)

In the **Figure 4.10** below, it shows the Quick References storyboard and **Table 4.17** provide the description of the item in the storyboard.

Screen Description: This is the page where users may look for references such as the dictionary, mathematics tips and tricks, study tips and motivational tips.

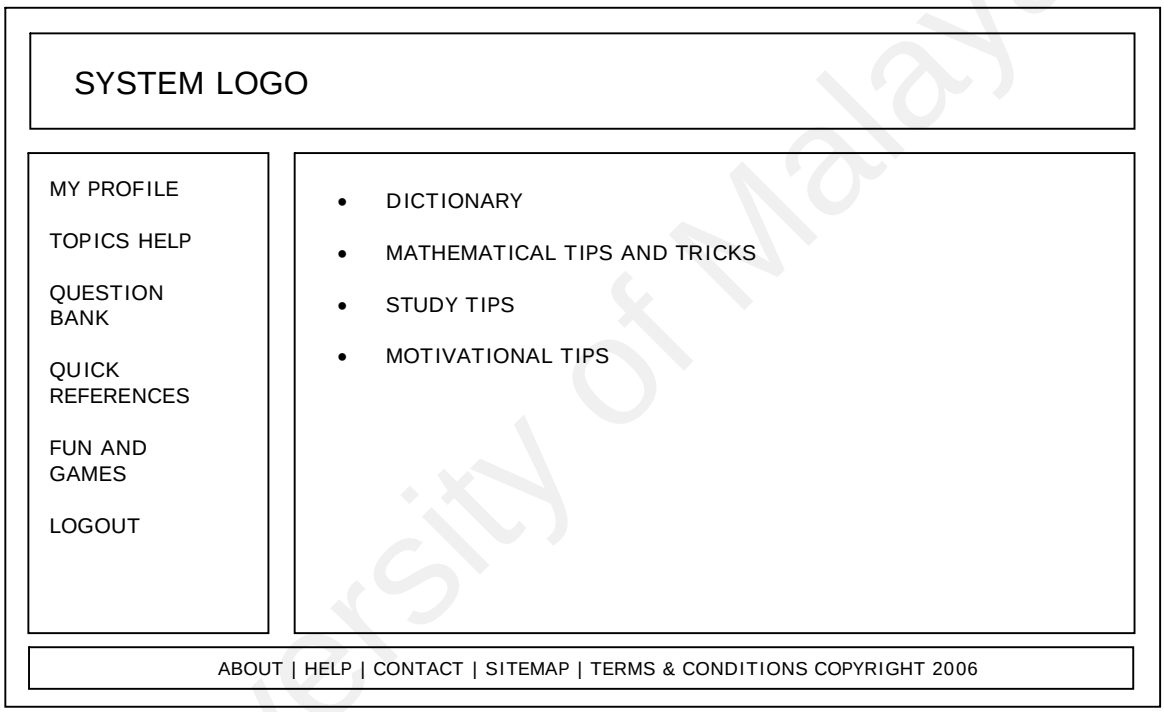


Figure 4.10
Quick References Storyboard

University of Malaya

Table 4.17
Quick References Storyboard Description

Item	Description
Narration	This module is divided into four sub-modules namely; dictionary – an English to Malay dictionary; mathematical tips and tricks – simple tips and tricks to help calculate faster; study tips – tips on how to be a better student; and motivational tips – tips on how to motivate themselves.
User Interaction	User may choose from the four sub-modules listed to go the sub-modules section.
Placement	1. Graphics: The logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Other graphics and texts will be based on quick reference's content accordingly.
Colors	There will probably more than three colors involved here to highlight different areas between the four sections.
Text	A list of the four sub-modules will be listed for user to choose from.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There will be no animation here.
Links from screen(s)	This page is linked from all other pages which originated from the left-side menu.
Links to screen(s)	The link from the sub-modules list will take user to the sub-modules screen.

University of Malaya

4.6.8 Fun and Games Storyboard (Screen 8 of 9)

In the **Figure 4.11** below, it shows the Fun and Games storyboard and **Table 4.18** provide the description of the item in the storyboard.

Screen Description: This is the page where users take a break after a learning session and enjoy with some puzzles and mathematical games.

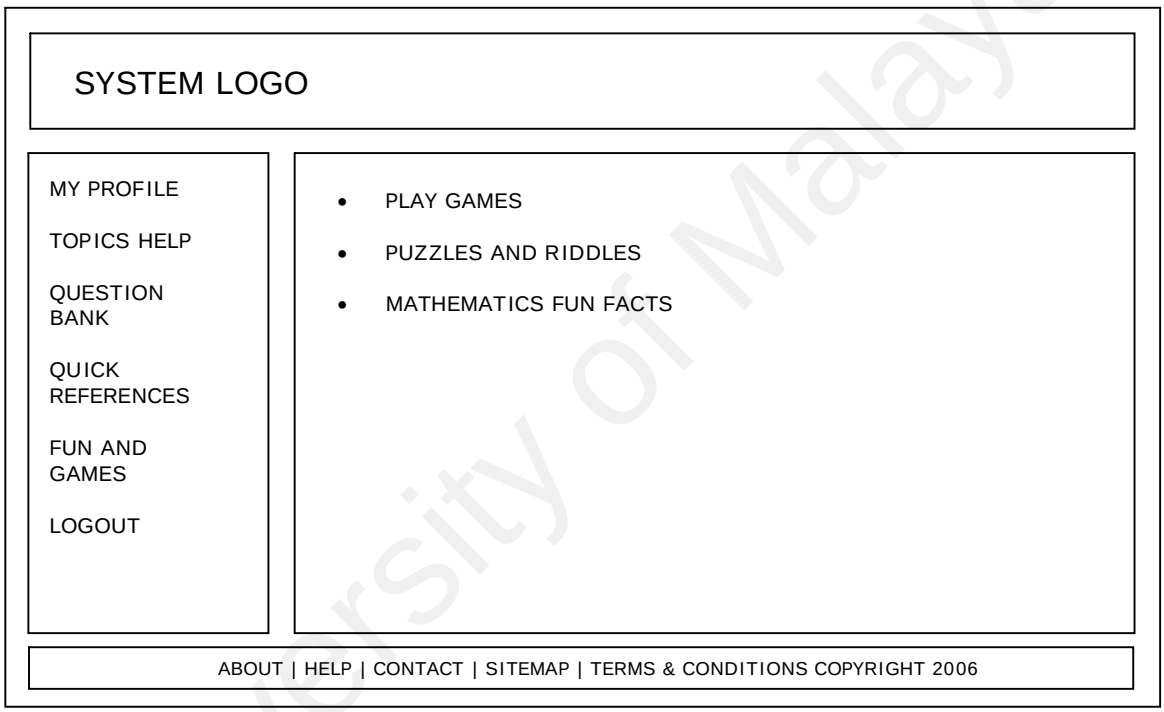


Figure 4.11
Fun and Games Storyboard

University of Malaya

Table 4.18
Fun and Games Storyboard Description

Item	Description
Narration	This module is divided into three sub-modules namely; games – mathematical games to help user build up their skill in mathematics the fun way; puzzles and riddles – a list of puzzles and riddles user can try to solve; fun facts – a list of mathematics fun facts.
User Interaction	User may choose from the three sub-modules listed to go the sub-modules section.
Placement	1. Graphics: The logo of the prototype remain at the top left of the screen to keep on the consistency. 2. Other graphics and texts will be based on each module's content accordingly.
Colors	There will probably more than three colors involved here to highlight different areas between the three sections.
Text	A list of the three sub-modules will be listed for user to choose from.
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	Animation may be present in mathematical games.
Links from screen(s)	This page is linked from all other pages which originated from the left-side menu.
Links to screen(s)	The link from the sub-modules list will take user to the sub-modules screen.

University of Malaya

4.6.9 Logout Storyboard (Screen 9 of 9)

In the **Figure 4.12** below, it shows the Logout storyboard and **Table 4.19** provide the description of the item in the storyboard.

Screen Description: This is the confirmation page after a user had successfully logged out from the prototype.

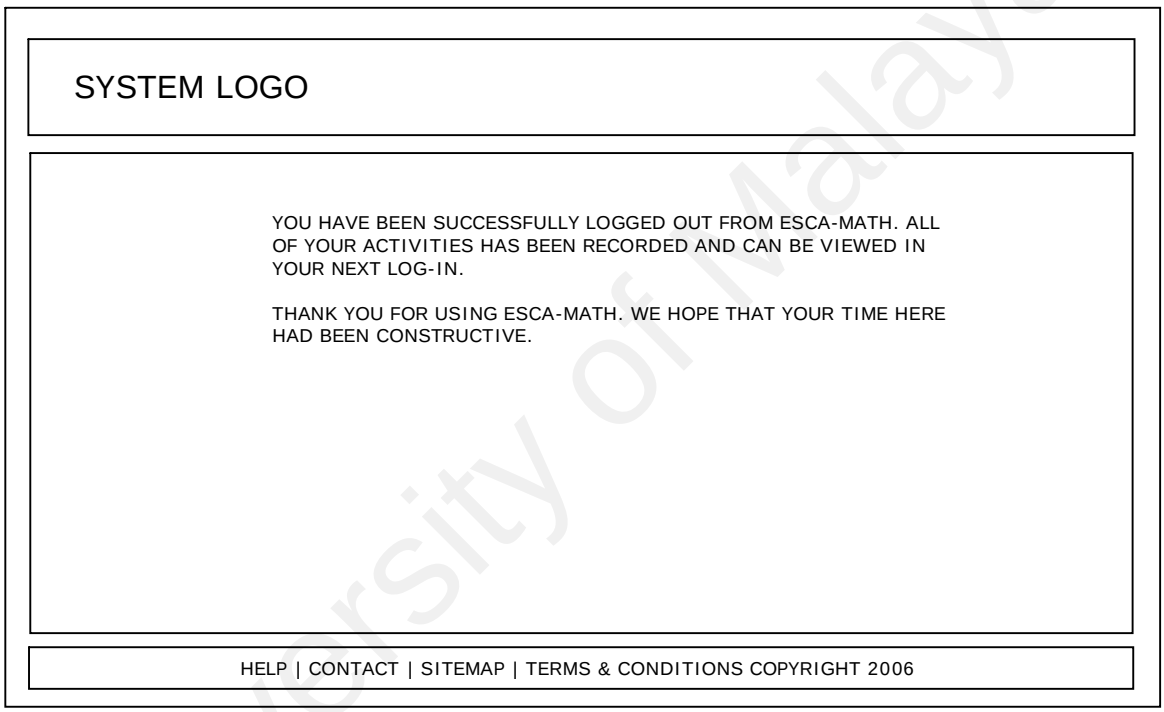


Figure 4.12
Logout Storyboard

University of Malaya

Table 4.19
Logout Storyboard Description

Item	Description
Narration	At any point of the learning process, when a user had decided to end their learning session, they need to click on the 'Logout' button to ensure that all of their activities will be recorded and compiled for their next visit.
User Interaction	There is no user interaction after the 'Logout' button is clicked except for them to wait for the page to load and tell them that their logging-out is successful.
Placement	1. Graphics: There is the logo of the prototype remaining at the top left of the screen to keep on the consistency. 2. Buttons: There is no button present here.
Colors	Limited to three colors to avoid it to become too colorful. ESCA-Math uses a combination of three main colors which are orange, grey and blue.
Text	There is a confirmation message on screen which is, 'You have been successfully logged out from ESCA-Math. All of your activities has been recorded and can be viewed in your next login. Thank you for using ESCA-Math. We hope that your time here had been constructive.'
Font	Arial will be used as fonts to accommodate most computers with older version of Windows with size 12 for text and links.
Animation	There is no animation in this page.
Links from screen(s)	This page is directly linked from the action of clicking the 'Logout' button.
Links to screen(s)	There is none.

University of Malaya

4.7 SUMMARY

The requirement analysis involved a questionnaire and research on the frequently Internet-accessed location. Questionnaire results revealed a positive sign of implementing Mathematics e-learning in the educational system. This can be seen in the high percentage of students who had been using e-learning as part of their educational pursuit. What is more convincing is that most of these students learned to use the Internet by themselves. This would make the introduction to ESCA-Math easier.

Furthermore, the questionnaire also reveals that, from the various purposes of students using the Internet, educational is amongst the highest. This shows that these students are beginning to realize that there are other medium they could turn to, to help them with their schools work besides the textbooks and teachers. This can be seen by the highest percentage of reasons for using e-learning which is to seek help with homework and revision. In the last section of the questionnaire, students are presented with twenty-five statements in Likert-scale for further calculation. These statements are addressing five issues.

The first issue is regarding the level of students' mindset towards e-learning and the result is very promising when it shows that students are leaning towards 'strongly agree' in implementing e-learning in the educational system. The second issue covers the facility and tools needed in order to use e-learning. It shows that the equipments are still at the moderate level, but it is also worth to note that Malaysian government is still in the process of overcoming the deficiency by providing RM2.1 billion out of the Ninth Malaysia Plan for education. The third issue is concerned with students'

University of Malaya

experience with e-learning. The results revealed that students are satisfied with it so far. However they believe that if they are highly skilled with how to use the Internet, they will benefit more from them.

The fourth covers students' perception between e-learning and traditional method which is teachers and textbooks. The results show a moderate level of confidence these students have in class and they heavily agree that multimedia elements help them in learning Mathematics better. Combining these two statements, it will further increase the significance of the study companion so that students are able to seek help other than textbooks, no matter how low their confidence level is in class. The last issue concerns with students' perception towards Mathematics and the results show that they do realize the importance of succeeding in this subject. This will make the implementation easier seeing that they know what is at stake should they fail it, and thus this will encourage them to seek help where available. Hence, the support system.

The research on the frequently Internet-accessed location was meant to find out about the condition of computers at school after discovering that a high percentage of places to access the Internet are at their schools' computer laboratories. The visit shows that students mostly have access to the Internet during non-school session or with teachers' permission should they want to use them during school. Flash player has been installed in each and every one of these computers to ensure the smoothness of execution when it is ready to be used.

University of Malaya

The prototype design phase is concerned with defining the prototype framework, functional and non-functional requirements, prototype architecture, prototype flowchart, web development tools and the proposed storyboards.

Prototype framework reflects to literature review's revelation of Mathematics anxiety and some of the results from the analysis phase. This prototype is aimed to become a learning tool and not to replace the role of the teacher entirely. Prototype flowchart laid out the roadmap of events to differentiate the two types of users; a registered one and the unregistered one. Storyboard shows nine different types of screen and their layout namely; Main Page, Registration Page, Quick Test Page, My Profile Page, Topics Help Page, Question Bank Page, Quick References Page, Fun and Games Page and Logout Page. When the system has been successfully implemented, users shall have an alternative tool other than what they are taught in classes and they can find in both textbooks and revision books.

