Students' Perceptions toward Financial Mathematics Teaching Process: An Empirical Study on Engineering Undergraduate Students

Arturo, GARCÍA-SANTILLÁN Ph. D.
Full time Researcher
Economic-Administrative Research Center
Cristóbal Colón University
Boca del Río, Veracruz, Mexico

Rubén, EDEL-NAVARRO Ph. D.
Full time Researcher,
Education Research Department
Universidad Veracruzana
Veracruz, Mexico

Milka, E. ESCALERA-CHÁVEZ Ph.D.
Full time Researcher
Multidisciplinary Unit Middle Zone
Universidad Autónoma de San Luis Potosí, SLP Mexico.

David ALDANA-PRIETO & Felipe P. CORNEJO-WELLER
(First year students, Doctoral Program in Science Administration)
Cristóbal Colón University. Boca del Río, Veracruz, Mexico

Abstract

Nowadays virtual environments are forcing us to live very closely with technology, computers and information networks. Thus, the present study analyzes the students' perception to learning process of financial mathematics mediated by ICT in the "Tec Milenio" University at "Tecnológico de Monterrey Campus Veracruz". 85 questionnaires were applied to engineering undergraduate student. The survey used was EAPHMF (APTFMS) scale of García and Edel (2008). In order to measure data, the statistical procedure was the factor analysis by principal component extraction and chi-square test statistic (X^2) and the Bartlett's test of sphericity, KMO (Kaiser-Meyer, Olkin) and MSA (measure sample adequacy). The results suggest the rejection of Ho, which means that, the variables: HMCTT, PHC, DSF, PI and CV helps to understand the students' perception towards the teaching process mediated by ICT.

Keywords: Design of simulators, content of the history of mathematics and workshop-type class, spreadsheet programming, computer platforms and virtual communities.

JEL Classification: **I2: I23**

1. Introduction

This empirical study starts from the need that has been presented by the Ministry of Education in Mexico, to include financial mathematics courses in all academic programs, from high school to the university. Likewise, the corporate sector has been involved in this request, which has led to the academic authorities of *Universidad Tec Milenio Campus Veracruz*, to join this concern about including the courses in the curricula of all programs that the institution offers. It is clear that today has become imperative to know the perception that the student has in relation to the process of teaching and learning mathematics and specifically, the financial mathematics and attitude towards this process in all engineering academic programs.

In order to find answer; we took a sample of students to replicate the model of García and Edel (2008), Garcia, Escalera and Edel (2010) to a group of engineering students who's are pursuing the financial mathematics course in "*Universidad Tec Milenio Campus Veracruz"*.

The problem lies in the context of social sciences, but, financial mathematics is part of mathematics, therefore, is placed in the exact sciences. However, the problem has to do with the teaching of mathematics; its connotation is given in the field of Psychology and Education, which places it in the social sciences. This will address studies related to the teaching of financial mathematics based on the use of information and communication technologies (ICT), technology-based educational platforms and virtual learning communities. With this, we want to find an answer to the following question:

RQ1: What is the variables structure to helps understand student's perception toward financial mathematics?

2. Conceptual framework and research hypotheses

The variables of model proposed by Garcia and Edel (2008), Garcia, Escalera and Edel (2010) are also integrated in the scale EAHMF which are: Contents of the history of mathematics and workshop-type class (HMCTT), Programming spreadsheet (PHC), Designing financial simulations (DSF), computer platforms (PI), virtual Learning Communities (CV). In addition to these variables, several are the studies that support the relevance of its inclusion in the process of teaching mathematics; for example, the arguments from Fauvel (1991), Russ (1991), Pizzamiglio (1992), Moreno and Waldegg (1992), Clinard (1993), Toumasis (1995), Barbin (1997), Furinghetti (1997), Fauvel and Van Maanen (1997), Ernest, (1998), Núnez and Servat (1998) in relation to the variable "HMCTT", who's suggest the need to place its historical context of mathematics, to make the traditional classroom a type of workshop where students are taught to build their knowledge from scenarios based on past experiences and current context (García and Escalera, 2011).

Furthermore, the variable programming spreadsheet has been proposed in several studies, highlighting the work of Pamela Lewis in the area of computers in education at St. Luke College in Brookfield, Wisconsin, USA where she teaches to students and faculty how to integrate technology into the curriculum. She is also the author of *Spreadsheet Magic* which has 40 classroom projects that integrate the technological tool in several areas of the curriculum (Lewis, 2003) and finally Goldenberg (2000) who has referred in their studies that one of the forces is the ongoing growth, development and teaching of mathematics, has been from new technologies. In the field of education, the importance of certain ideas have been raised, problems and solutions proposed, issues more accessible with the use of technology, and has provided new ways of representing and managing mathematical information.

