Animated Introductory Calculus: Development and perception

Kamel Ariffin Mohd. Atan[1], Rustem Suncheleev[2], Mahendran Shitan[3], Mohd. Shafie Bin Mustafa[3]

(1. Laboratory of Theoretical Studies, Institute of Mathematical Research, University Putra Malaysia, Serdang Selangor 43400, Malaysia;

2. Malaysian Institute of Aviation Technology, University Kuala Lumpur, Dengkil Selangor 43800, Malaysia;

3. Laboratory of Applied and Computational Statistics, Institute of Mathematical Research, University Putra Malaysia, Serdang Selangor 43400, Malaysia)

Abstract: Recent years it has an explosive development of IT technologies. However, the problem of natural integration of modern technologies in teaching and learning mathematics is far from its final solution. In teaching mathematics at universities, these capabilities either are ignored or have extremely limited applications.

In our study, we consider animation as one of the tools that could increase students' motivation, curiosity and understanding. In order to evaluate the perception about using animation in the study of calculus, a brief survey was conducted in University Utara Malaysia (UUM). The survey consisted of 17 lecturers and 25 students from UUM. The survey also conducted in UPM (University Putra Malaysia) and UniKL (University Kuala Lumpur), which comprised of 82 students and 49 students respectively. At the same time, we are interested in whether or not the perception of students differs by factors like gender, age group, entry qualification, program of study and previous grades. This survey was conducted in UPM comprised of 160 students.

In this paper, we describe our data and report our findings, make a comparison between students' perception in UPM, UUM and UniKL. Further a comparison is also made regarding perception of UniKL students from two different programmes of study. To evaluate the performance of students, a simple comparative experiment between Computer Aided Learning Method (CALM) and the Traditional Learning Method (TLM) conducted in UUM and UPM and we report our preliminary findings in this paper.

Key words: computer aided learning; animation in calculus; students' perception; lecturers' perception; students' performance

1. Introduction

Recent years it has a growing recognition among educators that technology plays an important role to enhance many aspects of teaching and learning mathematics. Now we are witnessing an explosive development of information technologies.

Boyle (1997) proposed a systematic theoretical basis for educational multimedia design. According to Boyle, the central challenge for educational multimedia designers is creating interactive contents for promoting effective

Kamel Ariffin Mohd. Atan, professor and director, Laboratory of Theoretical Studies, Institute of Mathematical Research, University Putra Malaysia; research field: number theory.

Rustem Suncheleev, associate professor, Malaysian Institute of Aviation Technology, University Kuala Lumpur; research field: functional analysis.

Mahendran Shitan, senior lecturer, Laboratory of Applied and Computational Statistics, Institute of Mathematical Research, University Putra Malaysia; research fields: spatial models and time series.

Mohd. Shafie Bin Mustafa, tutor, Laboratory of Applied and Computational Statistics, Institute of Mathematical Research, University Putra Malaysia; research field: applied statistics.

learning. Bradley (2003) evaluated multimedia contents compared with text-based contents. In his study, the animated contents were evaluated superior to the text contents in the questionnaires about usefulness.

The problem of natural integration of modern technologies in teaching and learning mathematics is far from its final solution. Our research reveals a broad gap between technology capabilities and their practical applications in teaching and learning mathematics. In teaching mathematics at universities, these capabilities either are ignored or have extremely limited applications. In view of this, the objectives in this research were:

(1) To develop a fully compact *Introductory Calculus* textbook and CD;

(2) To evaluate the perception of lecturers;

(3) To evaluate the perception of students.

In 2002 an Intensification of Research in Priority Areas (IRPA) Project—"Interactive and Animated Mathematics for Math Education" was initiated by the Institute of Mathematics in University Putra Malaysia as the attempt to close this gap. The aim was to develop a compact *Introductory Calculus* textbook and CD with animated explanations for all calculus concepts, to receive feedback from the students and analyze the student's response to teaching mathematics with animations. The result of this project is the first fully animated university course in *Introductory Calculus* (software and a textbook) where technology guides the learner through all definitions, concepts and processes leaving to textbook important but still supplementary role. Using professional software, we created animation atmosphere to help students develop "mental models" of basic mathematics concepts, understand them, and use these visual images to support abstract definitions and theorems. In this way, students avoid memorizing a lot of isolated facts and formulae but derive these facts and formulae from well developed "mental model" of the particular mathematical concepts.

In all stages of the development of the project, we collected students' response to improve the design and content delivery. In the past 5 years, more than 1,000 students at the three universities of Malaysia were exposed to teaching and learning mathematics with animations and we felt the great response and support from the students. One of our observations was that animated mathematics changes atmosphere in the classroom. Students were interested in some animations, eagerly participate in discussions on what they see on the screen, ready to ask and answer questions, try to predict information based on the animations they have seen.

Another advantage of animated delivery was, as we estimated, about 20% of the classroom time saved as compared to traditional delivery.

In section 2, the principles of animation development are discussed and selected snapshots from *Animated Introductory Calculus* which are provided to support these principles. In section 3, we describe and discuss the lecturers' perception. In sections 4 and 5, we describe and discuss the students' perception and performance. Finally, the conclusions, limitations and further research plans are presented in section 6.