As a conclusion, this requirement analysis reveals a very promising prospect to continue carrying on with the project.

University of Malaya

CHAPTER 5

PROTOTYPE DEVELOPMENT

5.1 INTRODUCTION

This chapter explained the prototype development for ESCA-Math prototype. It comprises a detail explanation on prototype modules and the topic assessment algorithm (TASA) that is used in this prototype.

5.2 PROTOTYPE MODULES

This prototype consists of 5 modules and they are as follows:

5.2.1 User Profile

In this module, all students' progress will be recorded and the display will be from the recent progress in each of their visit. The main function of this module is to record and display student's progress in a graph. This module contains:

1. Student's performance chart – a chart which will show all tests and examinations that students had taken in the prototype.
2. Performance summary – a short summary of student's performance will be displayed at the side of the performance chart. This summary consists of an average grade for student's overall performance as a means to encourage them further, a summary of student's weak and strong topics which will make it easier for students to decide the direction of their next

University of Malaya

revision session and a record of how many tests and examinations they have taken.

3. Student's individual profile such as user ID, password, full name, address, age and which form they are in.
4. SPM Countdown – a countdown towards their most important examination in their school life; SPM. This countdown will be displayed according in what year the students are in. If they are in Form 4, then there is more than a year for them where as students in Form 5, they have less than a year.

Other function includes the utility to change password. **Figure 5.1** below shows the screenshot for the User Profile module.

University of Malaya

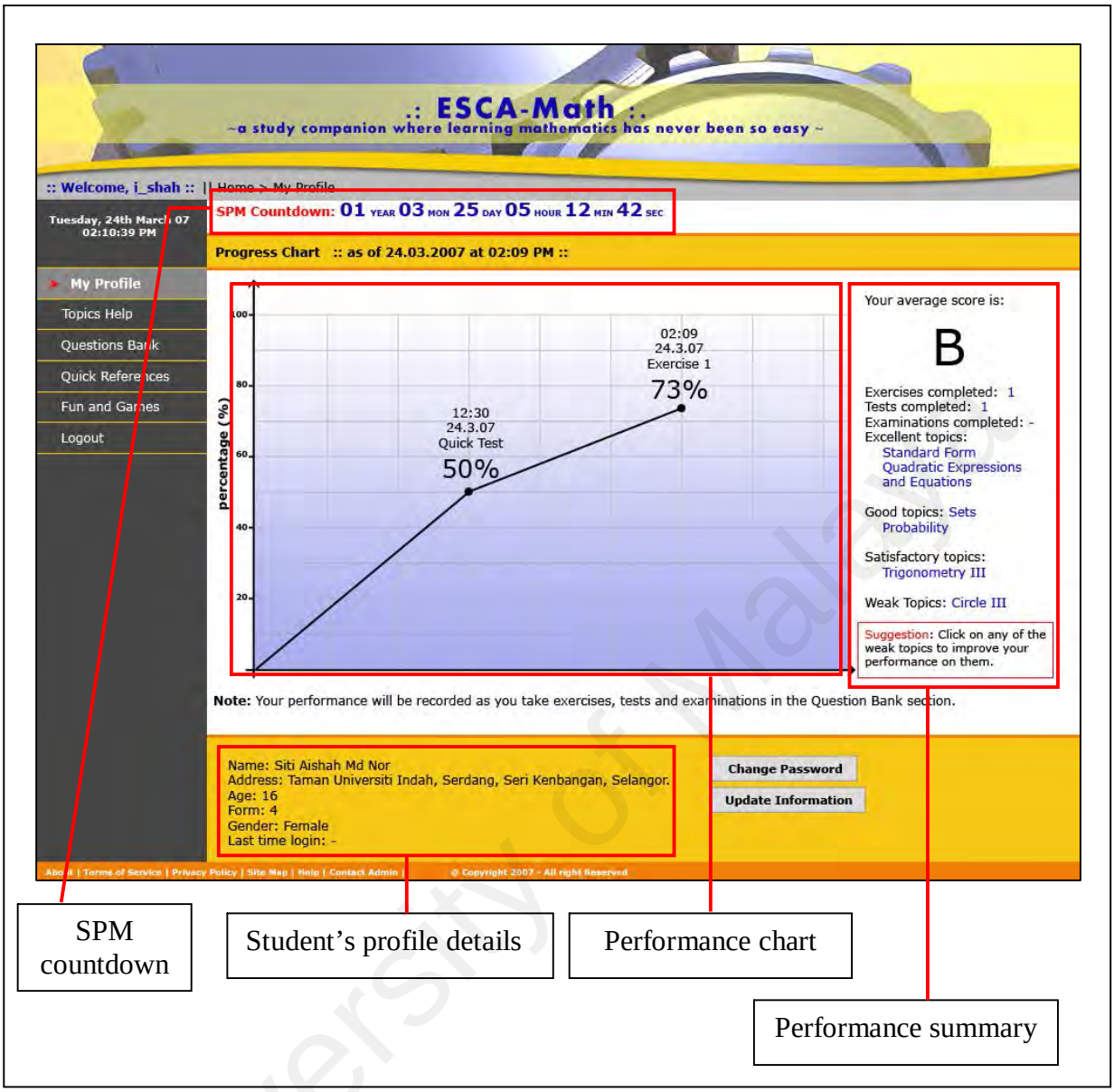


Figure 5.1
User Profile Screenshot

University of Malaya

5.2.2 Topics Help

This is the largest module in the prototype. It provides extensive help to the students for each of the topics in the Mathematics syllabus. Users will choose whichever topic they wish to view and the learning module for the topic will be displayed. This learning modules consists of,

1. Syllabus and Topics Instructions – it is an instruction of what students are supposed to learn and what they are supposed to gain from it. A summary at the end of the topic's lesson will summarize what each particular topic is about.
2. Animated Formulas – all formulas will be in the animated format to help students to understand the concept behind it. If these formulas are written plainly, then there is not much difference between a web system and a book. Perhaps by having it animated, it will ease them to, first and foremost, understand and are able to apply it when answering questions later. They are however, an option for the students to click to ease down the page download times. If students feel like they could use the extra help, then they should click on the option.
3. Example of Questions and Answers – these are to test students' ability on the subjects. Questions will appear first on the screen without any solution to allow students a chance to try them. When they click on the 'Solution' button, they can check whether they had gotten the right answer. Questions that follow will be arranged in difficulty level. As they go further, the questions will be more difficult.
4. Challenge Yourself – This will be the part where a list of exercises for each of the specific topic. This part is to test students' understanding

University of Malaya

further from the overall topic and questions level of difficulties will vary.

Figure 5.2 below shows the screenshot for the Topics Help module.

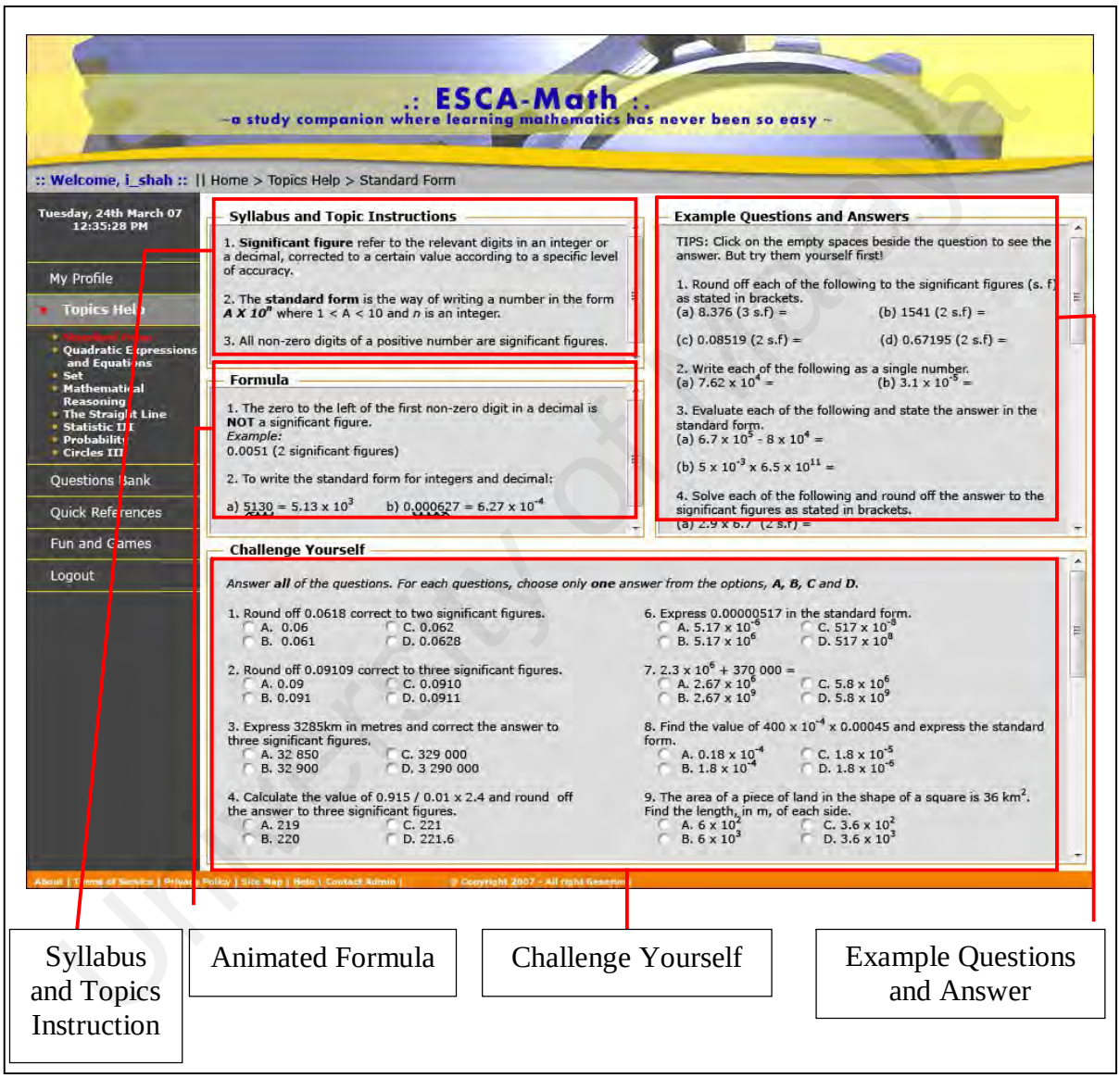


Figure 5.2
Topics Help Screenshot

5.2.3 Question Bank

This can also be called as the evaluation module. A result from the analysis phase shows that mostly students are 'strongly agree' that the drill and practice is an effective way to master Mathematics (*see* **Section 4.2.4.1**). By taking a lot of exercises, students will be able to grasp the concept better. This module provides the students with a lot of practices and they come in three different types which are as follows,

1. Topic Tests – a list of questions based on each of the topics in the syllabus. This is different from those in the 'Topics Help' module in the way that those exercises will not be recorded and compiled in the progress chart but here they will.
2. Exercises – a list of questions from all topics but not in the format of the real Examination papers and does not take as long to complete.
3. Examination Papers – a list of questions from all topics in the format of the real examination papers as outlined by the Malaysian Examination Association (LPM). There are two types of papers. Paper 1 takes an hour and a half while Paper 2 takes two and a half hour to complete. There will be a timer utility to assist students to keep up to time as though they are taking real examinations.

In all modules, there will be a timer and submit button to evaluate answer upon clicking it. All activities in this module will be recorded and compiled in the Progress Chart. **Figure 5.3** below shows the screenshot for the Question Bank module.

University of Malaya

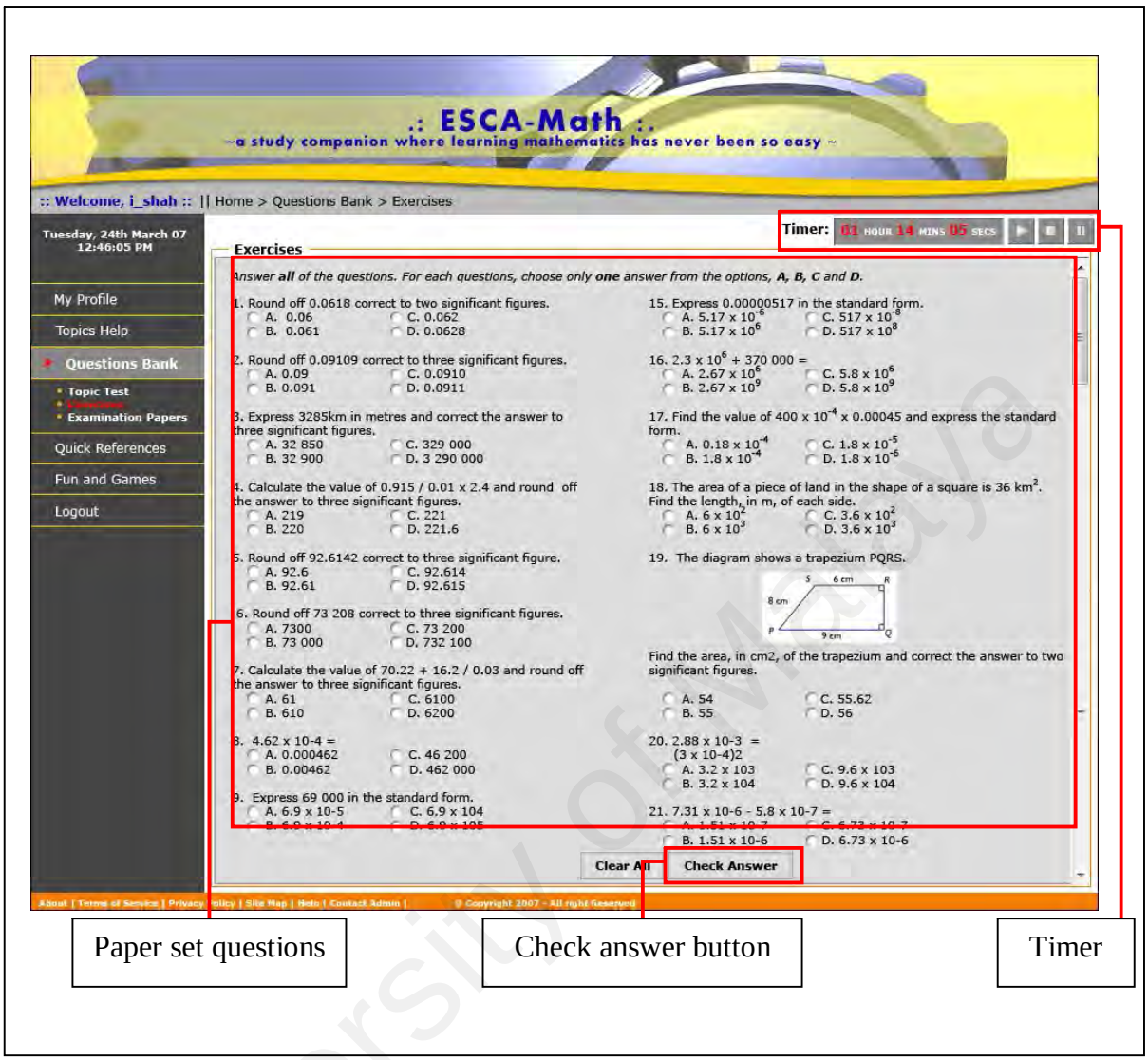


Figure 5.3
Question Bank Screenshot

University of Malaya

5.2.4 Quick References

This module plays as the additional assistant to complete the system as a comprehensive learning tool. There are four items in this module and they are as follows,

1. English to Bahasa Melayu Dictionary – since the implementation of teaching and learning Mathematics and Science in English, many had claimed that Mathematics had turned into an even harder subject. When one look at it carefully, one would realized that Mathematics does not play with a lot of words but numbers. All that is needed is a good dictionary to translate certain terms. In **Figure 5.4** below, it shows the screenshot for this dictionary.
2. Mathematics Tips and Tricks – There are many tips and tricks in mathematics. Some helps students to count faster and save a lot of time for other questions. This part is dedicated to aid students in that way.
3. Study Tips – Some students do not achieve good results not because they are slow learner, but because they do not know how to study better. This part is aiming to help students study better.
4. Motivational Tips – In some cases, students might get discouraged after failing to answer certain questions. This part is dedicated to help them and encourage them not to quit just yet.