Goldenberg concludes that the inclusion of technology as an alternative offered in the content and methodology for teaching, which most likely did not have before. Thus, the spreadsheet that the information technology provides has become a predominant element in the learning process, although for this study, we only refer to financial mathematics as a branch of mathematics. Regarding the financial simulator design variable, Abramovich (2003) and Garcia et al (2007), has been making a series of proposals on the design of financial tools, considering the Excel spreadsheets as bridge to transform mathematical theorems in practical tools called simulators. In the study by Garcia, Edel and Escalera (2010), some step by step manuals are presented in computer language simulation design.

The simulation has been a form of potential element for learning, since one of its benefits is, to allow students face learning situations, by creating different scenarios for the solution of specific problems and its possible outcomes, be in the classroom with a computer, or in a specially equipped computer lab for this learning environment. It is clear that manipulation of variables in the scenarios proposed by the student to solve mathematical problems of everyday life which permits the student to have a different view of the impact on certain economic phenomena, that will facilitate the understanding of the theories learned in the classroom on mathematics and its teaching processes. In summary, the simulation helps the educational process by altering the time scale and can better prepare the student for real time decision making, without having to wait for that time to elapses, an example of this, we can make financial exercises with multiple variables, and the results would be a 20 year credit report with different management scenarios.

The creating and sharing knowledge within the learning process is a task that not only promotes this process, but it becomes a stimulus to the student, since it assumes a commitment to collaborate with colleagues within or outside of classrooms. In this regard, Salinas (2003), cited in Garcia *et al*, (2010), refer that there is a greater probability of achieving virtual learning communities, when the class group have similar interests. That is why the tools designed by the students, as part of the teaching strategy in the workshop-type class, shared with other people, including academic institutions or whoever is interested in obtaining them (Wallace, 2001; Mousround, 2007).

Finally, the relevance of including the variable *computer platforms* to the teaching of financial mathematics (i.e. Moodle platform) is an important element, since this alternative takes the student from being a mere spectator to a participant; and takes the teacher to be a tutor of teaching the use of many tools that the computer platform provides as studies have suggested Rheingold (1996 and 2001), Hagel and Armstrong (1997), Jonassen, Pech & Wilson (1998).

Today, it is a fact that an individual can no longer stay with traditional training. A more integrated training will be needed in the future and it will need constant updating. With the interaction of learning the different networks that exist in universities, which forces everyone to stay updated in their field of study, and learn to live together and use these new tools in learning environments, as studies have referred to Hagel and Armstrong (1997), Tarin (1997), Jonassen, Pech and Wilson (1998), Wallace (2001) and Rheingold (2001), Cho & Jonassen (2002).

For the theoretical and empirical arguments outlined above, this study seeks to identify, what is the structure of variables to understand the student's perception regarding the process of financial mathematics education, considering the contents of variables history of mathematics and workshop-type class (HMCTT) spreadsheet programming (PHC), design financial simulators (DSF), computer science platforms (IP) and virtual learning communities (CV).

2.1. Hypothesis

H1: The structure of the latent variables: the contents of the history of mathematics and workshop-type class (HMCTT) spreadsheet programming (PHC), design financial simulators design (SFD), computer science platforms (IP) and virtual communities learning (CV) helps to understand the students' attitude toward financial mathematics.

3. Design and Research Methodology

This is a descriptive non-experimental study, the variables is not manipulated and we seek to describe the features of this phenomenon and the probable correlations between the variables involved: the contents of the history of mathematics and workshop-type class (HMCTT) spreadsheet programming (PHC), financial simulators design (DSF), computer science platforms (IP) and virtual learning communities (CV).

3.1. Population and sample size

We considered engineering undergraduate students' in the *Universidad Tec Milenio, Campus Veracruz*. The sample is not calculated because it was taken from the population census record.

Table 1. Population *Universidad Tec Milenio-Veracruz, Mexico*

Total Student	Student	Partial	Cumulative	Rejected	Accepted
Engineering	87	87	87	2	85
Σ	87	87	87	2	85

Source: obtained from *Tec Milenio, Campus Veracruz*

3.2. Test and Measurement Procedure

Apply the test EAPHMF (APTFMS), "Attitudes and Perceptions towards Financial Mathematics Scale" of García and Edel (2008). The scale is divided into 31 indicators with a Likert scale. The data is collected and statistically processed with SPSS software v.20, applying the exploratory factor analysis with principal component extraction.

