Framework to Integrate Spreadsheet into the Teaching and Learning of Financial Mathematics

Chee-Keong Chong
chongck@utar.edu.my
Faculty of Business & Finance
Universiti Tunku Abdul Rahman
Malaysia

Marzita Puteh
marzita@fsmt.upsi.edu.my
Faculty of Science and Mathematics
Sultan Idris Education University
Malaysia

Swee-Choo Goh
goh.sc@fppm.upsi.edu.my
Faculty of Education and Human Development
Sultan Idris Education University
Malaysia

Abstract

In this paper, we will formulate a conceptual framework to integrate spreadsheet into the teaching and learning of Financial Mathematics. A sample of 85 undergraduates taking Quantitative Techniques took part in this study. They were taught Financial Mathematics through the traditional approach in the previous trimester. A pre-test was carried out to find out their performance level. Later, they were exposed to spreadsheet approach on the same topic and a post-test was administered to assess their performance. Post-test results showed significant improvement. A survey was carried out at the same time to determine their perceptions on (i) ease of spreadsheet use, (ii) the use of spreadsheet template, (iii) awareness of the importance of spreadsheet, (iv) the urgency in learning spreadsheet and (v) the best way to integrate spreadsheet into learning of Financial Mathematics from the students' viewpoints. A conceptual model of implementing the integration of spreadsheet into the teaching and learning of Financial Mathematics is also proposed.

1. Introduction

Many business undergraduates face difficulties in mastering basic Financial Mathematics because they are weak in basic mathematics and hence most of them develop anxiety toward mathematics. The teaching and learning of Financial Mathematics is never an easy task. With the advent of modern digital technology, it sheds some light on it. Electronic spreadsheet was developed specially for business use but with innovation from mathematics educators its use has been extended to become a pedagogical tool for the improvement in teaching and learning. Although spreadsheet is a useful pedagogical tool for the teaching and learning of Financial Mathematics, its use in universities is still limited because teachers' beliefs on how to teach mathematics were generally affected or influenced by how they learned mathematics [16]. Many mathematics educators limit the use of technology to demonstration, verification, and drill and practice only. Their knowledge of students' understandings, thinking, and learning in mathematics are confined to mastery of skills. Spreadsheet can be used to enhance the learning of Financial Mathematics because it is suitable for knowledge construction. In order to implement the integration of spreadsheet into the teaching and learning of Financial Mathematics, we need to understand Technology, Pedagogy, and Content

Knowledge (TPACK) [14] possessed by teachers of mathematics, and also the rational behind the sequencing of content and prior knowledge on learning mathematics based on Cognitive Load Theory (CLT) [4]. Apart from that the level of acceptance of spreadsheet by undergraduates that can be explained by Technology Acceptance Model (TAM) [6] is also an important factor in determining the success of the integration of technology into teaching and learning of mathematics in general.

2. Literature Review

2.1 Introduction

With the advent of computers, the landscape of teaching and learning mathematics has undergone tremendous changes. Many believe that computers bring many benefits to the teaching and learning of mathematics, because through computer technology many difficult concepts can be visualized easily and this makes the learning of mathematics easier. On top of that tedious calculation on mathematics can be easily handled by computer software and learners can spend more time on meaningful interpretation of results [3]. One important aspect when introducing digital technology to school is that the emphasis is not on the technology itself but how the technology helps in teaching and learning. Earle [7] clarified that the integration of technology into teaching and learning is not solely on learning the technology but more on the effective delivery of content.

In order to integrate technology successfully into the teaching and learning of mathematics, it is essential to understand the notion of technology, pedagogy, and content knowledge (TPACK) proposed by Koehler and Mishra [9]; how to sequence the content with the integration of spreadsheet into it by using (CLT) [4]; and the understanding of (TAM) [6] in the adoption of technology into teaching and learning mathematics; as well as the status and level of spreadsheet use by undergraduates [12].

2.2 Technological, Pedagogical and Content Knowledge (TPACK)

Shulman [18] initially introduced the concept of Pedagogical Content Knowledge (PCK). In his model there are two main types of knowledge: content and pedagogy that teachers should acquire for effective teaching. A sound content knowledge coupled with effective delivery method will result in effective teaching. Later, with the introduction of education technology into teaching and learning, another framework has evolved, that is, TPACK. This framework is put forward by Mishra and Koehler [14] to help teachers in integrating technology into teaching and learning. In this model, there are three main components of teachers' knowledge: content, pedagogy, and technology. The successful interaction of these three types of knowledge will result in an effective teaching and learning experience. According to Koehler and Mishra [9], content knowledge (CK) is teachers' knowledge about the subject matter to be taught to students or learned by students. Pedagogical knowledge (PK) is teachers' own knowledge on teaching and learning methods. Technological knowledge (TK) is knowledge on the effective use of technology to achieve the desired outputs in learning. TPACK is the resulting interaction of the above three types of knowledge and it is the basis of effective teaching with technology [9]. TPACK provides a dynamic framework for describing teachers' knowledge required for designing, implementing, and evaluating curriculum and instruction with the use of technology [15].

2.3 Technology Acceptance Model (TAM)

TAM was developed by Davis [6] to explain the computer-usage behavior of users. There are two important determinants of the actual system used: perceived ease of use (PEOU) and perceived usefulness (PU). On the context of integration of spreadsheet into the teaching and learning of Financial Mathematics, the users (teachers or students) must have perceptions that spreadsheet is useful in improving the teaching and learning process; ease of use means users are able to use spreadsheet in teaching and learning without much training. The teachers uphill tasks are to make students aware of its use in any future workplace, as well as to ensure students confidence that it is easy to use.