2. Principles of animation development

In developing the animated software we have adhered to the following principles:

(1) Use animation to support abstract definitions and theorems.

(2) Focus on the whole concept rather than on the bulk of isolated facts.

(3) Use animation and other technology to develop visual model of mathematical concept before (wherever it is possible) giving rigorous, abstract definitions.

(4) Encourage students to analyze, interpret and predict information using visual images.

(5) Develop mental link between real life problems and their mathematical interpretations.

(6) Animate processes as well as objects.

(7) Provide interactive features to help students solve problems, eliminating routine operations by using technology.

(8) Provide features that enable to use this software in both web based and class based education.

(9) Getting a feedback from the students to optimize effectiveness in the delivery of course content using technology.

We provide below selected snapshots from the *Animated Introductory Calculus* (Figures 1-8 show selected snapshots from *Animated Introductory Calculus*.)

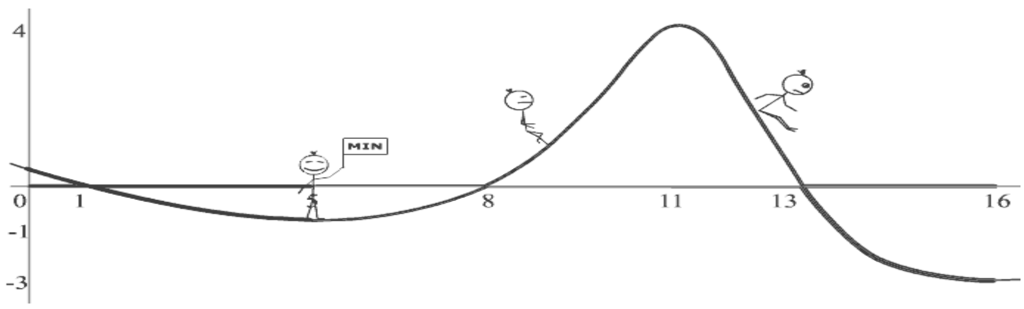

Figure 1 Animation showing properties of a function in connection with intuitive perception of students

Animation in Figure 1 discusses the concepts of increasing, decreasing, local maximum, local minimum and others graphically long before we give formal definitions.

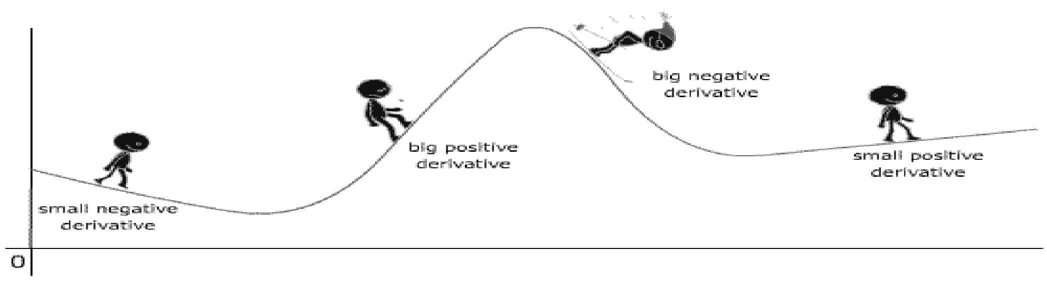

Figure 2 Animation illustrating slope-derivative concept

Animation in Figure 2 provides students with intuitive understanding of the concepts of the slope and the derivative of the function, which inspire students to analyze and predict behavior of the function and its derivative.

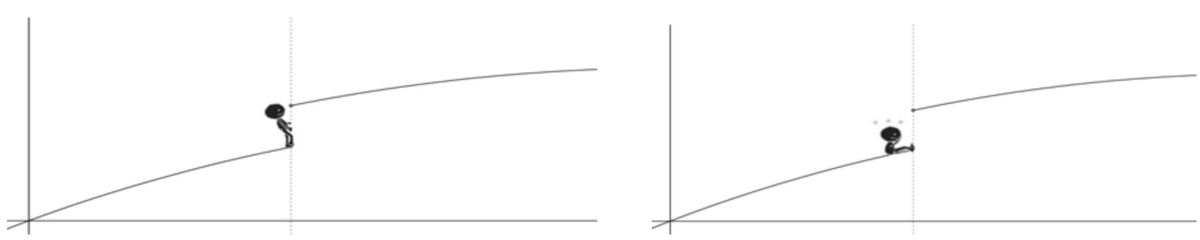

Figure 3 Animation illustrating concepts of continuity and discontinuity of a function

Animation in Figure 3 visualizes concepts of continuity and discontinuity of a function, different types of points of discontinuity.