University of Malaya

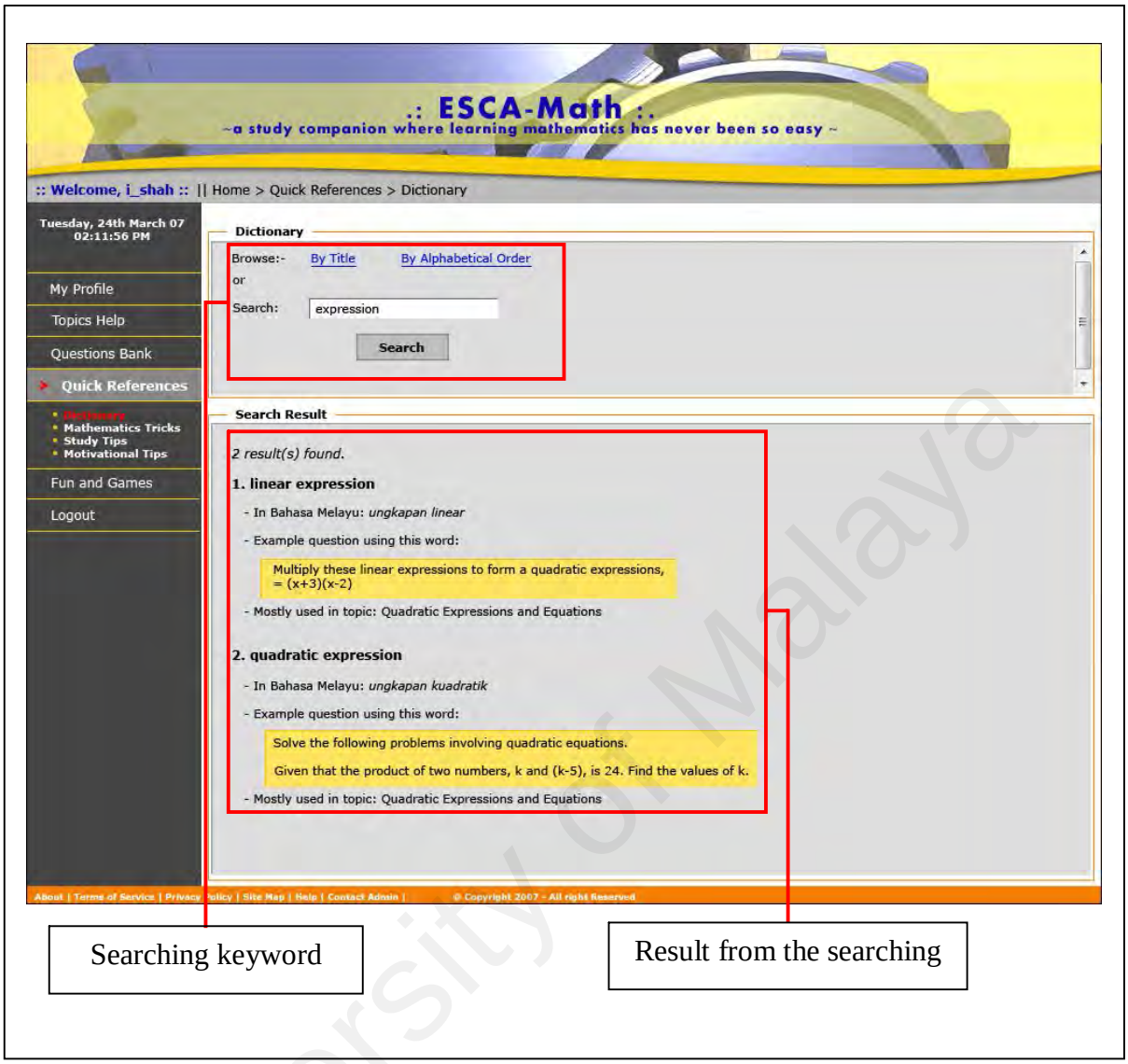


Figure 5.4
English to Bahasa Melayu Dictionary Screenshot

University of Malaya

5.2.5 Fun And Games

One of the result from the analysis process shows that students go to the Internet for entertainment purposes as much as for educational purposes (*see* **Graph 4.7** *in* **Section 4.2.2.1**). Admittedly, after a long session of studying, these students deserve some time off to unwind and thus the entertainment pursuit. This is part of the reason for this module. Granted, students may find other means of entertainment which will suit their need than this, but this does not mean this system cannot provide some recreational and yet constructive activities for them. There are three types of activities provided and they are as follows,

1. Mathematical Games – Games that are related to doing some mathematics work. These are good exercises towards calculating with the mind rather than using calculator.
2. Mathematical and Logical Puzzles and Riddles – This is self-explanatory. This part compiles all sort of mathematical puzzles and riddles for the students to try out. In **Figure 5.5** below, it shows the screenshot for the puzzles and riddles section in ESCA-Math.
3. Mathematics Fun Facts – This is a compilation of interesting facts of mathematics. There will be some experiments that they can try out on their own. By showing how magical mathematics can be, students are able to get comfortable with mathematics and lessen their anxiety towards this subject.

University of Malaya

All of the activities here will not be recorded for the progress chart to further affirm that they are meant for recreational activities only.

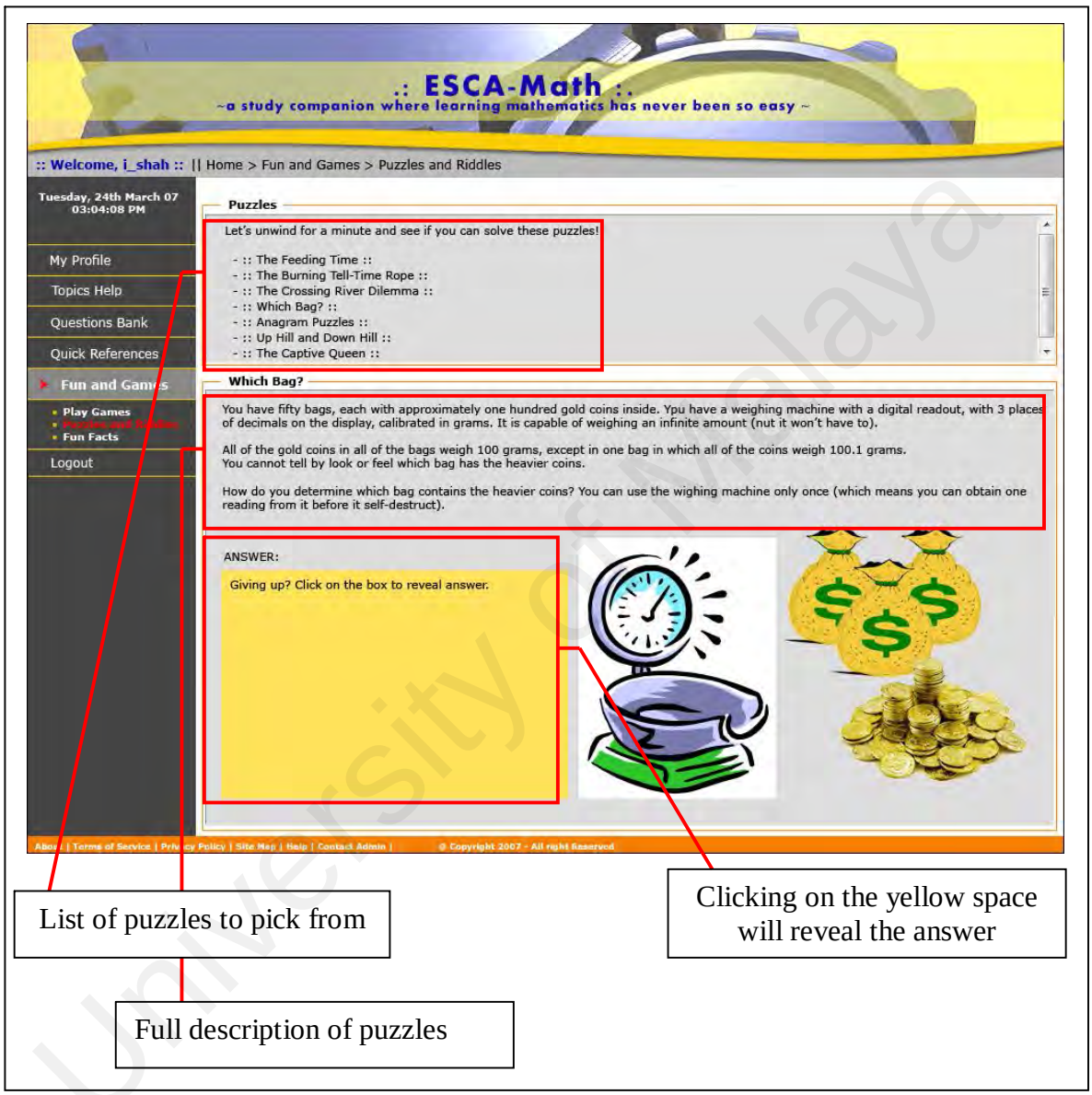


Figure 5.5
Fun and Games Screenshot

University of Malaya

5.3 TOPIC ASSESSMENT ALGORITHM (TASA)

As of the year 2000, the Malaysian Certificate of Education (SPM) introduced a new grading system for students' examination results. It is divided into 9 levels and can be summarized into 4 categories. Below is the grading system, see **Table 5.1**.

Table 5.1
SPM Grading System

Marks	Grade	Category
80 – 100	1A	Excellent
75 – 79	2A	
70 – 74	3B	Credit/Good
65 – 69	4B	
60 – 64	5C	
55 – 59	6C	
50 – 54	7D	Pass/Satisfactory
45 – 49	8E	
0 – 44	9G	Fail/Weak

The student's progress record keeps track of the student's performance as they use ESCA-Math. This progress record consists of several evaluations namely student's current grade, total tests, exercises and examinations taken within ESCA-Math and lists of topic assessment which will help them determine their strong and weak topics.

To process the topic assessment, ESCA-Math uses a topic assessment algorithm (TASA) to calculate them. **Figure 5.6** shows the TASA flowchart.

University of Malaya

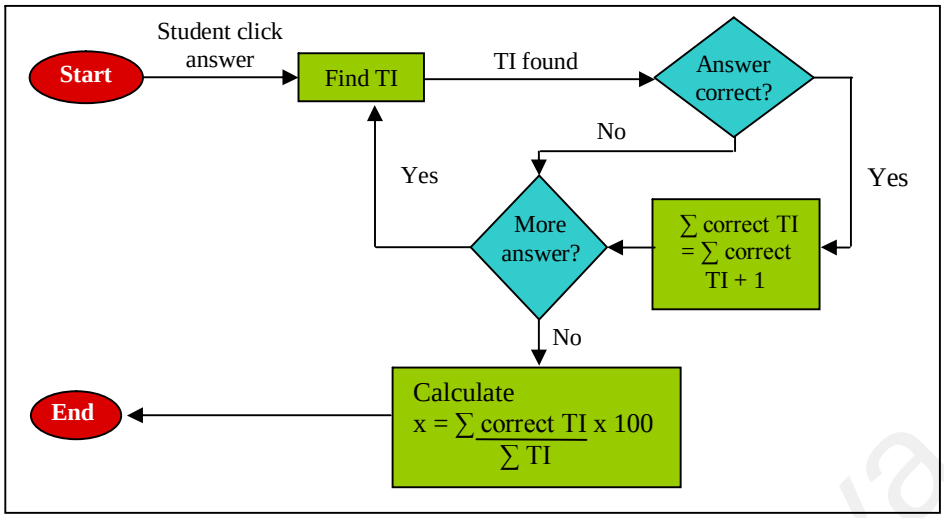


Figure 5.6
TASA Flowchart

Every time student takes a test, exercise or an examination, this algorithm is invoked. Within these paper set there is a topic identifier (TI) to each question to point which topic they are belonging to. With every question answered, the marking scheme will evaluate for wrong and correct answers within the topic range. For each correct answer, the correct answer calculator will increase the current total of the specific topic to 1. When all answers have been assessed, the percentage of last total correct answer over total questions for that specific topic that appear within the paper set will be calculated. This calculation can be seen in **Figure 5.7** below.

$$X = \frac{\sum \text{correct answers}}{\sum \text{questions of specific topic}} \times 100$$

Figure 5.7
TASA Calculation Scheme

University of Malaya

The x will next be mapped into the grading system similar to the grading system used by the examination board. For example (*see* **Figure 5.8** *below*),

```
if … x = 66;
then … topic A = 'Good';
        then … current 'Good' list +=  topic A;
```

Figure 5.8
TASA Grading System

And so, the topic will be listed under the 'Good topic' category.