2.4 Cognitive Load Theory (CLT)

The sequencing of contents is an important component of pedagogical skill. Teachers need to introduce the subject matter based on prior knowledge of the learners; from known to unknown; concrete to abstract and easy to difficult. Clarke et al. [4] pointed out that instruction needs to be developed in a manner that facilitates the acquisition of knowledge in long-term memory while reducing unnecessary demands on working memory to avoid cognitive overload. When integrating technology into teaching and learning, we should try to avoid cognitive overload, otherwise technology will become a burden to students. The sequencing of content knowledge and technological knowledge must be done with care. Clarke et al. [4] found that for students with little knowledge of spreadsheets, sequential instruction on spreadsheets followed by mathematics instruction was better to a concurrent presentation and the reverse was true for students with better knowledge of spreadsheets. Therefore it is important to find out the level of spreadsheet knowledge of the users before the implementation of spreadsheet integration into teaching and learning of mathematics in general.

2.5 Spreadsheet as Cognitive Tool

Pournara [17] quoted "Mathematicians compress, mathematics teachers decompress". This statement describes the situation aptly for the learning and teaching of Financial Mathematics, as a lot of concepts are distilled to become equations or formulas and one needs to untie all these concepts into easily understandable forms. Spreadsheet can help the learners to decompress the formula into visible formats so that they can understand the concepts easily as Lave and Wenger [11] say the transparency of the spreadsheet enables the students to unpack both the mathematical and financial ideas of annuities. This also can help in translating ideas between symbolic forms [5]. Many researchers recognize that computers are cognitive tools and these have no implied intelligence of their own, but rather rely on the user to derive meaning by using the tools to extend his or her capabilities. These tools should not be viewed as crutches, but rather as scaffolds. Unfortunately many use spreadsheet as a productive/utility tool to enhance performance. Spreadsheet can be elevated to become a pedagogical/cognitive tool to help in changing the focus of the classroom from one that is teacher-centered and controlled to one that is learner-centered and open to inquiry, dialogue, and creative thinking on the part of learners as active participants. The use of spreadsheets in teaching and learning financial mathematics is intended to be used as a cognitive/pedagogical tool. Traditional mathematics instruction is defined as instruction that is not supplemented with the use of computer spreadsheets. Traditional instruction could include the use of cognitive tools other than spreadsheets, such as calculators and tables. Mathematically speaking, spreadsheets have considerable potential. They can be used for tabulating functions, graphing functions, statistical analysis, and simulation on financial mathematics. All these require some expertise by the user to manipulate the inbuilt spreadsheet functions efficiently to achieve the

desired end. Besides that using spreadsheets also promotes higher order thinking skills, promotes the development of problem solving skills and supports "what if…" type questions which are more desirable in this computer age [1, 13].

2.6 Status of Spreadsheet Usage by Undergraduates

A lot of people assume that undergraduates are becoming more computer literate. The results of the survey done by Lim [12] and Treadwell et al. [21] indicated that there is a significant deficiency in the use of spreadsheets. There are a significant proportion of students who are unable to use spreadsheets when they enroll in their universities. Although these studies were carried out in Australia and Africa respectively, the scenario is no different in Malaysia; many undergraduates are computer literate, but a significant number of them do not know how to use spreadsheets as expected in their undergraduate study. According to The Australian Chamber of Commerce and Industry and the Business Council of Australia [20], employers of graduates from all disciplines are demanding that their future employees have competency in the use of spreadsheets. Therefore spreadsheet is gradually increasing in its importance as a tool for teaching and learning in primary level up to tertiary level [2]. Students who develop a practical working knowledge of this tool while at school or university then have a skill greatly valued in the business world [19]. Many studies indicate that the use of spreadsheets in the workplace is ubiquitous and that graduates find them relatively easy to learn, easy to use and very useful for their work. Spreadsheet skills are considered very valuable. In another study by Kyng & Taylor [10] on postgraduate students employers support the view that university courses should include training in the use of spreadsheets.

3. Research Question

Financial Mathematics is an important component of Business Mathematics. Most of the business students are weak in this topic because they are weak in their algebraic manipulation. With the advent of technology, this topic can be taught and learnt in a better way. This paper intends to answer the research question of "What is a better approach to the teaching and learning of Financial Mathematics from the pedagogical perspective?" In answering this question a conceptual framework is proposed for the smooth implementation of spreadsheet into teaching and learning of Financial Mathematics.

4. Methodology

A sample of 85 students who attend Quantitative Techniques II in a local private university was selected for this study. The university was chosen because it has a fair coverage and is representative of all undergraduates from Malaysia. There are 1205 students taking this unit in the current trimester and they are organized into 40 tutorial groups. A cluster sampling method was applied to draw this sample since the students in each of these tutorial groups are quite homogeneous. Initially a pre-test was carried out to find out their achievements on Financial Mathematics (which they had completed in the previous trimester in Quantitative Techniques I through traditional method of teaching). They were then exposed to an alternative approach using spreadsheets. After a week students were given a post-test on the same related Financial Mathematics topic with the use of spreadsheet. Students' perceptions on the use of spreadsheets were collected through a survey questionnaire. Results from both tests were analyzed using SPSS.

5. Results and Discussion

There were 85 students taking part in the study. The gender distribution of the respondents shows that 58 (68%) were female and 27 (32%) were male. They were distributed among 7 programs of studies in the university: BBA (Bachelor of Business Administration), BEN (Bachelor of Entrepreneur), BMK (Bachelor of Marketing), BFN (Bachelor of Finance), BBF (Bachelor of Banking & Finance), BAC (Bachelor of Accounting) and BFE (Bachelor of Financial Economics). Their distributions in the various program are shown in Table 1. The students' achievement in Quantitative Techniques I (in previous trimester) is depicted in Table 2. About 40% of them achieved a minimum grade C. Their achievements in this subject were rather low. There are about 18% of them exempted from this unit because they are diploma holders.