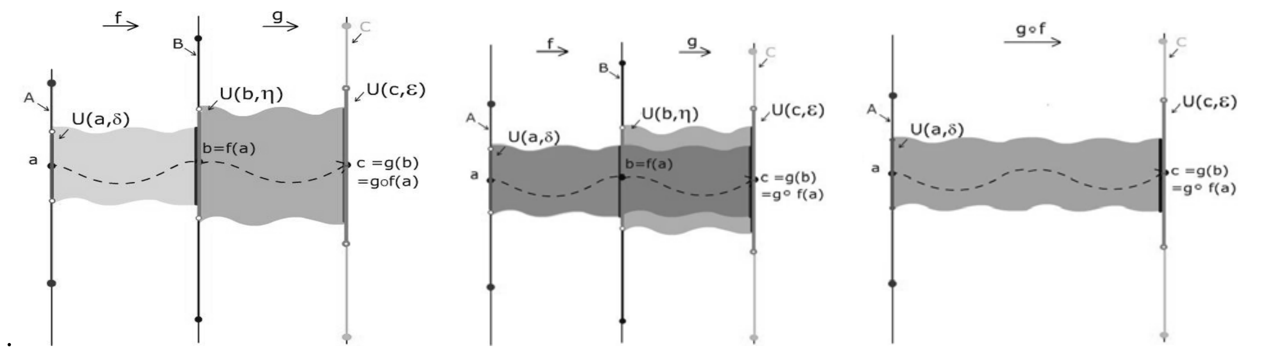

Figure 4 Animation illustrating proof of continuity of a composite function

Accurate proof of the theorem of continuity of a composition of functions is supported by animation in Figure 4.

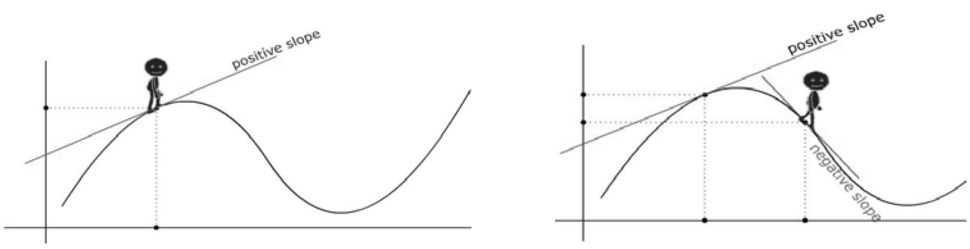

Figure 5 Animation illustrating the first derivative test

Animation in Figure 5 makes the first derivative test visual and predictable.

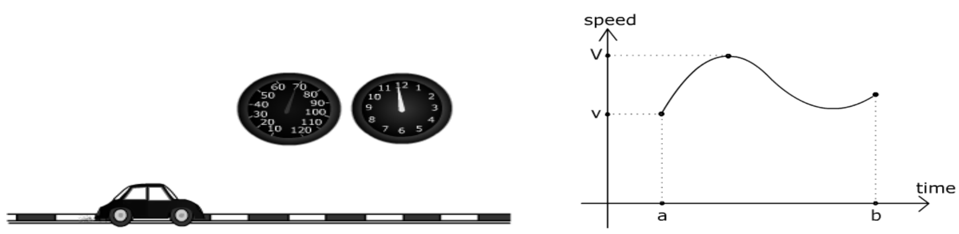

Figure 6 Speed-distance animation

Animation in Figure 6 provides the link between the derivative of a function and real life applications.

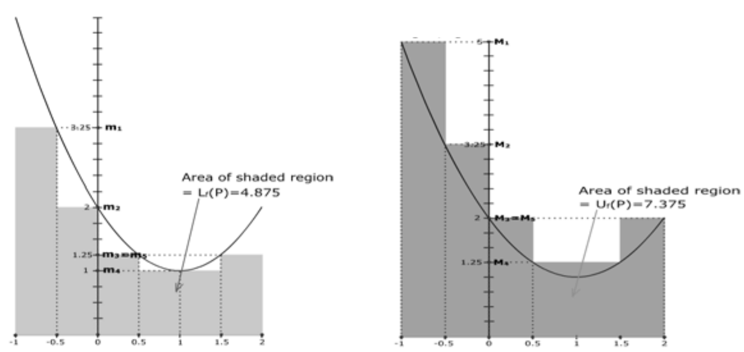

Figure 7 Animation illustrating upper and lower integral sums

Animation in Figure 7 illustrates approximation of the area below the curve by upper and lower integral sums.

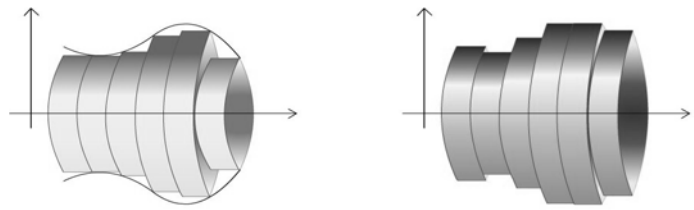

Figure 8 Animation illustrating volume of a solid of revolution

Animation in Figure 8 illustrates approximation of a solid of revolution by cylinders.

3. Lecturers' perception survey

In this section, we discuss the lecturers' perception of CALM. In this survey, data has been collected from 17 UUM lecturers (7 male and 10 female lecturers) and majorities of them are Master degree holders. A questionnaire (see Appendix 1) consisting of twelve questions was administered to each of the seventeen lecturers and they were asked to respond whether they strongly agreed, agreed, were not sure, disagreed or strongly disagreed with the statements contained in the questionnaire. The results of this survey tabulated in Table 1.