5.4 SUMMARY

This system consists of 5 modules which complements one another to become a comprehensive study companion tool. The modules are User's Profile, Topics Help, Questions Bank, Quick References and Fun and Games.

The topic assessment algorithm (TASA) is an algorithm used to process students' strong and weak topics. This algorithm is invoked every time students take a paper set from within ESCA-Math. This algorithm will increase the credibility and efficiency of topic assessment summary.

University of Malaya

CHAPTER 6

PROTOTYPE IMPLEMENTATION AND TESTING

6.1 INTRODUCTION

This chapter explains prototype implementation and the different test levels including unit testing, integration testing, prototype testing and user acceptance testing.

Prototype implementation is a process of developing a prototype based on the requirements. The main concern in prototype implementation is the installation of the prototype to be tested in the prototype testing phase. Installation of the prototype is done to integrate all of the functions in each module developed in the prototype. Therefore, the deliverables of the prototype installation is an operational system – but in prototype mode – that will function as required by the objectives and specifications of the prototype.

Prototype testing is often reflected as verification and validation. Validation makes sure that the developer is building the right product according to the specifications, and verification checks the quality of the implementation (Pfleeger 1999). Prototype testing will ensure that the prototype is producing the intended output. Testing and debugging are important processes used in prototype development to discover a defect or bug that is present in the product.

The main purpose of testing is to uncover different types of errors that exist while running the prototype. Prototype testing is the critical element of quality assurance

University of Malaya

and represents the ultimate review of specification, design and coding. A successful testing will uncover errors in the prototype and demonstrates that functions of a prototype appear to be working according to specification.

6.2 ENVIRONMENT PREPARATION

ESCA-Math testing environment was established for the implementation phase to be conducted. The minimum requirements for software and hardware in PC to run and operate ESCA-Math are determined.

6.2.1 Software Requirements

Below are the software requirements for the user to use the prototype:

Table 6.1
Software Requirements

Description	Requirement
Internet Browser	Internet Explorer 6.0 or later
Other requirement	Flash player 6.0 or later

University of Malaya

6.2.2 Hardware Requirements

Below are the hardware requirements for the user to use the prototype:

Table 6.2
Hardware Requirements

Description	Requirement
Processor	Pentium III 400 MHz processor or higher
Operating System	Windows XP or later
Random Access Memory	128MB RAM or above
Monitor	At least a 800 x 600 pixels resolution screen
Other	Microsoft Mouse or other compatible pointing devices, standard keyboard
Internet Availability	Must be connected to the Internet s

6.3 TESTING PROCESS

Testing is a process of evaluating ESCA-Math prototype to verify that is has satisfied requirements and to determine whether there are differences from the expected and actual results. Testing is probably the least understood part of a software development projects. A bug is an unexpected, questionable, or undesirable aspect or behavior displayed, facilitated or caused by the prototype that being tested. Testing can uncover different classes or errors in a minimum amount of time and with a minimum amount of effort. The strategies used for testing are unit testing, integration testing, prototype testing and user acceptance testing.

University of Malaya

6.3.1 Unit Testing

Unit testing is a small unit testing that aims at the verification of the smallest unit within a program. Unit testing verifies that the component functions properly with the types of input expected from studying the component's design. This testing is done on individual components of the prototype to ensure that they operate correctly. Each function is tested independently, without other prototype components or before the entire application was tested.

The first stage of testing ESCA-Math is unit testing. The following steps specify how unit testing is carried out for this application:

i. Examining the code

The code of the program is examined by reading through it to spot for algorithmic faults and syntax faults. This method is useful to identify faults that have been left out accidentally.

ii. Control objects testing.

Command buttons are clicked to test their functionality and text boxes are tested with different data types including null value to ensure invalid data will not cause any fault.

iii. Choosing test cases

Test cases are developed to ensure that the input is properly converted to the desired output. Therefore, to test a component, suitable input data and condition are carefully chosen. Then the component is allowed to manipulate the data, before the output is observed.

University of Malaya

In ESCA-Math, units that were independently tested are Register Account module, User Profile module, Topics Help module, Questions Bank module, Quick References module, and Fun and Games module. The complete unit testing for ESCA-Math is presented in **Table 6.3**.

Table 6.3
Unit Testing Result

Module: Register Account		
Unit	**Expected Output**	**Actual Output**
1. Insert User ID.	1) System will check for user ID availability. 2) If it is available, user ID will added to the system. 3) If not, an error message will appear asking for other user ID.	1) User ID availability is determined. 2) Upon available, it is accepted. 3) Taken User ID prompt an error message asking for other User ID.
2. Insert password.	Password typed appears in asterisk format to conceal it from other people.	Asterisks appear in password text box instead of letters or numbers.
3. Insert full name.	Full name will appear in User Profile.	Full name appeared in User Profile.
4. Insert address.	Address will appear in User Profile.	Address appeared in User Profile.
5. Select age.	Selected age will appear in User Profile.	Selected age appeared in User Profile.
6. Select Form.	Selected Form will appear in User Profile.	Selected Form appeared in User Profile.
7. Click 'Submit' button in Register page.	1) New user information will be added to database. 2) User will be taken to the Quick Test page.	1) User information is added to the database. 2) User is taken to Quick Test page.
8. Click 'Submit' button in Quick Test page.	1) User's test will be evaluated. 2) User will be taken to their User Profile page.	1) User's test is evaluated. 2) User is taken to their User Profile page.
Module: User Profile		
Unit	**Expected Output**	**Actual Output**
1. Change password.	1) User will be prompt to enter current password. 2) User will be prompt to enter new password. 3) Current password will be replaced by the new password.	1) User is prompted to enter current password. 2) User is prompted to enter new password. 3) Current password is replaced by the new password.
2. Edit user profile.	1) User will be taken to edit	1) User is taken to edit profile

University of Malaya

	profile page. 2) User may edit their profile.	page. 2) User is able to edit their profile.
3. Display SPM Countdown	SPM countdown will be displayed depending on what form user is.	SPM countdown is displayed depending on what form user is.
Module: Topics Help		
Unit	**Expected Output**	**Actual Output**
1. View learning module	Learning module will be display depending on topics user chooses.	Learning module is displayed depending on topics user chose.
2. Try out the exercises	User should be able to pick the right answer from the multi-choices radio buttons.	User is able to pick the right answer from multi-choices radio buttons.
Module: Questions Bank		
Unit	**Expected Output**	**Actual Output**
1. Select answer in paper set.	User should be able to pick the right answer from the multi-choices radio buttons.	User is able to pick the right answer from multi-choices radio buttons.
2. Pause timer	Timer should be able to be paused when the pause button is pressed.	Timer is paused when the pause button is pressed.
3. Start timer	Timer should be able to be resumed when the start button is pressed.	Timer is resumed when the start button is pressed.
4. Submit result	Result will be evaluated.	Result is evaluated.
5. Display result	Result will be displayed in the next screen.	Result is displayed in the next screen.
Module: Quick References		
Unit	**Expected Output**	**Actual Output**
1. Insert keyword in 'Dictionary'	1) Keyword will be inserted in the text box. 2) Result will be displayed according to the keyword inserted.	1) Keyword is inserted in the text box. 2) Result is displayed according to the keyword inserted.
2. Select mathematical tips and tricks.	Mathematical tips and tricks will be displayed.	Mathematical tips and tricks are displayed.
3. Select study tips.	Study tips will be displayed.	Study tips are displayed.
4. Select motivational tips.	Motivational tips will be displayed.	Motivational tips are displayed.
Module: Fun and Games		
Unit	**Expected Output**	**Actual Output**
1. Select mathematical games.	Mathematical games will be displayed and user is able to take part in it.	Mathematical games are displayed and user is able to take part in it.

University of Malaya

2. Select puzzles and riddles.	Puzzles and riddles will be displayed.	Puzzles and riddles are displayed.
3. Select fun facts	Fun facts will be displayed.	Fun facts are displayed.

As can be seen in **Table 6.3**, no error was found from the unit testing in ESCA-Math.

6.3.2 Integration Testing

Based on the unit testing, when each individual unit is working correctly and meeting the objectives, they are combined into a working prototype. In other words, integration testing is a process of verifying the prototype components that work together as described in the system prototype and program design specifications. Integration testing was carried out to ensure valid linking and dynamic relationship establishments between modules of the whole prototype and between sub-modules contained in all individual modules.

Integration testing is used in ESCA-Math to construct its program structure in conjunction with other tests to uncover errors associated with interfacing. The objective of this test is to take unit-tested modules and to build a program structure that has been dictated by design. This testing will ensure that the interface such as the tracking progress record is systematized and produce the correct result.

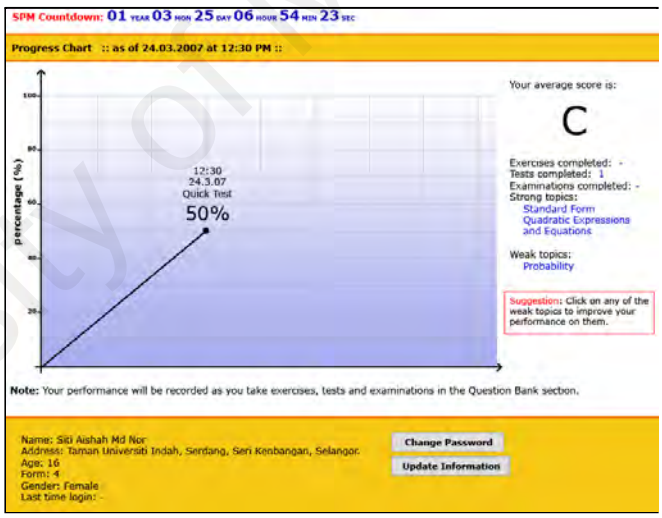
The incremental integration strategy approach is used in ESCA-Math for this purpose. The employed approach that was used in this testing is the bottom up approach. Each module is individually tested from the lowest to the highest

University of Malaya

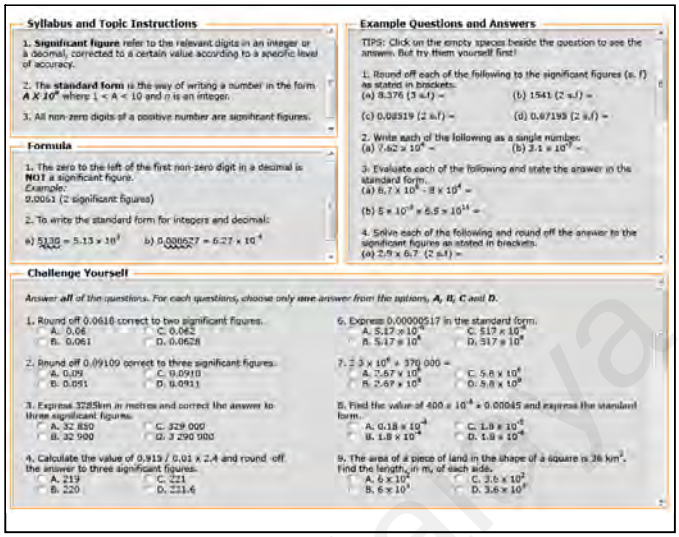
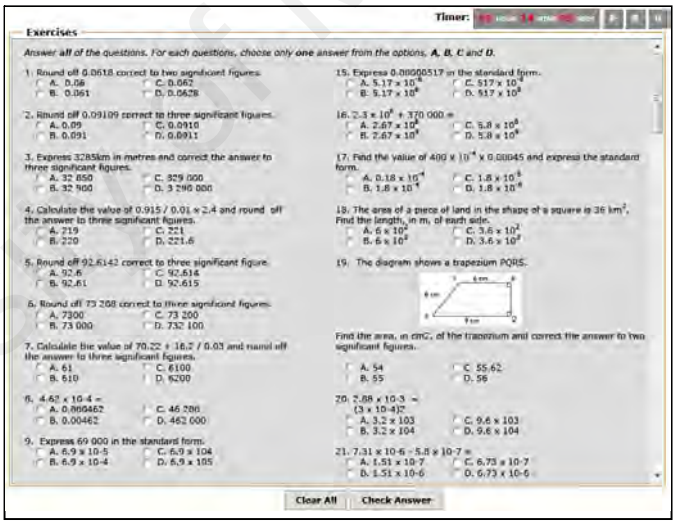
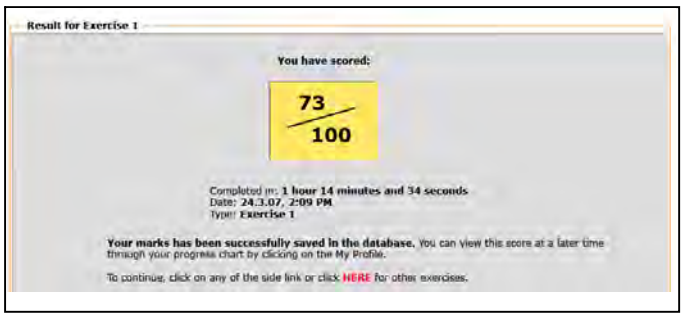
level of the prototype hierarchy. Subsequently, all related modules are tested. This approach is repeated until all modules are successfully tested.

In the ESCA-Math integration testing, integration forms which consist of User Profile, Topics Help and Questions Bank modules are tested. **Table 6.4** illustrates the integration testing for ESCA-Math.

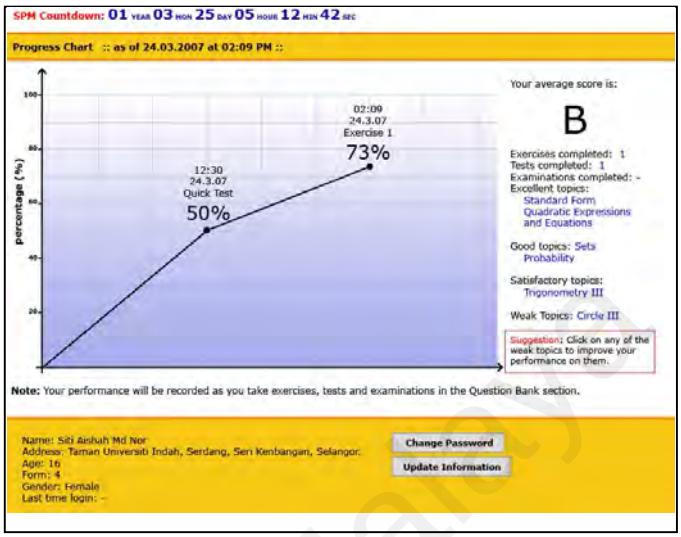
Table 6.4
Integration Testing Result

Step	Result
1. User logging in.	When the user had entered the correct user ID and password, ESCA-Math will displayed their User Profile upon clicking 'Enter'. 