Table 1: Program of Study

Program	Frequency	Percent
BBA	10	11.8
BEN	2	2.4
BMK	6	7.1
BFN	6	7.1
BBF	18	21.2
BAC	39	45.9
BFE	4	4.7

Table 2: QT1 Grade Obtained in Previous Trimester

QT I Grade	Frequency	Percent
Exempted	15	17.6
A	13	15.3
B	23	27.1
C	34	40.0

A pre-test was carried out to find out the achievement of students on Financial Mathematics. There are four questions in the pre-test: (i) to calculate the repayment of a loan; (ii) to construct a loan amortization schedule; (iii) use the loan amortization schedule to find the balance of principal after two payments; and (iv) to find the total interest paid. Similar questions were asked in the post-test, except the construction of the loan amortization schedule was replaced by using a spreadsheet template. Tables 3-8 show the results of pre- and post-tests. There are great improvements on the tasks given. There is a significant difference between the use of traditional approach (pre-test) and the use of spreadsheet approach (post-test). Although there is an improvement on the concept of balance of principal by the use of spreadsheet, the improvement is rather low. It may be due to the fact that students did not totally understand the concept of balance of principal. The t-test results (Table 4, 6 and 8) show that there are significant improvements in the post-test.

Table 3: Paired Samples Statistics (Pair 1: Amount of Repayment)

	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	.42	85	.497	.054
Post-test	.99	85	.108	.012

Table 4: Paired Samples Test (Pair 1: Amount of Repayment)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% C.I. of the Difference				
				Lower	Upper			
Pre-test Vs Post-test	-.565	.499	.054	-.672	-.457	-10.439	84	.000

Table 5: Paired Samples Statistics (Pair 2: Total Interest Paid)

	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	.24	85	.427	.046
Post-test	.92	85	.277	.030

Table 6: Paired Samples Test (Pair 2: Total Interest Paid)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% C.I. of the Difference				
				Lower	Upper			
Pre-test Vs Post-test	-.682	.517	.056	-.794	-.571	-12.176	84	.000

Table 7: Paired Samples Statistics (Pair 3: Balance of Principal)

	Mean	N	Std. Deviation	Std. Error Mean
Pre-test	.16	85	.373	.040
Post-test	.42	85	.497	.054

Table 8: Paired Samples Test (Pair 3: Balance of Principal)

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% C.I. of the Difference				
				Lower	Upper			
Pre-test Vs Post-test	-.259	.601	.065	-.388	-.129	-3.973	84	.000

The perceptions of students on the use of spreadsheet are positive. About 99% of them think that spreadsheet approach is easier as compared to the traditional approach on the learning of Financial Mathematics (Table 9). Besides that about 92% of them are able to use pre-prepared spreadsheet template for their learning. It may be because of the easy learning curve on the use of spreadsheet (Table 10). About 94% of the students are aware of the importance of spreadsheet in their future workplaces and moreover about 92% of them intend to learn it now (Table 11 and 12). There is a need to revise the existing curriculum so as to integrate the use of spreadsheet in the teaching and learning of Financial Mathematics. The study also reviews that the level of knowledge on spreadsheet is still very low. About 19% of them do not have knowledge on spreadsheet and a further 73% of them are beginners (Table 13). The result obtained is similar to the study done by Treadwell et al. [21] where they described the students' spreadsheet skills as at beginner level.

Therefore, there is a need to consider introduction training on spreadsheet use before integration of spreadsheet into the Financial Mathematics curriculum.

Table 9: Use of Spreadsheet is Easier

	Frequency	Percent
No	1	1.2
Yes	84	98.8

Table 10: Are Able to Use Template

	Frequency	Percent
No	7	8.2
Yes	78	91.8

Table 11: Aware of the Importance of Spreadsheet

	Frequency	Percent
No	5	5.9
Yes	80	94.1

Table 12: Urgency to Learn Spreadsheet

	Frequency	Percent
Now	78	91.8
After Grad.	7	8.2

Table 13: Level of Spreadsheet Knowledge

	Frequency	Percent
None	16	18.8
Beginner	62	72.9
Intermediate	7	8.2

Table 14: Use of Spreadsheet to Explain Compound Interest and Annuity Concepts

	Frequency	Percent
Agree	80	94.1
Neutral	2	2.4
Disagree	3	3.5

Table 15: Use of Spreadsheet Template in Tutorial

	Frequency	Percent
Agree	80	94.1
Neutral	2	2.4
Disagree	3	3.5

Table 16: Construction of Spreadsheet in Assignment/Project

	Frequency	Percent
Agree	35	41.2
Neutral	10	11.8
Disagree	40	47.0

Table 14 depicts the perception of students on using spreadsheet in lecture. The majority (94%) of them agreed on the use of spreadsheet in explaining the concepts of compound interest and annuity

and about 6% of them disagreed or neutral on this. Similar results were obtained for the use of spreadsheet templates in tutorials (Table 15). This may be due to either the fact that they are able to understand better using spreadsheet or this task is within their abilities. On the construction of spreadsheet in assignment or project (Table 16), the result was not encouraging as only about 41% agreed on that and 59% of them disagreed or neutral on this. The root cause of this may be students are not confident in using spreadsheet for higher level work.