Table 1 Responses obtained from UUM lecturers

Key concept	Strongly agree		Agree		Not sure		Disagree		Strongly disagree	
	No.	%	No.	%	No.	%	No.	%	No.	%
Q1 Increase in interest	6	35.3	9	52.9	0	0	1	5.9	1	5.9
Q2 Better understanding	5	29.4	11	64.7	1	5.9	0	0	0	0
Q3 Learning faster	3	17.6	13	76.5	0	0	1	5.9	0	0
Q4 Longer retention	8	47.1	8	47.1	1	5.9	0	0	0	0
Q5 Better grades	1	5.9	12	70.6	4	23.5	0	0	0	0
Q6 More benefit	5	29.4	12	70.6	0	0	0	0	0	0
Q7 Time saving	1	5.9	8	47.1	6	35.3	2	11.8	0	0
Q8 Non- tiredness	1	5.9	10	58.9	6	35.3	0	0	0	0
Q9 Active involvement	3	17.6	9	52.9	5	29.4	0	0	0	0
Q10 Better attendance	3	17.6	13	76.5	0	0	1	5.9	0	0
Q11 Easier to deliver lectures	2	11.8	12	70.6	3	17.6	0	0	0	0
Q12 Easier to prepare lectures	1	5.9	10	58.9	4	23.5	2	11.8	0	0

From Table 1, we can see clearly that majorities (more than 90%) of lecturers felt that CALM would enable the students to *understand the lectures better*, *learn faster*, and *retain the information* for a longer period. More than 75% of the lecturers agreed that the students might be able to get *better grades* with the CALM method. Approximately 65% of the lecturers felt that CALM would not make students tired while 55% of them agreed that

CALM would *save time*. However, about 35% were not sure about these statements. More than 81% of the lecturers also agreed that by using CALM it is *easier to deliver the lectures*, while 17.6% of the respondents were not sure.

4. Students' perception survey

In this section, we discuss the student's perception of CALM. In particular, the students' overall perception in UPM, UUM and UniKL is discussed in section 4.1. In section 4.2, we present the results of the students' perception by gender, while section 4.3 contains the students' perception by age category and entrance qualification. In section 4.4, a discussion about the students' perception by program and previous grades is provided, while in section 4.5 we discuss students' perception by programme of study in UniKL. Finally, in section 4.6 a comparison is made about students' perception among UPM, UUM and UniKL students.

4.1 Students' overall perception

In order to evaluate *student's perception* about using animation, two surveys were conducted in UUM, UPM and UniKL, which comprise of 25, 82 and 49 students respectively. The students were required to respond whether they strongly agreed, agreed, were not sure, disagreed or strongly disagreed with the statements contained in the questionnaire.

The results from UUM students are contained in Table 2.

Table 2 Responses obtained from UUM students

Key concept	Strongly agree		Agree		Not sure		Disagree		Strongly disagree	
	No.	%	No.	%	No.	%	No.	%	No.	%
Q1 Increase in interest	9	36	15	60	1	4	0	0	0	0
Q2 Better understanding	3	12	16	64	6	29	0	0	0	0
Q3 Learning faster	10	40	9	36	3	12	3	12	0	0
Q4 Longer retention	3	12	12	48	6	24	3	12	1	4
Q5 Better grades	4	16	8	32	11	44	2	8	0	0
Q6 More benefit	6	24	16	64	2	8	1	4	0	0
Q7 Time saving	5	20	13	52	6	4	1	4	0	0
Q8 Non- tiredness	6	24	13	52	2	8	4	16	0	0
Q9 Active involvement	5	20	8	32	5	20	6	24	1	4
Q10 Better attendance	6	24	17	68	1	4	1	4	0	0

From Table 2, we observe that more than 92% of the 25 UUM students agreed that CALM had *increased their interest* in learning mathematics and *attending the classes*. However, only 52% of the respondents agreed that CALM had increased their *active involvement* during the lectures and around 28% disagreed with the statement. Although 67% of the lecturers felt that students would be able to get *better grades* with CALM, only 48% of the students felt the same way. Hence, there appears to be a difference in perception regarding the issue of ability to get better grades. Students also responded positively to the questions of *understanding*, *learning faster*, *retaining information*, *time saving* and *non-tiredness* (76%, 76%, 60%, 92%, and 76% respectively). Overall 88% of the students believed that they *would benefit* more from CALM courses in one way or another.

In Table 3, the responses of UPM students are given.