University of Malaya

2. User choose weak topics link from progress record summary	ESCA-Math will take user to Topics Help module with the topic they had chosen as the content. 
3. User takes paper sets from the Questions Bank module.	1. User select answers from the multi-choices radio buttons.  2. User click 'Check Answer' button when they have finished answering. 3. Result will be displayed and the link to their User Profile will be provided. 

Universiti Malaya

	4. User Profile is displayed with the latest result added to the progress chart.  5. Topic Assessment Algorithm display the latest topic assessment to guide user in proceeding with their learning process. 

As can be seen, the integration testing was conducted successfully without any error found.

6.3.3 Prototype Testing

The last testing procedure is prototype testing. Testing the prototype is quite different from unit testing and integration testing. Prototype testing includes

University of Malaya

series of different tests, which primary purpose is to test the whole prototype to uncover its limitation and to measure its capabilities. This test includes the testing on the performance, reliability, accuracy and other criteria. Below are the various testing included in this prototype testing:

- Recovery testing – ESCA-Math should be able to recover from different value input that causes unexpected errors.
- Functional testing – ESCA-Math should be to fulfill functional requirement that were listed in **Section 4.4.3**.
- Performance testing – ESCA-Math should be able to fulfill the non-functional requirement that were listed in **Section 4.4.4**.

This prototype testing is explained in **Table 6.5** below.

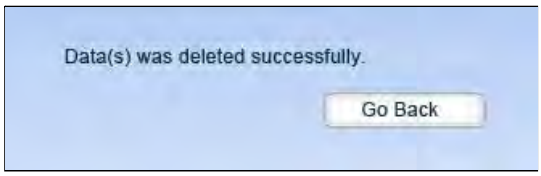
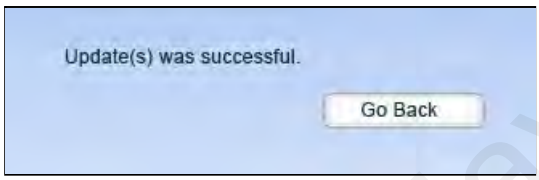
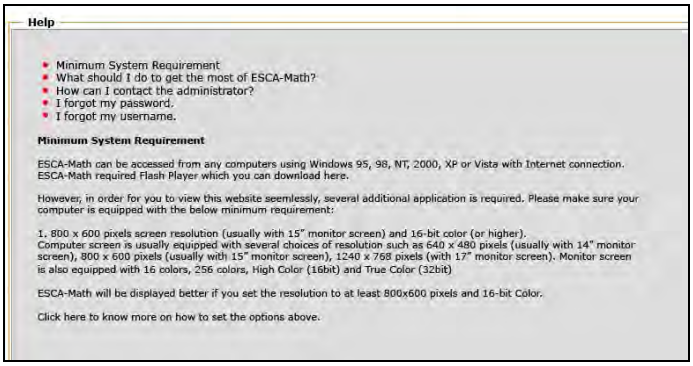
Table 6.5
Prototype Testing Result

Step	Result
Recovery testing: **A. Logging In Page** 1. User inserts only Username or password but not both.	1. Error box appeared asking user to insert the other information. 

University of Malaya

	
2. User did not insert username and password.	2. Error box appeared asking user to insert both user ID and password. 
3. User inserts the wrong username and/or password.	3. Error box appeared asking user to either register or try again. 
B. Register Page 4. Empty text box(es) or unanswered radio button(s).	4. Error box appeared asking user to fill in incomplete box(es). 
Functional testing: 1. Click on User Profile	1. User Profile displayed the latest information.

University of Malaya

2. Delete content by the administrator	2. Administrator is able to delete content from the system. 
3. Edit content by the administrator	3. Administrator is able to edit content from the system. 
Performance testing: 1. Site Map feature	1. Site map showing the overall diagram of the system is displayed. 
2. Help feature	2. Help screen is displayed. 

University of Malaya

As can be seen, the prototyping testing was conducted successfully without any error found.

6.4 TYPES OF USERS

ESCA-Math has two levels of users as described in **Table 4.10** (*see* **Section 4.4.1**).

6.4.1 Student

Form 4 and Form 5 students are the end-users whom this prototype was developed for and tested on. Due to time and budget constraint, test was only implemented on several students from the three schools selected for questionnaire distributions in Requirement Analysis phase. Test revolves around the following modules:

- Registering for an account
- Creating User Profile
- Display and viewing Topics Help
- Taking test in Questions Bank
- Display and viewing Quick References
- Display and viewing Fun and Games

6.4.2 Administrator

For this prototype, administrator is a person who would maintain and update prototype's content. Due to time and budget constraint, test was only implemented on several teachers who are the best candidate for administrator post for ESCA-Math in this prototype as they know the inside out of Form 4

University of Malaya

and Form 5 Mathematics syllabus. Test revolves around the following modules:

- Adding content
- Editing content
- Deleting content

6.4.3 User Acceptance Testing

At this stage, user acceptance testing verifies the whole prototype function properly and it involved the end users. User acceptance testing will be tested by the end users who can be divided into two categories namely; students and administrator. It is to make sure the objectives and requirements of the proposed system will be fulfilled.

6.4.3.1 Students

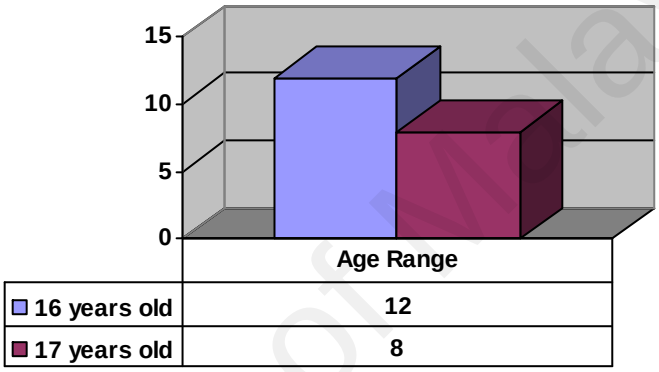
20 students involved in this user acceptance testing. Each of the students will test the prototype individually. Questionnaire is distributed during the testing process. Their evaluation of ESCA-Math is gathered in their feedback and comment that were filled through the questionnaire form **(Appendix D).**

The questionnaire was made up of three parts. The purpose of part one was to know the respondents' information, part two was on evaluation of functionality of each module in ESCA-Math and the final part centered for the evaluation of the ESCA-Math.

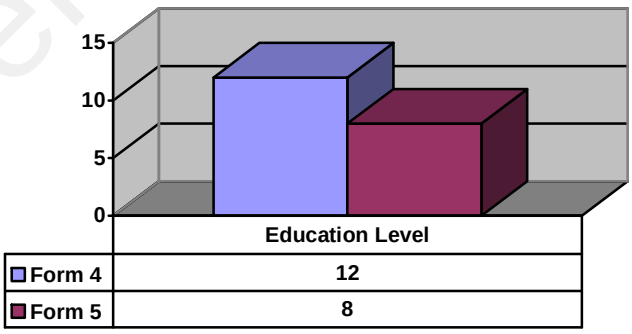
University of Malaya

Part I: Respondent Information

The first part is called respondents' information which consists of the first three questions of the questionnaire. In this part, respondents were asked a few questions in relation to their gender, education level and age range. **Graph 6.1** illustrates the respondents' age range. **Graph 6.2** illustrates the respondents' education level. **Graph 6.3** illustrates the respondents' gender information.

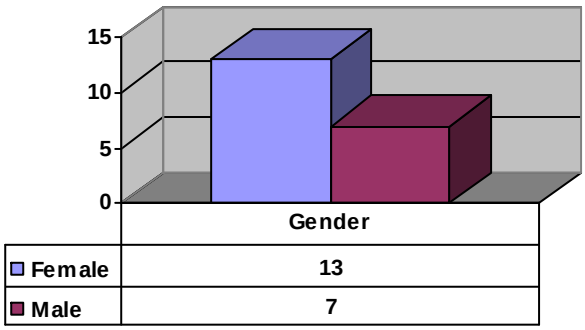


Graph 6.1
Respondents' Age Range – Students



Graph 6.2
Respondents' Education Level – Students

University of Malaya



Graph 6.3
Respondents' Gender Information – Students

Based on the results obtained, 13 female students and 7 male students were involved in this survey in which 8 of them are Form 5 students and 12 are Form 4 students with 8 of them are 17 years old and 12 of them are 16 years old respectively.

Part II: Evaluation of each module in ESCA-Math

In this part students have been asked to evaluate the functionality of each module. The reason was to identify whether the users were satisfied with the functionality of each module. This part is presented to measure their perspectives in score of a five point Likert-scale from 1 (poor) to 5 (excellent). In order to analyze this part, Mean (M) and Standard Deviation (SD) are calculated.

Table 6.6 shows the mean and standard deviation of respondents' rates for each module. Based on the results, the highest mean of the functionalities ESCA-Math modules is 'Topic evaluation scheme' with 4.75 and it receives the lowest score of standard deviation with 0.444. This shows that

University of Malaya

almost all of the students rates 'excellent' for the functionalities of ESCA-Math in providing topic evaluation scheme.

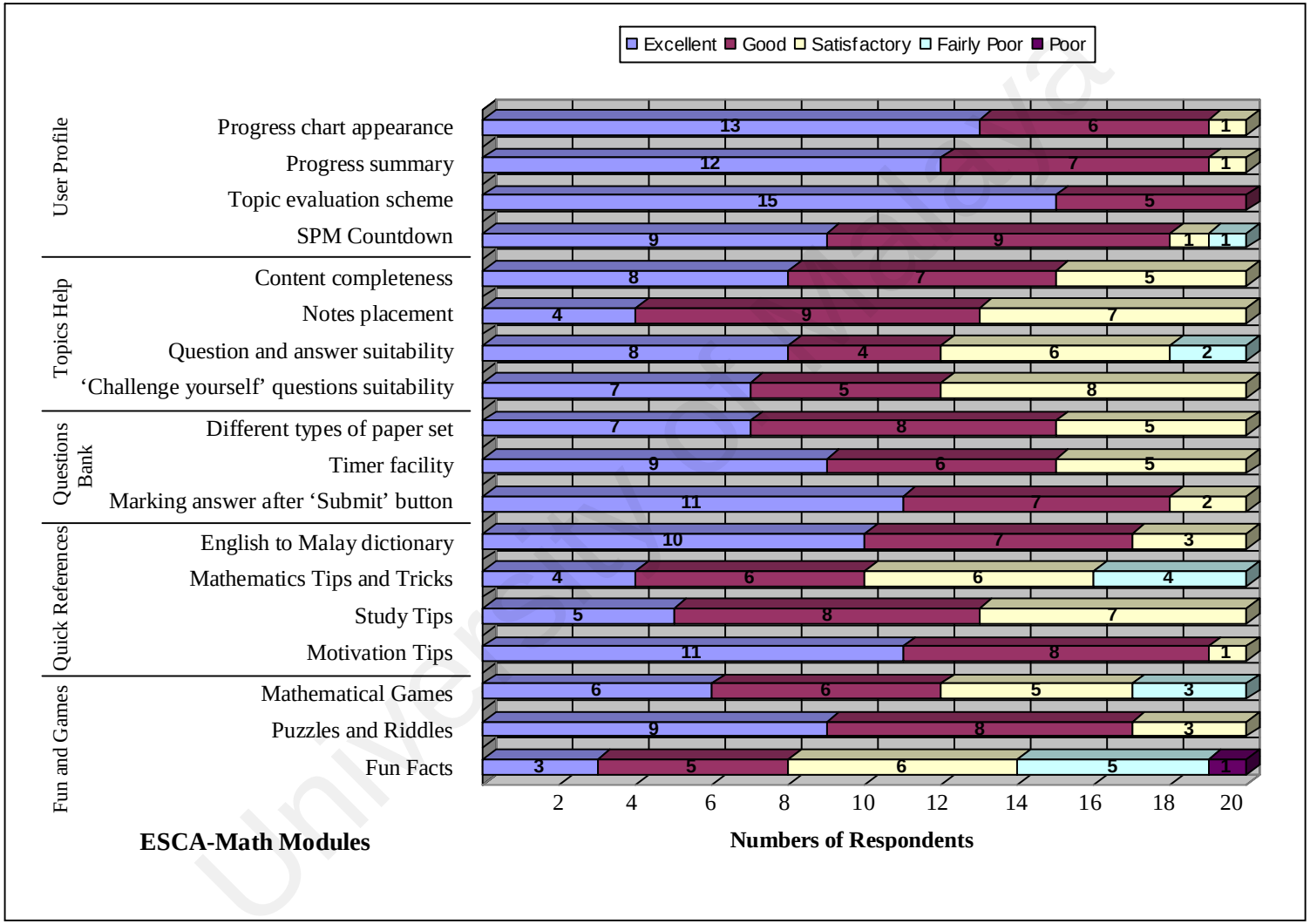
The second highest mean is 'Progress chart appearance' with 4.60 and it receives the second lowest score of standard deviation with 0.598.

Table 6.6
Mean and Standard Deviation of the Functionalities of Each Module – Students

Module	Functionality	Mean (M)	Standard Deviation (SD)
User Profile	Progress chart appearance	4.60	0.598
	Progress summary	4.55	0.605
	Topic evaluation scheme	**4.75**	**0.444**
	SPM Countdown	4.30	0.801
Topics Help	Content completeness	4.15	0.813
	Notes placement	3.85	0.745
	Question and answer suitability	3.90	1.071
	'Challenge Yourself' questions suitability	3.95	0.887
Questions Bank	Different types of paper set	4.10	0.788
	Timer facility	4.20	0.834
	Marking answer after clicking 'Submit' button	4.45	0.686
Quick References	English to Malay dictionary	4.35	0.745
	Mathematics tips and tricks	3.50	1.051
	Study tips	3.90	0.788
	Motivation tips	4.50	0.607
Fun and Games	Mathematical Games	3.75	1.070
	Puzzles and Riddles	4.30	0.733
	Fun facts	3.20	1.152

Statistics of all modules were combined and shown in **Graph 6.4** for further explanation of the functionalities of each module results.