6. Proposed Conceptual Framework and Examples

6.1 The Proposed Conceptual Framework

From the literature review, it was found that spreadsheet skills are needed in future workplace of business graduates but the present usage is low [10, 12]. It is timely that it should be integrated into the teaching and learning of Financial Mathematics, not solely because it is a useful utility tool; more importantly it is a pedagogical tool that will enhance the teaching and learning of Financial Mathematics. In order to integrate spreadsheet successfully into the present curriculum, few teaching and learning theories are employed like TPACK, TAM and CLT [4, 6, 14] to guide the implementation process. The three-stage approach: lecture, tutorial and assignment for the implementation of integrating spreadsheet into teaching and learning of Financial Mathematics is shown in Figure 1. In order not to disturb the present curriculum too much, lecture still follows the traditional approach where most of the teaching and learning are of the expository manner with some introduction of spreadsheet to explain some important concepts like compound interest and annuity. With the use of time-line and spreadsheet, the time-value of money can be shown immediately and this makes learning more effective and meaningful. Further integration of spreadsheet is done during tutorial and assignment. Tutorials are confined to simple use of spreadsheet which includes a prepared template to determine the variables in loan amortization and the interpretation of the loan amortization schedule. Assignment has a more challenging task that involves mathematical and spreadsheet skills. These will consolidate learning because it involves the construction of concepts through the use of spreadsheet. Since most of the students are with none or beginner level of spreadsheet knowledge (92%), it is important that instructors or lecturers should provide basic spreadsheet knowledge to students before integrating it into teaching and learning [4]. The use of prepared template during the initial stage of implementation is because the writing of even the simplest spreadsheet requires a large amount of prior knowledge [8]; we must not under-estimate this. Writing one's own spreadsheet is not a realistic task for the initial stage. English [8] proposed a three-stage approach, at the initial stage we use a pre-written spreadsheet, and we then explore how this pre-written spreadsheet works and only then writing our own spreadsheet. In order for the users to write their own spreadsheets, they need to understand the concepts of cell referencing, variables and formulas as well as the syntax of the spreadsheet package used. All these are in line with the findings mentioned earlier in the results section.

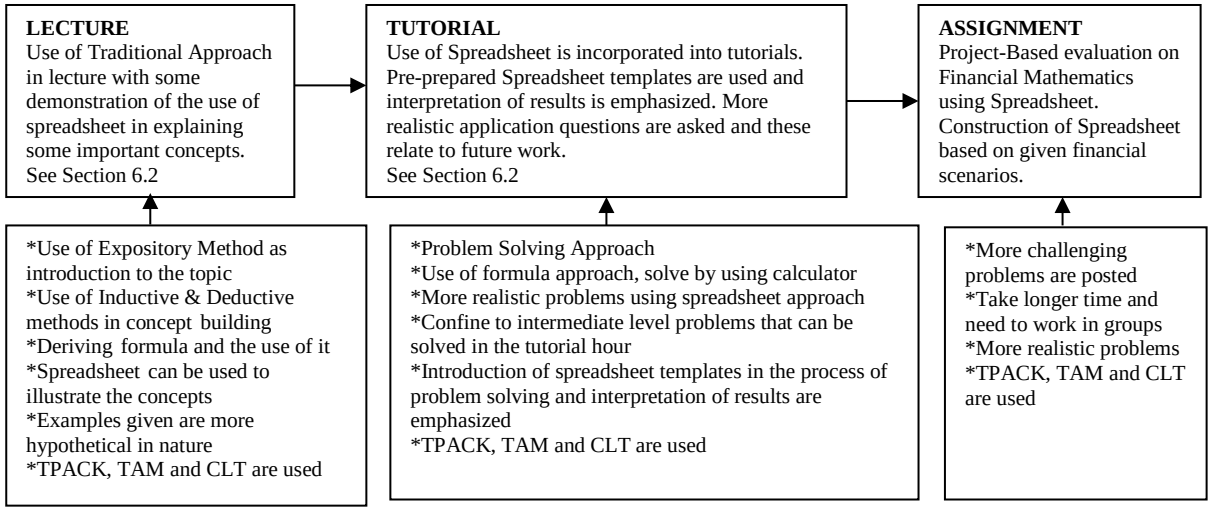


Figure 1: Conceptual Framework for Integration of Spreadsheet into Teaching and Learning Financial Mathematics

6.2 Examples[1]

Lectures are designed using blended traditional and spreadsheet approaches; the example below shows the traditional and spreadsheet approaches in explaining the concept of compounded interest.

Example 1: How much will $100 compound to after three years if it is paid 10% yearly interest?

Table 17 shows the calculation using addition of yearly interest (10% of the deposited amount) with the amount deposited for that particular period. For the multiplication concept the yearly deposit is multiplied by 1.1 (110%).

Table 17: Timeline shows the accumulated amount using addition and multiplication

Year	0	1	2	3
Amount	100	100+(100x0.10)=110	110+(110x0.10)= 121	121+(121x0.10)=133.1
Amount	100	100x1.1=110	110x1.1=121	121x1.1=133.1

[1] The following examples can be solved by using Excel templates that are available at Online Resources of eJMT at https://php.radford.edu/~ejmt/Resources.php