Table 3 Responses obtained from UPM students

Key concept	Strongly agree		Agree		Not sure		Disagree		Strongly disagree	
	No.	%	No.	%	No.	%	No.	%	No.	%
Q1 Increase in interest	12	14.6	64	78.1	5	6.1	1	1.2	0	0
Q2 Better understanding	11	13.4	51	62.2	18	22	2	2.4	0	0
Q3 Learning faster	4	4.9	57	69.5	17	20.7	4	4.9	0	0
Q4 Longer retention	6	7.3	43	52.4	28	34.2	4	4.9	0	0
Q5 Better grades	4	4.9	33	40.2	39	47.6	6	7.3	0	0
Q6 More benefit	10	12.2	53	64.6	14	17.1	4	4.9	0	0
Q7 Time saving	11	13.4	49	59.8	14	17.1	7	8.5	1	1.2
Q8 Non-tiredness	8	9.8	44	53.7	22	26.8	7	8.5	1	1.2
Q9 Active involvement	7	8.5	46	56.1	19	23.2	10	12.2	0	0
Q10 Better attendance	8	9.8	49	59.8	20	24.3	3	3.7	1	1.2

From Table 3, we can observe that more than 81% of the 82 UPM students agreed that CALM had *increased their interest* in learning mathematics and *attending the classes*. About 64% of the respondents agreed that CALM had increased their *active involvement* during the lectures and agreed that CALM did not make them *tired during lectures*. Approximately 48% of the students felt that they were not sure that they could get *better grades*. Students also responded positively to the questions on *understanding*, *learning faster*, *retaining information* and *time saving* (76%, 74%, 60%, and 73% respectively). Overall 78% of UPM students believed that they *would benefit* more from CALM courses in one way or the other.

The responses of UniKL students are given in Table 4.

Table 4 Responses obtained from UniKL students

Key concept	Strongly agree		Agree		Not sure		Disagree		Strongly disagree	
	No.	%	No.	%	No.	%	No.	%	No.	%
Q1 Increase in interest	15	30.6	26	53.1	5	10.2	3	6.12	0	0
Q2 Better understanding	6	12.2	26	53.1	10	20.4	6	12.2	1	2.04
Q3 Learning faster	10	20.4	18	36.7	13	26.5	7	14.3	1	2.04
Q4 Longer retention	5	10.2	23	46.9	15	30.6	5	10.2	1	2.04
Q5 Better grades	3	6.12	17	34.7	19	38.8	9	18.4	1	2.04
Q6 More benefit	7	14.3	25	51.0	12	24.5	4	8.16	1	2.04
Q7 Time saving	10	20.4	16	32.6	15	30.6	5	10.2	1	2.04
Q8 Non-tiredness	4	8.16	18	36.7	19	38.8	8	16.3	0	0
Q9 Active involvement	4	8.16	10	20.4	22	44.9	10	20.4	3	6.12
Q10 Better attendance	10	20.4	22	44.9	13	26.5	3	6.12	1	2.04

From Table 4, we observe that more than 83% of the 49 UniKL students agreed that CALM had *increased their interest* in learning mathematics. On the issue of *learning faster* and *longer retention*, about 57% of the students responded positively. Approximately 40% of the students were indecisive as far as *active involvement* and getting *better grades* are concerned. The students also responded positively to the questions of *understanding*, *time saving*, *non-tiredness* and *better attendance* (65%, 53%, 45%, and 65% respectively). More than 65% of UniKL students believed that they *would benefit* more from computer aided mathematics courses.

4.2 Student's perception by gender

In our study, there were 31 male and 126 female students while 3 respondents did not indicate their gender. The results indicated in Table 5 and there appeared to be no apparent difference between male and female students on the issue of *increased interest* in learning mathematics. However, the male students recorded higher percentages on the issues of *better understanding*, *retention of information* for a longer period and the ability to *learn faster*, *better grades* and *non-tiredness*. On the other hand, a higher percentage of female students felt that it was beneficial to have more CALM mathematics courses, and increased their *active involvement*, *saved time* and *increased interest* in attending lectures.

Table 5 Percentage of students who responded positively to CALM by gender

Key concept	Males	Females
	%	%
Q1 Increases in interest	81	83
Q2 Better understanding	77	68
Q3 Learning faster	68	56
Q4 Longer retention	74	71
Q5 Better grades	55	33
Q6 More benefit	58	71
Q7 Time saving	65	83
Q8 Non-tiredness	77	60
Q9 Active involvement	52	62
Q10 Better attendance	71	76

4.3 Student's perception by age category and entrance qualification

In this research, we defined *younger* students to be in the age category of *18 to 22 years* and *older* students in the age category of *23 to 27 years*. There were 140 students in the younger category and 20 students in the older category. The results show in Table 6. On the issues of *time saving* and increasing *interest in attending lectures*, there was no substantial difference between the younger and older students. However, on the other issues the older students responded more positively to the CALM method.

Table 6 Percentage of students who responded positively to CALM by age category and entrance qualification

Key concept	Younger	erOld	STPM	Matriculation	Diploma
	%	%	%	%	%
Q1 Increase in interest	81	90	83	81	82
Q2 Better understanding	69	80	69	73	70
Q3 Learning faster	57	70	60	54	59
Q4 Longer retention	71	70	66	88	70
Q5 Better grades	37	45	35	42	43
Q6 More benefit	69	75	69	62	75
Q7 Time saving	79	80	80	88	73
Q8 Non-tiredness	64	70	62	54	75
Q9 Active involvement	59	65	58	69	59
Q10 Better attendance	76	75	76	73	75

Students gain the entrance into the universities by having passed some pre-university examinations. These are the Malaysian Higher School Certificate Examination (STPM, Sijil Tinggi Persekolahan Malaysia, in Malaysia), Matriculation or Diploma exams. In our study, there were 89 students with STPM qualification, 26 students with Matriculation and 44 with Diploma qualification. One student did not indicate his entry qualification. We were interested to know whether there was a difference in perception amongst these different categories of students. The results appear in Table 6.