University of Malaya



Graph 6.4
Respondents' Rates on the Functionalities of Each Module – Students

In User Profile modules, most of them were satisfied with the functionalities of the module where 13 of them rated the *progress chart appearance* as 'excellent', 6 rated 'good' and the remaining 1 rated 'satisfactory'. In terms of the *progress summary,* 12 of them rated 'excellent', and 7 rated 'good', and 1 rated 'satisfactory'. In *topic evaluation scheme* module, 15 rated 'excellent' and 5 rated 'good'. This shows that students are mostly satisfied with this module that ESCA-Math is offering. Lastly, for *SPM countdown,* 9 of them rated 'excellent', 9 rated 'good', 1 rated 'satisfactory' and 1 rated 'fairly poor'. From these results, it can concluded that the User Profile module have satisfied the students.

As for the Topics Help module, 8 of the students rated *content completeness* as 'excellent', and 7 rated 'good' and 5 rated 'satisfactory'. Meanwhile, for *notes placement,* 4 of them rated 'excellent', 9 rated 'good' and 7 rated 'satisfactory'. The *question and answer suitability* was rated 'excellent' by 8 students while 4 rated 'good', 6 rated 'satisfactory' and 2 rated 'fairly poor'. In *'challenges yourself' questions suitability* 7 of the students rated it as 'excellent', 5 of them rated it as 'good' and 8 rated it as 'satisfactory'.

As for the Questions Bank module, 7 rated 'excellent', and 8 rated 'good' and 5 rated 'satisfactory' for the *different types of paper set.* It shows that students are satisfied with the three paper sets this module is offering namely; Topic Test, Exercises and Examinations. For the *timer facility,* 9 of the students rated it 'excellent', 6 of them rated it 'good' and the remaining 5 rated it as 'satisfactory'. For the *marking answer after clicking 'Submit' button,* 11 rated it as 'excellent', 7 rated it as 'good' and the remaining 2 rated it as 'satisfactory'. It shows that students are most satisfied with the function of marking answer only after they click the 'Submit' button in the questions bank module. These results have shown that the Questions Bank module is beneficial according to the students.

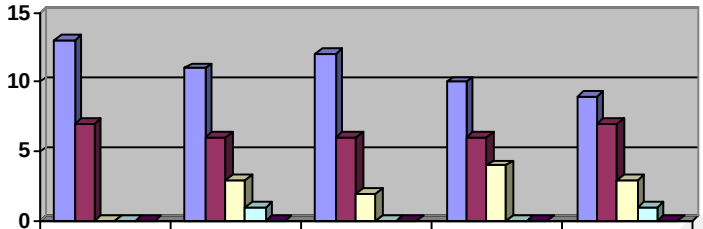
University of Malaya

In the Quick References module, 10 students rated 'excellent', 7 rated 'good', and 3 rated 'satisfactory' for *English to Malay dictionary*. Meanwhile, for the *mathematics tips and tricks* module, 4 students rated 'excellent', 6 rated it as 'good', 6 rated it as 'satisfactory' and 4 rated it as 'fairly poor'. In the *study tips* module, 5 students rated it as 'excellent', 8 more rated it as 'good' and the rest rated it as 'satisfactory'. *Motivation tips* receive 'excellent' by 11 of the students, 'good' by 8 of the students and 'satisfactory' by the remaining 1. These results showed that this module provide a good reference to the students as what it is suppose to offer.

The last module called the Fun and Games module. For the *mathematical games*, 6 students rated 'excellent', 6 students rated 'good', 5 students rated is as 'satisfactory' and 3 rated it as 'fairly poor'. *Puzzles and riddles* receive 9 'excellent' rating, 8 'good' rating and 3 'satisfactory' from the students. Lastly, the *fun facts* was rated 'excellent' by 3 of the students, 'good' by 5, 'satisfactory' by 6, 'fairly poor' by 1 and 'poor' by the remaining 1 of the students. This module receives the least 'excellent' from the students because it is only a supporting module unlike all of the other modules within ESCA-Math. Thus, these students did not find this module as significantly important as the other modules.

University of Malaya

Conclusion:



	User Profile	Topics Help	Questions Bank	Quick Reference	Fun and Games
Excellent	13	11	12	10	9
Good	7	6	6	6	7
Satisfactory	0	3	2	4	3
Fairly Poor	0	1	0	0	1
Poor	0	0	0	0	0

Graph 6.5
Total Rate of ESCA-Math Modules – Students

Based on the previous explanation, a conclusion is made for the rates of each module. As can be referred to **Graph 6.5**, the mode of respondents' rate is 'excellent' for all modules except for Fun and Games module which is probably it is the least significantly important compared to the other modules.

Part III: Evaluation of ESCA-Math

In this part, the students were asked on non-functional requirements of ESCA-Math in terms of user interface, simplicity and ease of use, accuracy, clarity of diagram and interactivity of the system. This part is presented to measure their perspectives in score of a five point Likert-scale from 1 (poor) to 5 (excellent). In order to analyze this part, Mean (M) and Standard Deviation (SD) are

University of Malaya

calculated. **Table 6.7** shows the evaluation given by respondents on the ESCA-Math.

Table 6.7
Evaluation from the respondents on ESCA-Math – Students

Functionality	Mean (M)	Standard Deviation (SD)
Attractive user interface	3.60	0.940
Learning modules provided suitable for the user	3.90	0.852
It is simple to use	4.25	0.786
Easy to learn and understand	4.35	0.745
It is easy to navigate from one module to another	4.05	0.887
The system does what is expected to do	3.80	0.894
Able to learn in 'peer-pressure' free environment	4.25	0.716
Able to learn in 'teacher-pressure' free environment	4.05	0.945
Able to learn mathematics in enjoyable way	3.95	0.826
Able to learn in own pace	4.40	0.681
Does not take long to learn the process to use system	3.85	0.745
After log-out, able to pick up where last left quickly	3.95	0.945
Progress chart is motivating	**4.80**	**0.410**
Topic evaluation scheme assist to concentrate weakness	4.65	0.587
Satisfied with what ESCA-Math has to offer	4.20	0.768
No error encounter while using ESCA-Math	4.00	0.918
User friendly	4.30	0.865
Overall	4.70	0.470

University of Malaya

From the result in **Table 6.7**, it can be seen that the highest mean is 'Progress chart is motivating' with 4.80 and it receives the lowest score of standard deviation with 0.410. This shows that the respondents commonly weight 'excellent' on the providing of progress chart in ESCA-Math. Meanwhile, the lowest mean is 'attractive user interface' with a 3.60 and standard deviation of 0.940. This could be contributed by the small amount of animation and graphics that could cause a longer download time of web pages. Their presence should be kept in the minimum since their presences do not benefit the student when they caused a longer download time.

Based on the results shown in the **Table 6.7**, it can be concluded however, that most of the respondents' options were leaning towards 'excellent' for the overall functionality of ESCA-Math as a study companion for them to learn mathematics.

6.4.3.2 Administrator

5 teachers were involved in this user acceptance testing. Questionnaire is distributed during the testing process. Their evaluation of ESCA-Math is gathered in their feedback and comment that were filled through the questionnaire form *(***Appendix E***)*.

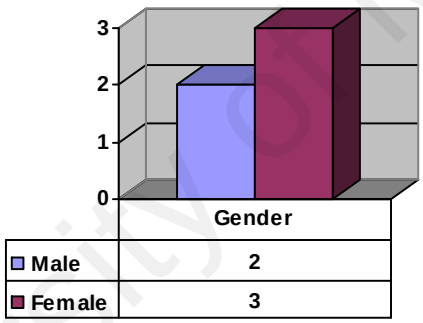
The questionnaire was made up of three parts. The purpose of part one was to know the respondents' information, part two was on evaluation of

University of Malaya

functionality of each administrator control in ESCA-Math and the final part centered for the evaluation of the overall administrator feature in ESCA-Math.

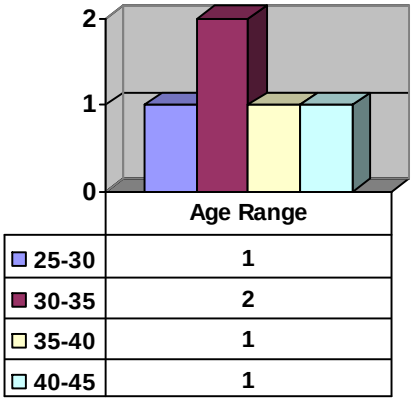
Part I: Respondent Information

The first part is called respondents' information which consists of the first two questions of the questionnaire. In this part, respondents were asked a few questions concerning their gender and age range. **Graph 6.6** illustrates the chart for the gender and **Graph 6.7** illustrates the age range.



Graph 6.6
Respondents' Gender Information – Administrator

University of Malaya



Graph 6.7
Respondents' Age Range – Administrator

Based on the results obtained, 3 female administrators and 2 male administrators were involved in this survey. One is in each age range except for 30-35 where there are 2 of them.

Part II: Evaluation of each administrator control in ESCA-Math

In this part teachers have been asked to evaluate the functionality of each module. The reason was to identify whether the users were satisfied with the functionality of each module. This part is presented to measure their perspectives in score of a five point Likert-scale from 1 (poor) to 5 (excellent). In order to analyze this part, Mean (M) and Standard Deviation (SD) are calculated.

University of Malaya

Table 6.8 shows the respondents' rates for each module. Based on the results, the highest mean of the functionalities ESCA-Math administrator control is 'editing content' with 4.60 and it receives the lowest score of standard deviation with 0.548.

Table 6.8
Results of Respondents' Rates on the Functionalities of Administrator Control – Administrator

Functionality	Mean (M)	Standard Deviation (SD)
Adding content	4.20	0.837
Deleting content	4.00	1.000
Editing content	**4.60**	**0.548**
Overall	4.40	0.894

As can be referred in **Table 6.8**, the highest mean from the respondents' belong to 'Editing content' followed by 'Adding content' and 'Deleting content'. In the overall, respondents rated the administrator feature as 4.40 (mean) which is 'good' and leaning towards 'excellent'.

Part III: Evaluation of the overall administrator feature in ESCA-Math

In this part, the administrators were asked on non-functional requirements of ESCA-Math in terms of user interface, simplicity and ease of use, accuracy and interactivity of the system. This part is presented to measure their perspectives in score of a five point Likert-scale from 1 (poor) to 5 (excellent). In order to analyze this part, Mean (M) and Standard Deviation (SD) are

University of Malaya

calculated. **Table 6.9** shows the evaluation given by respondents on the ESCA-Math administrator control.

Table 6.9
Evaluation from the Respondents on ESCA-Math Administrator Control – Administrator

Statements	Mean (M)	Standard Deviation (SD)
Attractive user interface	3.40	1.140
It is simple to use	3.80	0.837
Easy to learn and understand	3.60	0.894
Easy to remember even after not in used for a long time	4.00	0.707
The system does what is expected to do	4.60	0.894
Accuracy of the system output/results	4.40	0.548
No error encounter while using administrator control	4.20	0.837
User friendly	4.40	0.894
Overall	4.40	0.894

From the above result, it can be seen that the highest mean is the statement 'the system does what is expected to do' with 4.60 but the lowest score of standard deviation is in the 'system is accurate' statement with 0.550. The overall rate for ESCA-Math administrator control is 4.40 with a standard deviation of 0.894. This shows that the administrators leaning towards 'excellent' on the administrator control provided in ESCA-Math.

University of Malaya

6.5 SUMMARY

When it comes to the testing process, the software development life cycle almost reaches the final steps. The prototype was tested with a list of testing methods such as unit testing, integration testing and prototype testing. Unit testing was tested on every block of written code and every single component or functions built. Integration testing was conductor for interaction between two or more components. Prototype testing was performed on the whole prototype, from prototype loading to prototype termination. Finally, a survey was performed as the user acceptance testing was conducted to analyze the user satisfaction rates on the prototype. The user acceptance testing shows that the users are mostly satisfied with what ESCA-Math has to offer and thus, it is beneficial to these students.

University of Malaya

CHAPTER 7

CONCLUSION AND FUTURE WORK

7.1 INTRODUCTION

On the completion of testing and evaluation of ESCA-Math, the conclusion and future work are discussed in this chapter. This is crucial to evaluate processes of the developed prototype to identify the research contribution, strengths of the prototype, limitations of the prototype and objective achieved. Finally, future enhancements are suggested to improve the prototype ability as to minimize all constraints and limitations found.

7.2 RESEARCH CONTRIBUTIONS

This research is concerning with the development of a study companion to Form 4 and Form 5 students. Educational system consists of two groups of involvement namely; the teachers and the students. Consequently, ESCA-Math has contributed to these two groups. The contributions towards the students can be seen in the following ways;

- By providing a study companion to the students for mathematics subject.
- By helping in tracking down students' performance as they use the prototype along the way.
- By helping in decreasing the 'peer pressure' environment where students only have to compete with themselves to bring out their true potential.

University of Malaya

- By helping in decreasing the 'mathematics anxiety' among students by giving them the means to properly revise and evaluate their understanding in the mathematics subject.
- By helping in decreasing the 'test anxiety' as well among the students by giving them the chance to practice properly and getting them prepared for tests and examinations.
- By helping in improving their English language by developing ESCA-Math in English.
- By increasing students' computer skills along the way.

The contributions towards the teacher can be seen in the following ways;

- By providing the teachers with more time in class for other social activities such as class project, or mathematical games since the students are able to revise by themselves in their own pace outside the classroom.
- By easing the teacher to concentrate in creating two way interactions with the students since they do not have to rush to finish the syllabus since the revision can be done by the students themselves.

7.3 RESEARCH PUBLICATIONS

This research has been published in two proceedings namely ICE'06 and ICC'07 as the following;

- Nur Azizan @ Nur Azyan, Yusof, & Suraya, Hamid. *Mathematics Online System for Secondary School: An Analysis.* International Conference on Science & Technology: Application in Industry & Education (ICSTIE'06), MARA University of Technology, Penang. 2006, pp 12.

University of Malaya

- Nur Azizan @ Nur Azyan, Yusof, & Suraya, Hamid. *The Design and Development of Mathematics Online System (MOST) for Secondary School: A Scenario in Malaysia.* 12th International Conference on Education (ICE'07), Sultan Hassanal Bolkiah Institute of Education, Universiti Brunei Darussalam, 2007, pp 44.
- Nur Azizan @ Nur Azyan, Yusof, & Suraya, Hamid. *Mathematics Web-Based System as Students' Study Companion: A Scenario in Malaysia.* International Journal of Learning, Common Ground Publication, V14, 2008.