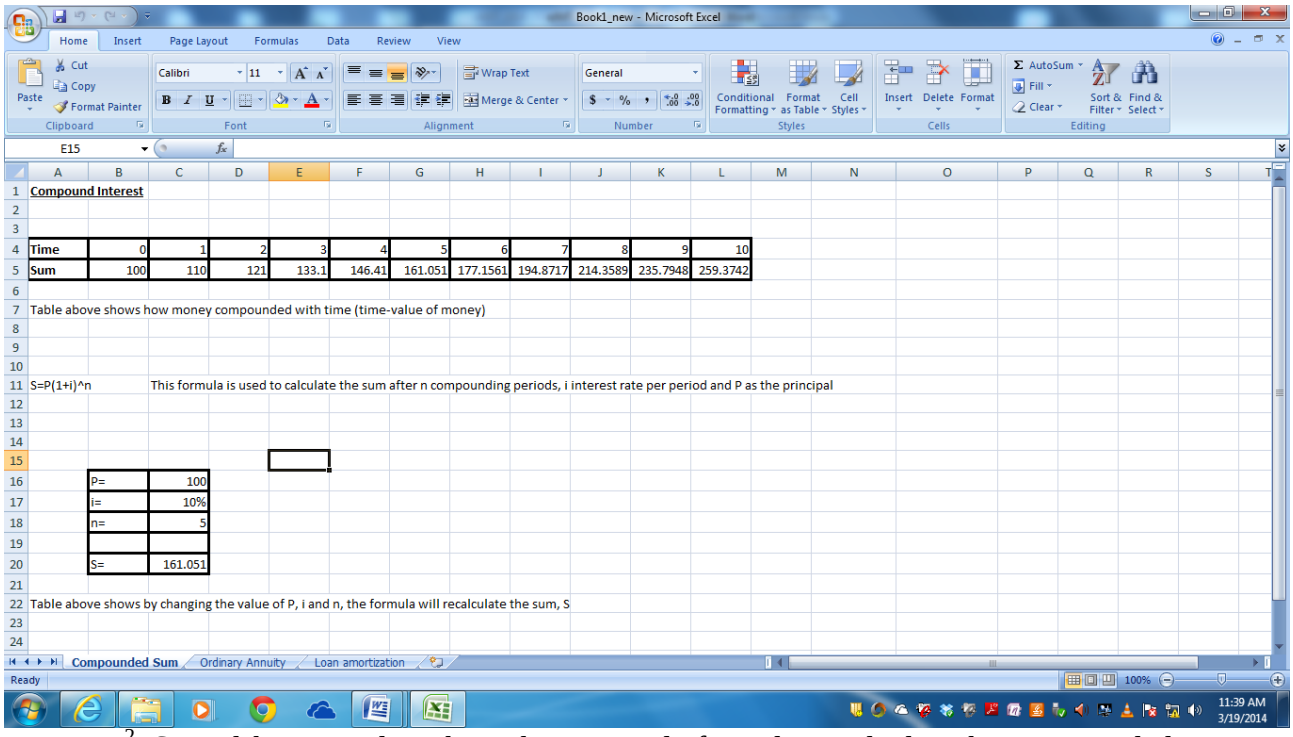


Figure 2[2]: Spreadsheet template shows how to apply formula to calculate the compounded amount and at the same time shows the concept of "time-value of money" on a timeline

The same concept can be taught and explored by using a spreadsheet. Students can explore the spreadsheet by changing the values of principal (P), interest (i) and the duration (n). They can validate the results by using calculators. Figure 2 depicts the spreadsheet design for this purpose. A principal of $100 deposited for five years at 10% per annum will compound to $161.05. The same result can be found in the table.

The concept of annuity can be taught or explored in a likewise manner; the annuity sum can be calculated on a sum-by-sum basis on the equal deposited amount.

Example 2: Find the annuity sum for an amount of $100 deposited at the end of the year for three years if interest is paid at 10% yearly.

Table 18 shows the initial condition of the time line without showing the compounded sum for each payment. Table 19 shows the compounded sum for each payment and its accumulated amount after three payments at the end of third year.

Table 18: Amount deposited at the end of each year

Year	1	2	3
	100		
		100	
			100

[2] The Excel template (FinancialMaths) is available at https://php.radford.edu/~ejmt/Resources.php

Table 19: Amount compounded at the end of the period and its annuity sum

Year	1	2	3
	100	110	121
		100	110
			100
Annuity Sum			331

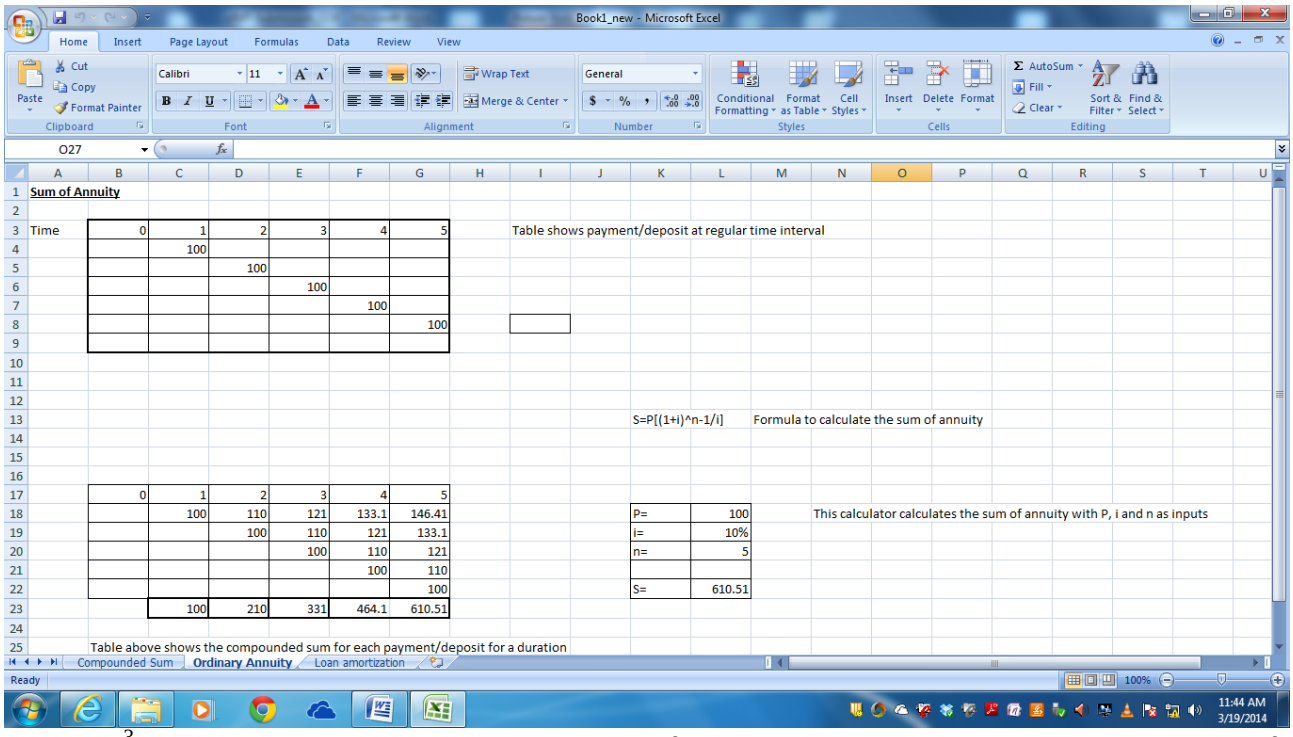
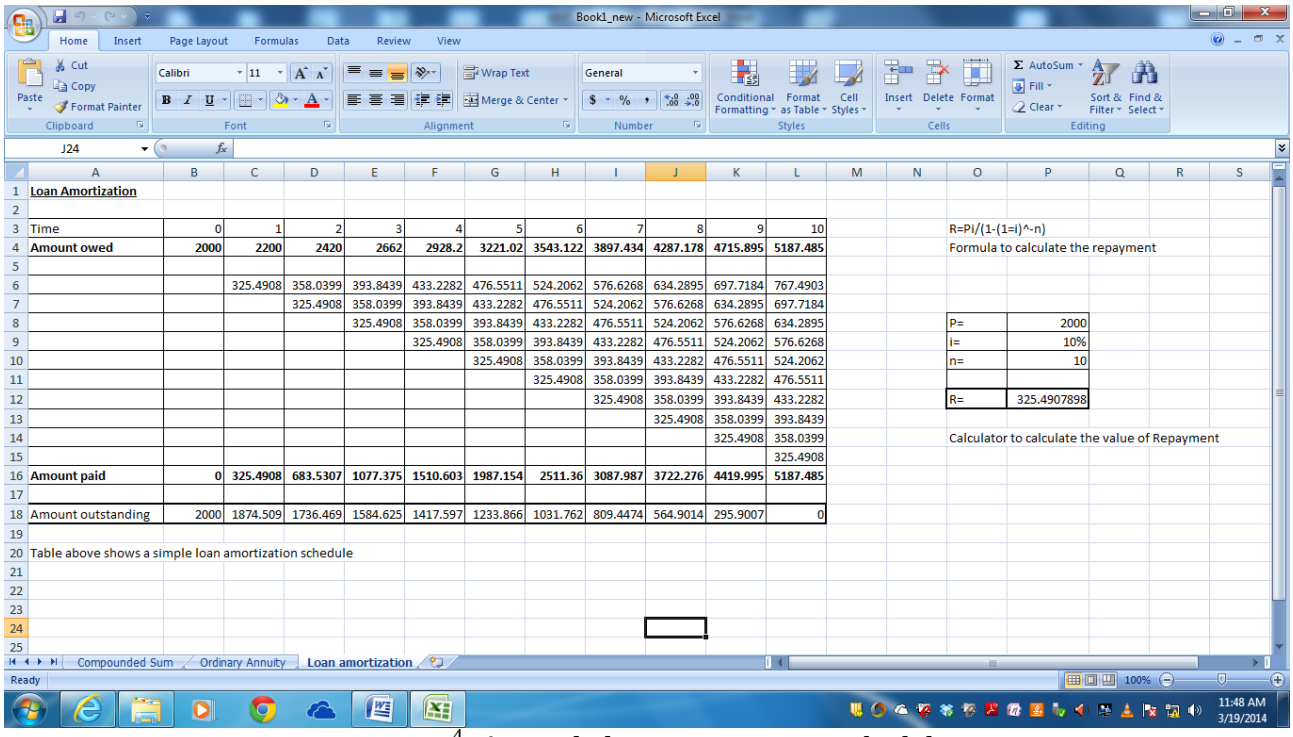