There appears to be no essential difference in the *students' perception* on the issues of *interest increasing* in learning mathematics, *better understanding* and *better attendance*. However, Matriculation students felt that they could retain information for a longer period and CALM would increase their *active involvement*, while Diploma students perceived that CALM would not *make them tired.* Both STPM and Diploma students recorded higher percentages in *learning faster* and *having benefit* more from CALM mathematics courses. The Matriculation and Diploma students responded that they could get *better grades* compared to the STPM students.

4.4 Student's perception survey by program and previous grades

The respondents in our study were students of the MTH3004 (Mathematics for Business and Finance) course offered in UPM and this is a service course taken by students from different programmes. There were 49 Computer Science students, 41 students majoring in Economics, 67 Business students, 2 students of Bio-Industry, 2 students from Science with Education while 6 students did not indicate their majors. Since there were only a small number of students from Bio-Industry and Science with Education, we confined our discussion to Computer Science, Economics and Business students. The results appear in Table 7.

Table 7 Proportion of students (in percentage) who agreed with CALM by program and previous grades

Key concept	Program			Previous grade			
	Computer science	Economics	Business	A	B	C	D
	%	%	%	%	%	%	%
Q1 Increase in interest	83	88	78	88	77	81	79
Q2 Better understanding	69	66	69	83	52	77	64
Q3 Learning faster	62	59	54	71	50	63	43
Q4 Longer retention	71	76	69	83	73	65	71
Q5 Better grades	45	34	36	42	27	44	29
Q6 More benefit	79	68	69	83	64	72	64
Q7 Time saving	76	80	79	88	84	77	79
Q8 Non-tiredness	74	56	61	71	48	79	64
Q9 Active involvement	60	59	60	71	66	58	57
Q10 Better attendance	79	73	75	79	77	74	79

No substantial difference was observed on the issues of *better understanding*, *saving time* and *active involvement*. Computer Science students recorded relatively higher percentages on the *ability to get better grades*, benefiting more from CALM mathematics courses, *non-tiredness* and *increasing interest in attending lectures*. Both Computer Science and Economics students felt more positive on the issues of increasing *interest in learning mathematics* and *learning faster* than that of the Business students. Economics students recorded higher percentages on the issue of *information retention.*

Students taking this course have different backgrounds in mathematics and their pre-universities grades recorded. Twenty-four of them had Grade A, 44 students had Grade B, 43 had Grade C, 14 had Grade D, 11 had other grades and 24 of them did not specify their grades. The results are shown in Table 7. Almost all issues students who had obtained Grade A recorded higher percentages, excepted for *non-tiredness*, while students with the Grade C responded better. Overall, students with Grade A and Grade C recorded higher compared with the Grade B and Grade D students.

4.5 Student's perception by program in UniKL

The students from UniKL were from two different programmes, namely the Malaysian-Russian Technology (MRT) and Aircraft Maintenance Technology (AMT). In the MRT programme there were a total of 31 students, of which were 24 males, 5 females and two of the respondents did not indicate their gender. In the AMT programme, there were 18 students, of which were 13 males, 4 females and one of the respondents did not indicate their gender. The detailed results appear in Table 8.

Table 8 Percentage of students who responded positively to CALM

Key concept	MRT programme		AMT programme	
	Male	Female	Male	Female
	%	%	%	%
Q1 Increases in interest	95.8	100	61.5	75.0
Q2 Better understanding	79.2	60.0	38.5	75.0
Q3 Learning faster	75.0	80.0	30.8	50.0
Q4 Longer retention	66.7	80.0	46.2	25.0
Q5 Better grades	54.2	40.0	30.8	25.0
Q6 More benefit	79.2	60.0	53.8	50.0
Q7 Time saving	66.7	60.0	30.8	75.0
Q8 Non-tiredness	45.8	40.0	61.5	0
Q9 Active involvement	50.0	0	15.4	0
Q10 Better attendance	79.2	80.0	46.2	50.0

From Table 8, it is clear that the students from MRT programme indicated a very high score on the issue of increased *interest in learning mathematics*, while students from the AMT programme recorded a somewhat lower score. Female students from both programmes indicated a higher score when compared with male students.

Students of the MRT programme generally agreed that CALM helped them to *understand better* and it would be *beneficial* if more mathematics courses were conducted by using CALM. Female students of the AMT programme also recorded that it helped them to understand better. However, the male students of AMT programme generally disagreed that it helped them to understand the course material better.

The MRT programme students generally agreed that CALM helped them to *learn faster*. On the other hand, only 50% of the AMT female students and about 30% of the AMT male students agreed that CALM helped them to learn faster.

On the question of *longer retention*, generally, students of the MRT responded positively to CALM but AMT students generally did not feel that CALM aided them in *longer retention*.