3.3. The statistical procedure

Based on the results of the multivariate statistical method of Exploratory Factor Analysis, we establish the statistical hypothesis: Ho: $\rho = 0$ has no correlation and Hi: $\rho \neq 0$ has correlation. The statistic test is: X^2 and the Bartlett Test of Sphericity KMO (Kaiser-Meyer_Olkin) and Measure of Sampling Adequacy (MSA). Under the null hypothesis, this statistic is asymptotically distributed through a X^2 distribution with $p(p-1)/2$ degrees of freedom, with significance: $\alpha = 0.05/2 = 0.025$, or $p<0.01$ and <0.05 The factor of 0.70 to 0.55 higher statistics factors. If H_0 is true, the eigenvalues are worth one and its logarithm would be zero, therefore the test statistic is zero, otherwise, Bartlett's test with high values of X^2 and a low determinant, suggest that there is a high correlation. So if the critical value: $X^2_{\text{calculated}} > X^2_{\text{tables}}$ there is clear evidence to reject H_0, so the decision rule is: Reject H_0 if calculated $X^2 > X^2_{\text{tables}}$.

4. Results

To answer the main question, we proceeded to apply the factor analysis to validate the survey with the information gathered in the field research. Firstly, we conducted a reliability analysis using Cronbach's alpha coefficient. The *CA* is not a statistical test; it is a coefficient of reliability or consistency. This is an internal consistency index that takes values between *0* and *1* and used to check if the instrument being tested collected inaccurate information and thus, lead us to wrong conclusions.

Cronbach's alpha is therefore a squared correlation coefficient which roughly measures the homogeneity of the questions by averaging all the correlations between all items. This interpretation is that the closer to the index 1, the better the reliability, considering a good reliability of 0.80 The reliability refers to the amount of times an instrument is repeatedly applied to the same subject or object; the results will be the same. Thus, the Cronbach's alpha can be set as a function of the number of items and the average of the correlations among the items, as show it in the formula:

$$\alpha = \frac{N * \check{r}}{1 + (N - 1) * \check{r}}$$

Where:
N = number of items (latent variables), **ř =** this is the correlation between items.
The results obtained are shown in Table 2.

Table 2. Reliability Statistics

Cronbach´s	Alpha	N of items	N=85 cases, zero excludes
INTEGRATED	0.813	5	ACUMULATED
ALL	0.926	31	ALL
HMCTT	0.840	13	1,2,5,6,7,9,10,11,12,13,14,15,17,
PHC	0.781	9	3,4,8,16,20,21,22,23,26
DSF	0.686	5	18,24,25,27,28
CV	0.657	3	29,30,31
PI	0.000	1	19

Source: Self made

The results obtained is = 0.813 and under the criteria of Cronbach's alpha >0.6 (Hair, 1999) we can say that the survey has the required characteristics of consistency and reliability. It is important to note that the Cronbach's alpha obtained for the 31 variables is = 0.926 therefore, the survey is validated.

Table 3 shows the descriptive statistics: mean and standard deviation, which are the basis for calculating the coefficient of variation ($CV = sd / \mu$) which identifies the variable that has the most variation with comparison to other variables of the model. This gives the variable CV = 33.83%, variable that has the highest dispersion, while DSF and PI have the lowest dispersion compared with the rest of the variables, but in general the behavior is very balanced.

Table 3. Descriptive statistics

	Mean μ	Standard Deviation Sd	N	Variation Coefficient CV=DE/MED
HMCTT	3.5584	1.1729	85	32.96%
PHC	3.5477	1.1530	85	32.50%
DSF	3.6800	1.1801	85	32.07%
PI	3.6118	1.1557	85	32.00%
CV	3.5686	1.2072	85	33.83%

Source: Self made

Based on the results described in Table 3, it can be seen that the variables: CV (33.83%) and HMCTT (32.96%) are the largest compared to the rest of the variables that show similar behaviour. After collecting the data, and in order to validate whether the statistical technique of factor analysis can explain the phenomena studied, we first conducted a contrast from Bartlett's test of sphericity with Kaiser (KMO) and Measure Sample Adequacy (MSA) to determine whether there is a correlation between the variables studied and whether the factor analysis technique should be used in this case. Table 4 shows the results KMO, MSA, X^2, significance (p <.01) and correlations of variables involved in the model.