Figure 3[3]: Spreadsheet template shows how to use formula and timeline to illustrate the concept of annuity

The same concept can be explored by students using the pre-designed spreadsheet template. Figure 3 shows the spreadsheet designed to calculate the annuity sum as well as the concept of annuity using timeline. Five equal amounts ($100 each) are deposited at equal yearly interval with 10% interest, at the end of fifth year the annuity sum is $610.51. The table in Figure 3 shows how these amounts are being accumulated. Cell L22 calculates the sum of annuity using formula shown in cell K13: S=P[(1+i)^n-1/i]. Students can explore the spreadsheet by changing the value R (the instalment amount), i (interest paid) and n (the number of payments). Electronic spreadsheet has the advantage to carry out recalculations almost immediately; students can have more time in doing "what-if-analysis". It promotes higher order thinking.

Similarly the concept of loan amortization can be explained by using spreadsheet template. Figure 4 shows a simple loan amortization schedule. Row 4 shows the amount owed (amount compounded each year if there is no payment). Row 16 shows the amount paid at the end of each year (sum of annuity). The amount outstanding at the end of a period is at Row 18 (Amount from Row 4 – Amount from Row 16). Cell L18 shows how the loan is being amortized.

[3] The Excel template (FinancialMaths) is available at https://php.radford.edu/~ejmt/Resources.php