Approximately 60% of AMT male students responded that CALM did not make them tired, but AMT female students and students from the MRT recorded a relatively low score on the issue of *non-tiredness*. Students from both programmes recorded a low score on *active involvement*. MRT students responded that CALM would encourage *better attendance* but less than 50% of the AMT students agreed that it encouraged better attendance.

Overall, the MRT students recorded more positive responses to CALM than the AMT students did. As far as gender is concerned, the female students were more positive about CALM.

4.6 Comparison of perception among UPM, UUM and UniKL students

In this section, a comparison is made among the responses obtained from UPM, UUM and UniKL students and the results are shown in Table 9.

Table 9 Percentage of students who responded positively to CALM among UPM, UUM and UniKL

Key concept	University Putra Malaysia (UPM)	University Utara Malaysia (UUM)	University Kuala Lumpur (UniKL)
	%	%	%
Q1 Increase in interest	92.7	96	83.7
Q2 Better understanding	75.6	76	65.3
Q3 Learning faster	74.4	76	57.1
Q4 Longer retention	59.7	60	57.1
Q5 Better grades	45.1	48	40.8
Q6 More benefit	76.8	88	65.3
Q7 Time saving	73.2	72	57.1
Q8 Non-tiredness	63.4	76	44.9
Q9 Active involvement	64.6	52	28.6
Q10 Better attendance	69.5	92	65.3

Overall, from Table 9, we can see that UPM and UUM (public universities) students responded more positively to CALM on all issues than that of UniKL (private university) students. The difference ranged from approximately 3% to 40%. The highest difference was observed on the issue of *active involvement* and the lowest was on *longer retention*.

5. Student's performance

To evaluate the performance of students a simple comparative experiment between Computer Aided Learning Method (CALM) and the Traditional Learning Method (TLM) was conducted in UUM and UPM.

In UUM the students were from the Faculty of Quantitative Sciences majoring in Decision Science and the profiles of these students are listed in Table 10. Majorities of the students were females in the age group of 18-20 years and had gained admission to university through the Matriculation programme.

Table 10 Profile of students

Characteristics	CALM group	TLM group
Gender		
Male	6	5
Female	12	15
Age		
18-20	10	17
21-24	2	1
Others	6	1
Entry qualification		
Diploma	0	1
STPM	5	9
Matriculation	13	10
Previous grades		
A	7	12
B+	0	1
B	10	6
C	1	1

Two lectures for each group conducted simultaneously and the topics discussed were functions and limits of functions. After each lecture, there was a test conducted for both groups in order to evaluate their understanding of the main concepts discussed. The results of these tests were analyzed using S-Plus software and the summary statistics presented in Table 11.

Table 11 Summary statistics of test results

Marks	Test I (total marks 25)		Test II (total marks 22)	
	CALM	TLM	CALM	TLM
Minimum	21.00	20.00	8.00	8.00
Mean	22.79	23.30	15.50	17.45
Median	23.00	24.00	15.50	18.00
Maximum	25.00	25.00	21.00	22.00
Total N	23.00	23.00	18.00	20.00
Standard deviation	1.10	1.29	4.34	4.37

In the CALM group, 24 students took Test I while 18 students took Test II. In the first test, the minimum score was 21 out of 25 marks and the maximum was 25 marks. The average score obtained was 22.79. In the second test, however, the minimum score was 8 points out of a total of 22 marks and the maximum was 21 marks. The average score in the second test was 15.5 marks.

In the TLM group, a total of 23 students sat for Test I while 20 students sat for Test II.. In the first test the minimum score was 20 points and the maximum was 25. The average score in the first test was 23.30. In the second test the minimum score was 8 out of 22 marks and the maximum was 22. The average score obtained was 17.45.

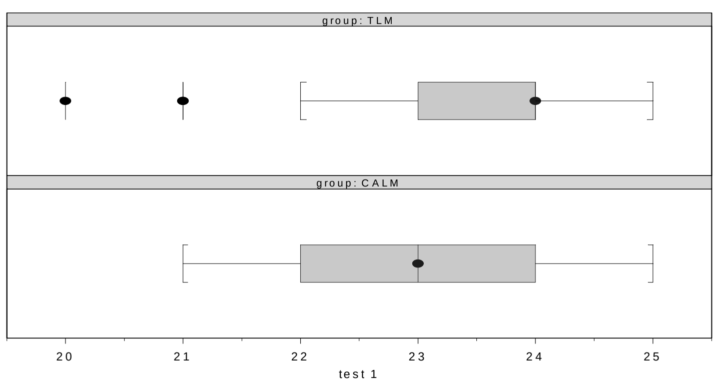

Figure 9 Box plot of test I

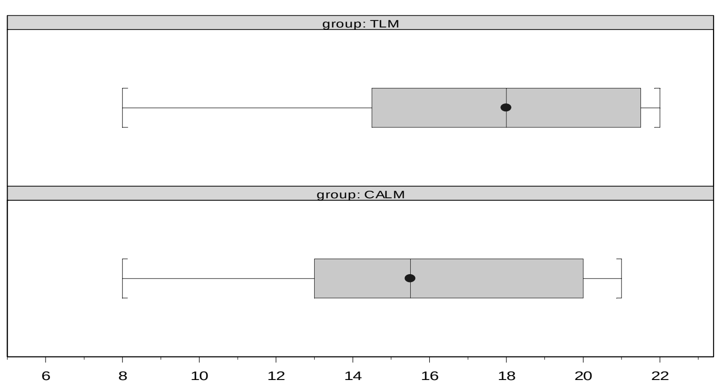

Figure 10 Box plot of test II

A graphical display of the results of Test I and Test II are shown as box plots in Figures 9 and 10, respectively.