The details of the paper works can be referred in **Appendix F**, **Appendix G** and **Appendix H** respectively.

7.4 STRENGTH OF ESCA-MATH PROTOTYPE

Although e-learning website has been in the Internet for more than a decade now, ESCA-Math is developed in such a way that it is different from any other e-learning. This distinguishable strength of ESCA-Math is as below;

- Taking a different approach than other e-learning website which is the concept of the study companion.
- Providing user with their own progress record where they can evaluate their understanding in mathematics subject.
- User friendly and easy to use interface
- Administrator control feature for future addition and maintenance

1. Uniqueness of the study companion concept

ESCA-Math concentrates on a different approach than other existing e-learning. Instead of simply providing another way for students to revise and

University of Malaya

seek help in homework, ESCA-Math goes one step further by providing a study companion to the student. All of the modules consist in ESCA-Math encompass the whole of students' learning process, from help with mathematics topic, to testing their understanding and recreational activities for them when they want to take a break for a while.

2. Progress record to evaluate ones understanding

ESCA-Math provides the students with their own progress record. This record will keep students' performance as they use ESCA-Math along the way. Apart from a record of their performance, ESCA-Math also provide with a list of strong and weak topic for guidance for them to start and carry on with the revision.

3. User friendly and easy to use interface

The evaluation test in Chapter 6 shows that students agree with 4.30 and 4.25 of mean respectively that ESCA-Math interfaces are easy to use and user friendly. Students only need to choose from the provided modules on the left side of the screen and click on them for the content to be displayed. There is also a 'Site Map' and 'Help' section to assist students in using ESCA-Math.

4. Administrator control feature

ESCA-Math will be provided with administrator control feature for future addition and maintenance. Mathematics KBSM syllabus will be bound to be upgraded by the ministry sooner or later. When this happens, ESCA-Math will

University of Malaya

not be obsolete since there is an administrator account to update all of the changes.

7.5 LIMITATIONS OF ESCA-MATH PROTOTYPE

Despite the various strengths of the prototype mentioned previously, it does have limitations. This prototype is not yet perfect as it lacks several important aspects. The limitations of ESCA-Math are:

- It focuses on several topics within mathematics subject
- It focuses for Form 4 and From 5 students only
- Only provide objective-formatted questions

1. It focuses on several topics within mathematics subject

Since ESCA-Math concentrate on developing other features such as the progress record and other modules like quick references and fun and games, not all mathematics topics will be included in this prototype. However with administrator control, this can be addressed easily when the appointed administrator has the ability to insert the learning material for other topics.

2. It focuses for Form 4 and Form 5 students only

ESCA-Math focuses on students in Form 4 and Form 5 only. However, these students are at the right age to be given the freedom to have a study companion where they may proceed in their own pace. Schools' computer laboratories also prioritize them over other students (Form 1 to Form 3 students) in computer usage.

University of Malaya

3. Only provide objective-formatted questions

Question bank module in ESCA-Math provides students with objective-formatted questions only. Subjective-formatted questions are not provided in this prototype.

7.6 OBJECTIVES ACHIEVED

ESCA-Math has three main objectives as described in Chapter 1. The objectives of this research have been successfully achieved based on;

i) *Objective 1: To investigate the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet and online system for educational pursuit among students.*

   Based on the questionnaire result and analysis, the current problem that resulted in low to moderate percentage of satisfaction in the usage of Internet and online system for educational pursuit among students are identified. The result in the questionnaire result shows that students do use the Internet and online system for educational pursuit but their satisfaction level is either low to moderate. The problem that has been identified includes the little time they have to properly use the system, the lack of enjoyable feature within the system and the inability for the system to personalize students' history of usage.

ii) *Objective 2: To create a viable framework based on the qualitative and quantitative research and analysis as a means of consideration in order to suggest for a solution to the problem.*

University of Malaya

From the analysis in Chapter 2 to Chapter 4, a framework has been created as part of the design process. This framework emphasize on the absence of teacher and peer pressure presence and focus on providing students with the study companion for them to proceed in their own pace. Each student will have their own account to keep their history of usage and they may pause and save at any time to continue at a later time. Recreational activities module provide the students with enjoyable activities as part of their learning process.

iii) *Objective 3: To develop a workable prototype based on the framework created which is called "E-learning using the Study Companion Approach: Mathematics (ESCA-Math)" that the user would use.*

Based on the evaluation and user acceptance testing in Chapter 6, it shows that students are satisfied with ESCA-Math. In **Table 6.7**, ESCA-Math received a Mean value of 4.70 for overall assessment, which is leaning towards 'excellent'. This also shows that students will very likely use ESCA-Math when it is implemented in the educational system.

7.7 RESEARCH QUESTIONS ANSWERED

In Chapter 1, two research questions have been identified. At the end of this research, the answers to these questions have been discovered. Below are the research questions and their answers:

i) *Could the low to moderate level of satisfaction in Internet usage for educational purpose due to impersonalized e-learning system or because students did not know how to get the best benefits out of e-learning?*

University of Malaya

After analyzing the data gathered from the survey, several inputs have been gained to give some insight on why students are less satisfied with e-learning system. It has been found out that e-learning system that does not regard the students as an individual person or in other words, e-learning system that does not personalize itself to students does contribute to the low to moderate level of satisfaction. Students do not have much time to spend on the Internet, what with curricular activities and homework to allocate their time to, thus, it is essential for the e-learning system to 'remember' these students or else it will be hard for them to benefit from the system. Students do realize the benefits they could gain from e-learning system, however, some of the system require monthly or yearly fees to provide these facilities. This causes them to shy away from these systems.

ii) *Would an e-learning using the study companion approach that treats its user as an individual person instead of any typical user able to address this situation?*

Based on the user acceptance result and analysis in Chapter 6, it shows that students are mostly satisfied with ESCA-Math that uses the study companion concept – a system that focuses on the students themselves, instead of having other parties such as the teachers and their parents breathing down their neck – and the personalize account offered in it so that they can carry on with their learning process as soon as they logged in into the system.

University of Malaya

7.8 FUTURE ENHANCEMENT

Future enhancement can be done in order to ensure ESCA-Math with more advancement. It is found that the system has a number of deficiencies. Thus, it is suggested here that several enhancements are made to ESCA-Math in the future to ensure that it is more powerful, robust, easy to use, more flexible, secure, effective and efficient. These suggestions include users' suggestions from the acceptance survey result which was carried out in Chapter 6 (Prototype Testing and Evaluation). The suggested future enhancements for ESCA-Math are:

- The ability for ESCA-Math to have and mark subjective-formatted questions
- The ability for students to draw graphs and other figures as requested in the questions

1. The ability for ESCA-Math to have and mark subjective-formatted questions

At the moment, ESCA-Math only provide students with objective-formatted questions for them to evaluate their understanding in mathematics topics. In future, ESCA-Math can be enhanced to include subjective-formatted questions as well.

2. The ability for the students to draw graphs and other figures

With objective-formatted questions, ESCA-Math does not need to provide students with the ability to draw graphs and figures; however, with the enhancement of subjective-formatted questions, it is necessary to include this facility as well.

University of Malaya

7.9 CONCLUSION

From this research, the following conclusions can be drawn.

As mentioned in Chapter 1, the first objective of ESCA-Math which is to investigate the problems that resulted in low to moderate percentage of satisfaction in the usage of Internet for educational pursuit such as e-learning among students has been identified. They include the lack of time they have to spend on the system, which failing them to use to its fullest capabilities. Another problem is the lack of enjoyable feature within the system and the inability for the system to personalize students' history of usage.

The second objective mentioned is the development of viable framework based on the qualitative and quantitative research and analysis as a means of considerations in order to suggest for a solution to the problem identified. Chapter 4 outlined this framework that was formulated based on the research that has been detailed in Chapter 2 to Chapter 4.

And the third objective is the development of workable prototype based on the framework created which is ESCA-Math as the learning tool that the students would use.

From the research that has been done, it can be concluded that all of these objectives has been achieved. It can be seen in Chapter 6 from where the testing was conducted. From the user acceptance testing, the overall rating shows that 70% of the students rated ESCA-Math as 'excellent' while the other 30% rated it as 'good'. The user

University of Malaya

acceptance test among administrator shows that 60% rated the administrator feature as ‘excellent’, 20% rated it as ‘good’ while the remaining rated it as ‘satisfactory’.

In the qualitative research and analysis of Chapter 2, a list of issues was mapped into existing systems and several weaknesses from these systems are discovered (*see* **Section 2.8.6**). ESCA-Math has successfully overcome these weaknesses and they are as follows;

- Most of the existing systems do not contain a clear course and learning objectives. This will make it hard for the students to get a clear understanding of the significant purpose of the system and the full benefit the system offer. ESCA-Math provides a clear course and learning objectives to emphasize the structure of the prototype and provide the students a clear understanding of how they can benefits from it.
- Most of the existing systems focus too much on the purpose to provide learning tools to the students that they fail to recognize other support activities that the student could endeavor as part of the learning process. Some of the existing systems provide examination questions without a companion of learning notes for the students to revise, while the other existing systems only provide learning notes without examination questions for them to evaluate their understanding. ESCA-Math provides both of the learning notes and examinations questions together with other supporting activities such as the timer facility and English to Malay dictionary.
- Not only do some of the existing systems do not contain supporting activities, the ones they provide are often incomplete. With the administrator feature in

University of Malaya

ESCA-Math, it is updatable for future maintenance. Any incomplete content can be filled in even after the prototype has been installed and implemented.

- Apart from that, most of the existing systems also do not provide the starting point which is very essential as guidance for the students to proceed with their learning process. Without this starting point, it will make it hard for the students to pinpoint where they should start and it will be a waste of time, where time, unfortunately is not a luxury for them. When students log-in to ESCA-Math, they will be presented with their progress record together with a list of their strong and weak topics so they know which topics to concentrate on. This will be their starting point to proceed with their learning process. It also acts as a reminder of their status and progress on their last login into the system.

In Chapter 6, it can be concluded that the testing conducted was successful where no error was found. In the integration testing, all the prototype components worked together as pre-defined by the functional and non-functional requirement. In terms of the prototype testing, the entire prototype had been tested with all possible triggers in which it is found that the prototype is capable and succeeds in handling all the triggers. As for the user acceptance testing, majority of the users were satisfied with the prototype. However, a few improvements need to be applied to this system.

As explained in **Section 7.8** which is the future enhancement section, there are ample possibilities to expand this prototype. Continuous improvements are the key to build an enhanced system and to ultimately produce more satisfied users. Last but not least, the completion of the prototype in this research has shown that there are still many

University of Malaya

areas for improvement as in depth and wider research needs to be carried out. It is also hoped that with the creation of this prototype, it would initiate more ideas for other researchers to develop an e-learning system with more features in the future to benefit the students in order for them achieved better grade in their examination.

As a conclusion, ESCA-Math has achieved and fulfilled the objectives and requirements as an e-learning system with the study companion approach for secondary school mathematics as determined at the early stage of this project and during system analysis.

There was a lot of knowledge gained throughout the development of this system. This includes knowledge in Internet environment, Internet technologies, various e-learning approaches and system development process. Developing ESCA-Math using Macromedia Flash with Actionscript programming proved to be a valuable experience. Even though programming and techniques are important in system development, good system engineering techniques must also be applied. Here, theories and knowledge gained throughout the course of computer science studies like system analysis and design, web development, and server were literally put into practice.

University of Malaya

REFERENCES

Abdul Razak Yaakub, 2000. E-pembelajaran ke arah sistem pendidikan cemerlang. *Seminar Teknologi Pendidikan, Institut Perguruan Darulaman*, 28 Ogos 2000.

Anohina, A., 2005. Analysis of the terminology used in the field of virtual learning. *Educational Technology and Society*, 8 (3), 91-102.

Anton, W.D., & Klisch, M.C., 1995. Perspectives on mathematics anxiety and test anxiety. In C.D. Spielberger and P. Vaggs ed. *Test Anxiety.* Washington, DC: Taylor & Francis, pp 108-126.

Asirvatham, D., 2003. Borderless Education Through E-learning, *MMLS Articles Archive.*

Asirvatham, D., Kaur, A. & Zoraini, W. A., 2005. *Country Report: E-Learning in Malaysia.* Asia E-Learning Network Conference 200. [Online]. Available at: http://www.asia-elearning.net/content/conference/2005/

Australia Bureau of Statistics., n.d. Sampling Analysis, [online] Available at: http://www.abs.gov.au/Websitedbs/D3310116.NSF/0/116e0f93f17283eb4a2567ac00213517?OpenDocument

Bentley, L.D. & Whitten, L.J., 2006. *Systems Analysis and Design for the Global Enterprise (Part Two: System Analysis Methods)*. McGraw-Hill International Edition.

Berge, Z., Collins, M.P., & Dougherty, K., 2000. Design guidelines for Web-based courses, In B. Abbey (Ed.), *Instructional and cognitive impacts of Web-based education* (pp. 209-216). London: Idea Group.

Block, H. & Dobell, H., 1999. *The e-Bang Theory*. Bank of America Securities. Educational Industry Overview, September 1999.

Brown, J.S., Collins, A. S., & Duguid, P., 1989. Situated cognition and the culture of learning. *Educational Researcher,* 18(1), 32 – 42.

Buckley, P.A., & Ribordy, S. C., 1982. Mathematics anxiety and the effect of evaluative instructions on math performance. Paper presented at the *Midwestern Psychological Association,* Minneapolis, MN.

Burns, M., Heath, M. & Dimock, V., 1998. Constructivism and Technology: On the Road to Student-Centered Learning. *Tap into Learning*, Vol 1, No. 1, Fall 1998. Southwest Educational Development Laboratory.

Chan Foong Mae, 2003. ICT At Work: Moving Ahead in Borderless Education Through e-Learning. *MAPCU National Higher Education Conference 2003,* Sunway Lagoon Resort Hotel, Petaling Jaya, Selangor, 26th & 27th May 2003.

University of Malaya

Cobb, P., Yackel, E. & Wood, T., 1992. A Constructivist Alternative to the Representational View of the Mind in the Mathematics Education. *Journal for Research in Mathematics Education.* pp232-333.