Book1_new - Microsoft Excel

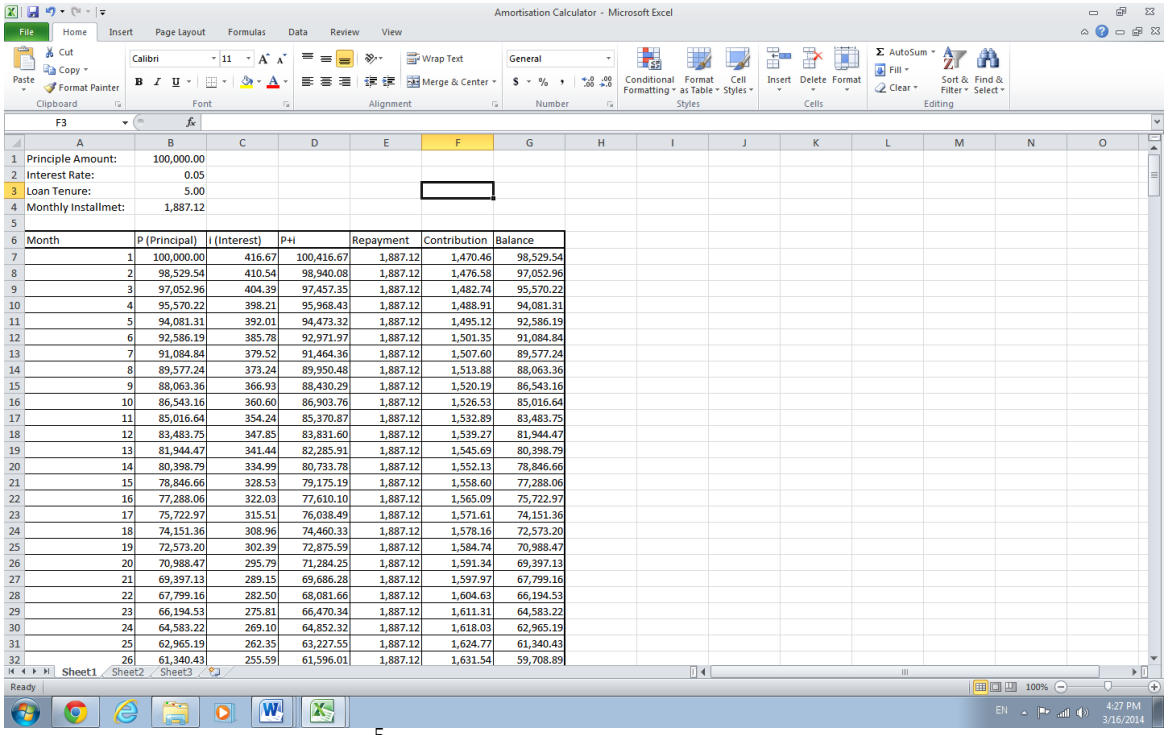
	A	B	C	D	E	F	G	H	I	J	K	L
1	**Loan Amortization**											
2												
3	Time	0	1	2	3	4	5	6	7	8	9	10
4	**Amount owed**	**2000**	**2200**	**2420**	**2662**	**2928.2**	**3221.02**	**3543.122**	**3897.434**	**4287.178**	**4715.895**	**5187.485**
5												
6			325.4908	358.0399	393.8439	433.2282	476.5511	524.2062	576.6268	634.2895	697.7184	767.4903
7				325.4908	358.0399	393.8439	433.2282	476.5511	524.2062	576.6268	634.2895	697.7184
8					325.4908	358.0399	393.8439	433.2282	476.5511	524.2062	576.6268	634.2895
9						325.4908	358.0399	393.8439	433.2282	476.5511	524.2062	576.6268
10							325.4908	358.0399	393.8439	433.2282	476.5511	524.2062
11								325.4908	358.0399	393.8439	433.2282	476.5511
12									325.4908	358.0399	393.8439	433.2282
13										325.4908	358.0399	393.8439
14											325.4908	358.0399
15												325.4908
16	**Amount paid**	**0**	**325.4908**	**683.5307**	**1077.375**	**1510.603**	**1987.154**	**2511.36**	**3087.987**	**3722.276**	**4419.995**	**5187.485**
17												
18	Amount outstanding	2000	1874.509	1736.469	1584.625	1417.597	1233.866	1031.762	809.4474	564.9014	295.9007	0
19												
20	Table above shows a simple loan amortization schedule											

R=PI/(1-(1=i)^-n)
Formula to calculate the repayment

P=	2000
I=	10%
n=	10
R=	325.4907898

Calculator to calculate the value of Repayment

Figure 4[4]: A simple loan amortization schedule



Amortisation Calculator - Microsoft Excel

	A	B
1	Principle Amount:	100,000.00
2	Interest Rate:	0.05
3	Loan Tenure:	5.00
4	Monthly Installmet:	1,887.12

Month	P (Principal)	I (Interest)	P+I	Repayment	Contribution	Balance
1	100,000.00	416.67	100,416.67	1,887.12	1,470.46	98,529.54
2	98,529.54	410.54	98,940.08	1,887.12	1,476.58	97,052.96
3	97,052.96	404.39	97,457.35	1,887.12	1,482.74	95,570.22
4	95,570.22	398.21	95,968.43	1,887.12	1,488.91	94,081.31
5	94,081.31	392.01	94,473.32	1,887.12	1,495.12	92,586.19
6	92,586.19	385.78	92,971.97	1,887.12	1,501.35	91,084.84
7	91,084.84	379.52	91,464.36	1,887.12	1,507.60	89,577.24
8	89,577.24	373.24	89,950.48	1,887.12	1,513.88	88,063.36
9	88,063.36	366.93	88,430.29	1,887.12	1,520.19	86,543.16
10	86,543.16	360.60	86,903.76	1,887.12	1,526.53	85,016.64
11	85,016.64	354.24	85,370.87	1,887.12	1,532.89	83,483.75
12	83,483.75	347.85	83,831.60	1,887.12	1,539.27	81,944.47
13	81,944.47	341.44	82,285.91	1,887.12	1,545.69	80,398.79
14	80,398.79	334.99	80,733.78	1,887.12	1,552.13	78,846.66
15	78,846.66	328.53	79,175.19	1,887.12	1,558.60	77,288.06
16	77,288.06	322.03	77,610.10	1,887.12	1,565.09	75,722.97
17	75,722.97	315.51	76,038.49	1,887.12	1,571.61	74,151.36
18	74,151.36	308.96	74,460.33	1,887.12	1,578.16	72,573.20
19	72,573.20	302.39	72,875.59	1,887.12	1,584.74	70,988.47
20	70,988.47	295.79	71,284.25	1,887.12	1,591.34	69,397.13
21	69,397.13	289.15	69,686.28	1,887.12	1,597.97	67,799.16
22	67,799.16	282.50	68,081.66	1,887.12	1,604.63	66,194.53
23	66,194.53	275.81	66,470.34	1,887.12	1,611.31	64,583.22
24	64,583.22	269.10	64,852.32	1,887.12	1,618.03	62,965.19
25	62,965.19	262.35	63,227.55	1,887.12	1,624.77	61,340.43
26	61,340.43	255.59	61,596.01	1,887.12	1,631.54	59,708.89

Figure 5[5]: A complete loan amortization schedule

Figure 5 shows a complete loan amortization schedule. It automates a lot of calculations by using control loops in the spreadsheet design. For example it can be used to calculate automatically how many payments in five years and generate the sixty payments details in the spreadsheet. Assignment question can be formulated to test students understanding of the concept as well as the appreciation

[4] The Excel template (FinancialMaths) is available at https://php.radford.edu/~ejmt/Resources.php
[5] The Excel template (Amortisation Calculator) is available at https://php.radford.edu/~ejmt/Resources.php

of technology in learning a difficult mathematical concept. We know very well that with limited calculations we cannot set real life problem. For example a five-year loan with sixty monthly instalments is very difficult to handle by students and it needs much more time if manual calculation is used, but with technology it can be done with few strokes of the keyboard.