For test I, the distribution of TLM group skewed to the left with two low outlying observations while the CALM group marks were more symmetrically distributed. In Test II, both groups were skewed to the left. Generally, in both of these tests the TLM group had obtained higher marks than that of CALM group. This could have been due to the TLM students having stronger mathematical background (see Table 10). Prior to conducting this experiment, we had no previous information on the mathematical background of the students. Consequently, we could not divide the students into homogenous groups.

6. Conclusion

In this study, we were interested to investigate the perception of lecturers and students regarding Computer Aided Learning Method. We were also interested to see whether or not there were any differences between students' performance that had been exposed to CALM versus students taught by the Traditional Learning Method.

Overall, the lecturers' and students' perception about using animation in the teaching and learning of mathematics were generally positive, though there were some discrepancies that required further investigation. We had also observed that students from public universities like UPM and UUM are more receptive towards CALM when compared with UniKL.

As far as students' perception by gender was concerned, there was mixed reactions. For instance, on certain issues such as *increased interest, better understanding* and *non-tiredness* the male students responded more positively than females. On other issues like *saving time, more benefits* and *active involvement*, the female students responded more positively. As far as students' performance was concerned, there did not appear to be clear difference between the two groups.

Generally, this study is an exploratory one and our aim has been to describe the lecturers' and students' perceptions towards Computer Aided Learning Method. Our investigation has raised some interesting questions that required further study.

References:

Boyle, T. (1997). *Design for multimedia learning*. Prentice Hall.

Bradley & Boyle, T. (2004). Students' use of learning objects. *Interactive Multimedia Electronic Journal of Computer-Enhanced Learning*, *6*(2).

Kamel Ariffin, Rustem Suncheleev, Mahendran Shitan & Rita Hashem Abdullah. (2005). *Computer Aided Technology in The Teaching and Learning of Calculus, Proceedings of The Seminar Matematik Dan Masyarakat*. Jabatan Matematik, Fakulti Sains dan Teknologi, Kolej Universiti Sains dan Teknologi Malaysia (KUSTEM), Kuala Terengganu, Terengganu, February, (26-27), 172-184.

Kamel Ariffin, Rustem Suncheleev, Mahendran Shitan & Rita Hashem Abdullah. (2005). *Students' Perception on Using Animation in Learning Calculus, Prosiding Simposium Kebangsaan Sains Matematik Ke-XIII*. Fakulti Sains Kuantitatif dan PERSAMA, Alor Star, Kedah, 31 May - 2 Jun, 295-303.

Kamel Ariffin, Rustem Suncheleev, Mahendran Shitan & Mohd Shafie Mustafa. (2007). Students' perception at Universiti Kuala Lumpur (MIAT) on using animation in learning. *Prosiding 1st International Malaysian Educational Technology Convention 2007*. Persatuan Teknologi Pendidikan Malaysia (PTPM), Senai, Johor Bahru, Johor, 2nd – 5th Nov, 295-303.

Appendix

Computer Aided Learning Method (CALM)
Questionnaire

How to complete the questionnaire.

For most of the questions tick appropriate box. For a few questions you are asked to write in your answer on the line provided.

Date:

Part A

Program: ___________________________

Age: 18☐ 19☐ 20☐ 21☐ 22☐ 23☐ 24☐ 25☐ 26☐ 27☐ other☐

Race: Malay ☐ Chinese ☐ Indian ☐ Other ☐

Gender: Male☐ Female☐

Entry qualification: STPM ☐ Matriculation ☐ Diploma ☐ Other ☐

Grades in Math: A☐ B☐ C☐ D☐ Other ☐ (Specify) ___________

Part B

In this part CALM - stands for Computer Aided Learning Method

TLM - stands for Traditional Learning Method

	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1. CALM increases my interest in learning mathematics	☐	☐	☐	☐	☐
2. In this course, where both CALM and TLM is used, I can understand better through the CALM portion	☐	☐	☐	☐	☐
3. I learn faster through CALM	☐	☐	☐	☐	☐
4. With CALM I can retain information for a longer period of time than when TLM is used.	☐	☐	☐	☐	☐
5. I believe that I can get better grades studying with CALM than with TLM.	☐	☐	☐	☐	☐
6. I would benefit if there were more CALM mathematics courses.	☐	☐	☐	☐	☐
7. CALM saves me time.	☐	☐	☐	☐	☐
8. CALM does not make me tired during the lecture.	☐	☐	☐	☐	☐
9. CALM makes me involved more actively during lecture than TLM	☐	☐	☐	☐	☐
10. CALM increases my interest in attending lectures.	☐	☐	☐	☐	☐

(Edited by Victoria and Lily)