Colquitt, J.A., LePine, J.A., & Noe, R.A., 2000. Toward an integrative theory of training motivation: A meta-analytic path analysis of 20 years of research. *Journal of Applied Psychology,* Vol. 85, pp. 678-707.

cookie., n.d. *Dictionary.com Unabridged (v 1.1)*. from Dictionary.com website. [online]. Available at: http://dictionary.reference.com/browse/cookie [accessed at March 28, 2007]

Coutts, N., Drinkwater, R. & Simpson, M., 2001. Using ICT in Learning and Teaching: a framework for reflection, planning and evaluation in school development, *Teacher Development,* Vol. 5, pp. 222-240.

Craig, J., & Green, H. (2005) Provocation paper: Assessment, Technology and Learner Voice: How can we involve young people in determining the focus and means of assessment systems? *Personalisation and Digital Technologies Seminar Series.* [online], Available at: http://www.futurelab.org.uk/events/past/demos_seminar3_provocation01.htm

Curriculum Development Center, 2002. [online], Available at: http://www.ppk.kpm.my/

cyberphobia., n.d.. *Dictionary.com Unabridged (v 1.1)*. from Dictionary.com website. [online]. Available at: http://dictionary.reference.com/browse/cyberphobia [accessed at June 10, 2007]

Department for Education and Skills (DfES), 2003a. Towards a Unified e-Learning Strategy: consultation documents. *Annesley: DfES Publications.*

Department for Education and Skills (DfES), 2003b. Surveys of Information and Communications Technology in School. *Annesley: DfES Publications.*

Fadzilah Ariffin, 2001. Penggunaan teknologi dalam menambah nilai bahan sumber. *Seminar Kebangsaan Penggunaan Bahan Sumber Pendidikan Dalam Pengajaran dan Pembelajaran* , 27-29 Jun 2001, Kuala Lumpur, Paper 4 (9p.)

Faisal Mohamad, Zuraidah Abdul Rahman & Zarina Samsudin, n.d. e-Pembelajaran: Satu Pendekatan Inovatif dalam Instruksi.

Flottemesch, K., 2000. Building effective interaction in distance education: A review of the literature. *Educational Technology,* Vol. 40(3), pp 46-51.

Furner, J.M. & Berman, B.T., 2003. Math Anxiety: Overcoming a Major Obstacle to the Improvement of Student Math Performance. *Childhood Education:* Spring 2003; 79, 3; *via ProQuest Education Journals,* pg 170-174.

University of Malaya

Green, H., Richards, O., & Hewitt, J., 2005. Report: Assessment, Technology and Learner Voice: How can we involve young people in determining the focus and means of assessment systems? *Personalisation and Digital Technologies Seminar Series*

Gyöngyösi, E., n.d. The More Effective Use of Computers in Teaching Mathematics. *International Journal for Mathematics Teaching and Learning,* March 18th 2002. [online], Available at: http://www.cimt.plymouth.ac.uk/journal/egcomp.pdf

Hannafin, R. D., & Scott, B. N., 1998. Identifying critical learner traits in dynamic computer-based geometry program. *The Journal of Educational Research,* Vol. 92(1), pp 3-12.

Harrison, C., et al., 2002. ImpaCT2: the impact of information and computer technologies on pupil learning and attainment. *Annesley: DfES Publications.*

Hedge, A., 2003. Ergonomics Considerations of LCD versus CRT Displays. *Cornell University, May, 2003.*

Herrington, J., Reeves, T. C. & Oliver, R., 2005. Online Learning as Information Delivery: Digital Myopia. *Journal of Interactive Learning Research;* 2005; 16, 4; ProQuest Education Journals, pp. 353-367.

Horne, M., 2005. What do we mean by personalised learning? *Personalisation and Digital Technologies Seminar Series*

Inglis, A., 1999. Is online delivery less costly than print and is it meaningful to ask? *Distance Education,* Vol 20(3), pp 220 – 239.

Iverson, K.M., Colky, D.L. & Cyboran, V., 2005. E-Learning Takes the Lead: An Empirical Investigation of Leaner Differences in Online and Classroom Delivery. *Performance Improvement Quarterly;* 2005; 18, 4; ABI/INFORM Global, pg 5-18

Janieki, T. & Liegle, J., 2001. Development and evaluation of a framework for creating Web-based learning modules: A pedagogical and system perspectives. *Journal of asynchronous Learning Networks,* Vol 5(1).

Kilpatrick, J., 2001. Adding It Up : Helping Children Learn Mathematics. Washington, DC, USA: *National Academies Press*, 2001. p ii. [online]. Available at: http://site.ebrary.com/lib/malaya/Doc?id=10038695&ppg=3

Koran, Jaya Kumar C., 2001. "Aplikasi `E-learning' dalam pengajaran dan pembelajaran di sekolah-sekolah Malaysia : cadangan perlaksanaan pada senario masa kini." *Seminar Kebangsaan Penggunaan Bahan Sumber Pendidikan Dalam Pengajaran dan Pembelajaran* 27-29 Jun 2001, Kuala Lumpur, Paper 8 (24p.)

University of Malaya

Lampert, M., 1990. When the problem is not the question and the solution is not the answer: Mathematical knowing and teaching. *American Educational Research Journal,* Vol. 27, pp 29-63.

Lancaster, D. R., 1988. The games computers play. *Educational Resources and Techniques,* Vol 27(3), pp 29-31.

Lazim, M.A., Abu Osman, M.T., and Wan Salihin, W.A., n.d. The Statistical Evidence in Describing the Students' Beliefs About Mathematics *International Journal for Mathematics Teaching and Learning,* October 12th 2004, Centre for Innovation in Mathematics Teaching.

Lerma, C.F, 2007. Creating Learning Objects. *Proceedings of the 2007 Informing Science and IT Education Joint Conference*. 22- 24 June 2007, Ljubljana, Slovenia. Informing Science Institute, Santa Rosa, California

Li, Q., 2003. Would we teach without technology? A professor's experience of teaching mathematics education incorporating the Internet. *Educational Research,* Vol. 45 No. 1 Spring 2003 61-77. Routledge, Taylor and Francis Group.

Mahathir Mohamad, 1991. Malaysia As A Fully Developed Country - One Definition [online]. Available at:, http://www.pmo.gov.my/website/webdb.nsf/vALLDOC/08A1EE6E797AB4FE48256E840034AD0F

Malone, T. W., 1981. Towards a theory of intrinsically motivating instruction. *Cognitive Science,* Vol 4, pp 333-369.

Maor, D., 2003. Teacher's and Students' Perspectives on On-line Learning in a Social Constructivist Learning Environment. *Technology, Pedagogy and Education.* Vol 12, No. 2, 2003.

Martindale, T., et al., 2005. Effects of an Online Instructional Application on Reading And Mathematics Standardized Test Scores. *Journal of Research on Technology in Education;* Summer 2005; 37, 4; *via ProQuest Education Journals* pg. 349.

Marzita, P., 2003. Bahasa- bukan penyebab kemerosotan pelajar. *Utusan Malaysia,* 11 April, 2003.

Minaidi, A. & Hlapanis, G.H., 2005. Pedagogical Obstacles in Teacher Training in Onformation and Communication Technology. *Technology, Pedagogy and Education.* Vol. 14, No. 2, 2005.

Ministry of Education, 1991. Kurikulum Bersepadu Sekolah Menengah. [online]. Available at: http://myschoolnet.ppk.kpm.my/sp_hsp/gubal.pps

Ministry of Education, Malaysia., 1997. *The Malaysian Smart School: A Conceptual Blueprint.* Kuala Lumpur: Ministry of Education.

University of Malaya

Ministry of Education, Malaysia., 2004. *Mathematics Form 4 Syllabus,* [online] Available at: http://myschoolnet.ppk.kpm.my/sp_hsp/mate/kbsm/hsp_maths_f4.pdf

Ministry of Education, Malaysia., 2004. *Mathematics Form 5 Syllabus.* [online] Available at: http://myschoolnet.ppk.kpm.my/sp_hsp/mate/kbsm/hsp_maths_f5.pdf

Ministry of Higher Education, 2005. *Unit Permohonan Universiti.*

Muilenburg, L.Y. & Berge, Z.L., 2005. Student Barriers to Online Learning: A factor analytic study. *Distance Education;* May 2005; 26, 1; via ERIC®, pg 29-48.

Multimedia Super Corridor., 1997. Edited on 2006. *MSC Flagship Applications* [online] Available at: http://www.mdc.com.my/msc/flagships.asp?link=ss#ss

Nastasi, B.K. & Clements, D.H., 1994. Effectance motivation, perceived scholastic competence and higher-order thinking in two cooperative computer environments. *Journal of Educational Computing Research*, 10, pp 249 – 275.

Ng, W. & Gunstone, R., 2003. Science and Computer-based Technologies: attitudes of secondary science teachers, *Carfax Publishing, Taylor & Francis Group*

Ninth Malaysian Plan, 2006. Chapter 11- Enhancing Human Capital. *The Economic Planning Unit, Prime Minister's Department, Putrajaya.* [online] Available at: http://www.epu.jpm.my/rm9/html/english.htm

Noraini Idris, 2004. Matematik dalam pembangunan kerjaya di abad 21, *Seminar Pembangunan Kerjaya Abad 21*. 29-30 Nov 2004, Kuala Lumpur, Paper 30 (15p.)

Norma Abu Seman & Normadiah Hj Che Abbas, 2002. Determining the Authoritativeness of Electronic and Web Resources: The Quality Issues of Information. *National Seminar on Electronic Resource Center*, 9 – 10 September, 2002.

O'Leary, D. & Parker. S, 2004. Learner Voice: How can technology be used to support learners to shape and direct their own curriculum? *Personalisation and Digital Technologies Seminar Series*

Pedretti, E., Mayer-Smith, J. & Woodrow, J., 1998. Technology, text and talk: students' learning in a technology enhanced secondary science classroom. *Science Education*, Vol 82, pp. 569 – 589.

Pejabat Pendidikan Daerah Muar, Muar, Johor.

University of Malaya

Perkhidmatan UPU (Kementerian Pendidikan), n.d. *Kemasukan Ke Institusi Pendidikan Tinggi Awam* [online] Available at: http://apps.emoe.gov.my

Perry, A.B., 2004. Decreasing Maths anxiety in college students. *College Student Journal;* Jun 2004; 38,2; *via ProQuest Education Journal*, pg 321-324.

Pittard, V., 2004. Evidence for E-learning Policy. *Technology, Pedagogy and Education,* Vol. 13, No. 2 2004.

Polyzou, A., 2005. Growth in Teachers' Knowledge While Learning to Teach with Multimedia: what has been learned from concrete educational experiences? *Technology, Pedagogy and Education,* Vol. 14, No. 2, 2005.

Prediger, S., 2005. Diversity as a Chance in Mathematics Classrooms. *International Journal for Mathematics Teaching and Learning,* October 25th 2005, Centre for Innovation in Mathematics Teaching.

Robiah Sidin & Nor Sakinah Mohammad, 2004. Pembudayaan Teknologi Maklumat dan Komunikasi (ICT) Di Kalangan Pelajar: Ke Arah Mengurangkan Jurang Pendidikan. *Persidangan Kebangsaan Sains, Teknologi dan Masyarakat* (10-11 Dis 2004 : Kuala Lumpur) : Vol.3 Paper 50 (19p.)

Rosenberg, M.J., 2001. E-learning: Strategies for delivering knowledge in the digital age. *McGraw-Hill.*

S. Indramalar & Tan Shiow Chin, 2005. Useful ideas for the classroom. *The Star – Education*. [online] Available at: http://www.msc.com.my/today/default.asp?sec=B&id=38&link=fulltext

Sadik, A. & Reisman, S., 2004. Design and Implementation of Web-based Learning Environment: Lesson Learned. *Quarterly Review of Distance Education:* Fall 2004; 5, 3; *via ProQuest Education Journals* pg. 157-171.

Sarason, I. G., 1987. Test anxiety, cognitive interference, and performance. *In R.E Snow & M. J. Farr (Eds.),* Aptitude, learning, and instruction: Volume 3: Cognitive and affective process analyses (pp. 131-142). Hillsdale, NJ: Erlbaum.

Sasser, J.E., 1990-1991. The effect of using computer tutorials as homework assignment on the mathematics achievement of elementary education majors. *Journal of Computers in Mathematics and Science Teaching,* Vol. 10(2), 95-102.

Schank, R., 2002. Designing World-Class E-Learning. *New York, USA: McGraw-Hill.*

Shaharom, N., 2003. Pentaksiran Kendiri Berasaskan Teknologi Maklumat dan Komunikasi Dalam Peperiksaan Kebangsaan. *Seminar Pentaksiran Pendidikan Kebangsaan 2003,* (5-8 Mei 2003), Kuala Lumpur. Anjuran Kementerian Pendidikan Malaysia dan Lembaga Peperiksaan Malaysia.

University of Malaya

Shulman, L. S., 1987. Knowledge and Teaching: foundations of the new reform. *Harvard Educational Review,* 57, pp. 1-22.

Smith, L.I., 2002. A Tutorial on Principal Component Analysis. *Cornell University, USA.* [online] Available at: http://kybele.psych.cornell.edu/~edelman/Psych-465-Spring-2003/PCA-tutorial.pdf

Smith-Gratto, K., 2000. Strengthening learning on the Web: Programmed instruction and constructivism. In B. Abbey (Ed.), *Instructional and cognitive impacts of web-based education.* London: Idea Group.

Spitzer, D., 2001. Don't forget the high-touch with the high-tech in distance learning. *Educational Technology.* Vol 41(2), 51-55.

Thompson, G. B., 1972. Effects of co-operation and competition on pupil learning. *Educational Research,* 15(1), 28-36.

Van Eck, R., 2006. The effect of contextual pedagogical advisement and competition on middle-school students' attitude toward mathematics and mathematics instruction using a computer-based simulation game. *Journal of Computers in Mathematics and Science Teaching* 25.2 (Summer 2006): 165(31). Expanded Academic ASAP. Thomson Gale. Universiti Malaya. 29 April 2006

Vonderwall, S. & Zachariah, S., 2005. Factors that influence participation in online learning. *Journal of Research on Technology in Education;* Winter 2005; 38, 2; ERIC®, pg.213-230.

Wang, Q., 2006. Quality Assurance – Best Practices for Assessing Online Programs. *International Journal on E-Learning*; 2006; 5, 2; *via ProQuest Education Journals* (pg. 265-274)

Yusuf Hashim & Razmah Man., 2001. An overview of instructional design and development models for electronic instruction and learning. *Malaysian Journal of Educational Technology.* Vol. 1 No. 1 June 2001.

Yusuf Hashim, 2000. *Teknologi pengajaran.* Shah Alam: Fajar Bakti.

University of Malaya