Example 3: Use the loan amortization schedule in Figure 4 to answer the following questions:

(i) How much is the loan?
(ii) At what interest rate you are paying for it?
(iii) How long do you need to repay the loan?
(iv) How much is each instalment?
(v) After paying for 5 years, how much is the outstanding loan?

The above questions can be rephrased to test students understanding on loan amortization. We are testing students understanding rather than manual calculation.

7. Conclusion

The above results show that with proper planning guided by sound theories, change can be implemented with encouraging results. The suggested conceptual framework in implementing the integration of spreadsheet into the teaching and learning of Financial Mathematics could be a viable one. Further research is needed to refine the needs on the TAM, TPACK and CLT models on this integration model. Apart from PEOU and PU, other determinants may be needed in the refined model of TAM in the integration of technology into the teaching and learning. As for TPACK we need to list the skills that involve content, pedagogical and technological for future improvement in this model. Finally, sequencing of subject matters and spreadsheet skills needed are important in the pedagogical aspect in teaching and learning. Different spreadsheet skills that match with the specific content should be drawn up for future reference. This study has its limitation because it involves only one private university in Malaysia. In future we could extend the study to include private and public universities in Malaysia. Then, the results obtained would be more representative and these could become future reference for policy makers in implementing technology integration in schools or universities.

Supplemental Electronic Materials

[1] Chong, C. K., Excel template on Financial Maths available at https://php.radford.edu/~ejmt/v9n1n3/FinancialMaths.xlsx

[2] Liew, C. Y., Excel template on Amortisation Calculator available at https://php.radford.edu/~ejmt/v9n1n3/AmortisationCalculator.xlsx

8. References

[1] Abramovich, S. (2003). Spreadsheet-enhanced problem solving in context as modeling. *Spreadsheets in Education (eJSiE)*, *1*(1), Article 1.

[2] Baker, J., & Sugden, S. J. (2007). Spreadsheets in education–The first 25 years. *Spreadsheets in Education (eJSiE)*, *1*(1), Article 2.

[3] Calder, N. (2010). Affordance of spreadsheets in mathematical investigation: Potentialities for learning. *Spreadsheets in Education (eJSiE), 3*(3), Article 4.

[4] Clarke, T., Ayres, P., & Sweller, J. (2005). The impact of sequencing and prior knowledge on learning mathematics through spreadsheet applications. *Educational Technology Research and Development*, *53*(3), 15-24.

[5] Davis, B., & Simmt, E. (2006). Mathematics-for-teaching: An ongoing investigation of the mathematics that teachers (Need to) know. *Educational Studies in Mathematics, 61,* 293-319.

[6] Davis, F.D. (1986). *A technology acceptance model for empirically testing new end-user information systems: Theory and results.* (Doctoral Dissertation), Sloan School of Management, MIT.

[7] Earle, R. S. (2002). The integration of instructional technology into public education: Promises and challenges. *Educational Technology*, *42*(1), 5-13.

[8] English, R. (1993). Introducing spreadsheets in mathematics. *Mathematics in School, 22*(5), 38-40.

[9] Koehler, M., & Mishra, P. (2009). What is technological pedagogical content knowledge (TPACK)? *Contemporary Issues in Technology and Teacher Education, 9*(1), 60-70.

[10] Kyng, T., & Taylor, P. (2008). Graduates' use of spreadsheet tools in learning and applying financial mathematics. *Asian Social Science*, *4*(3), 66.

[11] Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation.* Cambridge, MA, Cambridge University Press.

[12] Lim, K. (2005). A survey of first-year university students' ability to use spreadsheets. *Spreadsheets in Education (eJSiE), 1*(2), Article 1.

[13] Luderer, B., Weigand, S., & Handrock, S. (2004). Using computer programs in higher education – Good practice in mathematics.
Available at:
http://www.tu-chemnitz.de/mathematik/preprint/2006/PREPRINT_16.pdf

[14] Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *The Teachers College Record, 108*(6), 1017-1054.

[15] Niess, M. L. (2011). Investigating TPACK: Knowledge growth in teaching with technology. *Journal of Educational Computing Research, 44*(3), 299-317.

[16] Niess, M. L., Ronau, R. N., Shafer, K. G., Driskell, S. O., Harper, S. R., Johnston, C., & Kersaint, G. (2009). Mathematics teacher TPACK standards and development model. *Contemporary Issues in Technology and Teacher Education*, *9*(1), 4-24.

[17] Pournara, C. (2009). Spreadsheets as a transparent resource for learning the mathematics of annuities. *For the Learning of Mathematics*, *29*(3), 49-52.

[18] Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14.

[19] Sugden, S., & Miller, D. (2011). Basic finance made accessible in Excel 2007:"The Big 5, Plus 2". *Spreadsheets in Education (eJSiE)*, *4*(2), Article 1.

[20] The Australian Chamber of Commerce and Industry and the Business Council of Australia (2002). *Employability skills for the future*. Canberra: Department of Education, Science and Training.

[21] Treadwell, G., Estep, M., Smith, K. D., & Merritt, K. L. (2013). Spreadsheet proficiency in business school students: A preliminary study of student job preparedness. *Proceedings Federation of Business Disciplines.* Albuquerque, New Maxico.