Table 4. Correlation Matrix - KMO, MSA

Variable	Correlation	Sig	MSA	KMO	Esphericity test of Bartlett, (X^2)
HMCTT	0.856	0.000	0.763		
PHC	0.751	0.000	0.772	0.810	254.808
DSF	0.759	0.000	0.863		df 10
PI	0.564	0.000	0.824		
CV	0.548	0.000	0.873		

Source: Self made

As shown in the table above mentioned, the KMO statistic has a value = 0.810 which is close to one, indicating that the data is adequate to perform a factor analysis and, in contrast to Bartlett sphericity test with $X^2_{calculated}$ = 254.808 with 10 df > p-value X^2_{tabla} 0.000, there is significant evidence to reject the null hypothesis (*Ho*) acceptance Hi, considering that the initial variables are correlated. Thus, the statistical procedure of factor analysis allows us to answer the research question: RQ1: *What is the variables structure to helps understand student's perception toward financial mathematics?*

Now, in the Table 5 shows the results obtained from the anti-image matrix, which shows the covariance matrix and the anti-image correlation matrix. The covariance matrix of anti-image contains the negatives of the partial covariance; and correlation anti-image matrix contains the partial correlation coefficients with inverted signs (the correlations between two variables is biased, regarding the other variables included in the analysis). The diagonal line of correlation matrix anti-image is the measure of sampling adequacy for each variable (MSA). If the chosen factor model is appropriate to explain the data, the diagonal elements of anti-image matrix correlations should have a value close to *1* and the other elements should be small.

Table 5. Anti-image Matrix

		HMCTT	PHC	DSF	PI	CV
Anti-image Covariance	HMCTT	0.227				
	PHC	-0.143	0.296			
	DSF	-0.030	-0.137	0.365		
	PI	-0.151	0.057	-0.091	0.529	
	CV	-0.123	0.029	-0.096	0.021	0.577
Anti-image Correlation	HMCTT	***0.763***[a]				
	PHC	-0.553	***0.772***[a]			
	DSF	-0.106	-0.418	***0.863***[a]		
	PI	-0.435	0.145	-0.207	***0.824***[a]	
	CV	-0.341	0.071	-0.210	0.039	***0.873***[a]

a. . Measure of sample adequacy

Source: Self made

In the above table shows the results obtained from the coefficients anti-image correlation (diagonally) ranging from 0.763 to 0.873, these are significantly higher while the rest are less than 0.435 (except for one). So it is confirmed that the factor analysis is appropriate to identify the structure of the latent variables that can explain the student's perception towards the teaching of financial mathematics and thus answer the research question.

The percentage of variance that explains the case studied was obtained from the extraction of the principal components. Primarily, the communalities were obtained, which are the proportion of variance of the extracted component (Table 6), and later analyzed under the criteria of eigenvalues more than one, according to the latent root criteria (> 1). The number of components obtained from the analysis is one, as is shown in graph 1. Moreover, the sum of the square root of the loads, of the initial extraction the eigenvalues of each component is shown in table 7; where we can see that the component removed (one) explain 69.543% of the variance of the studied phenomena.

The following are tables and sedimentation graphs:

Table 6. Component and variance Matrix

Factors	Component 1	Communalities
HMCTT	1.000	0.8560
PHC	1.000	0.7510
DSF	1.000	0.7590
PI	1.000	0.5640
CV	1.000	0.5480
Total variance		3.478 = 69.543%

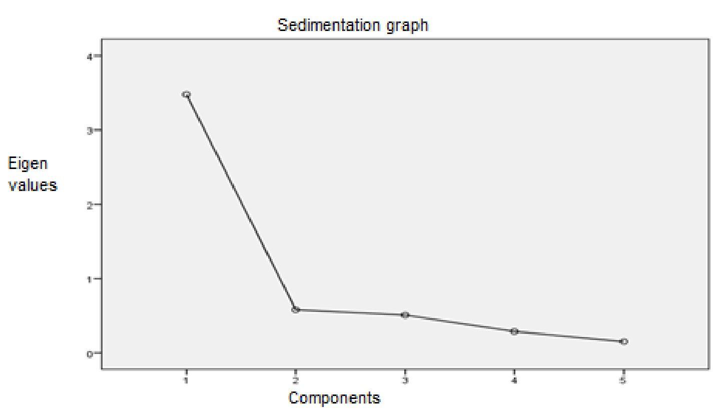
Source: Self made

Table 7. Total variance explained

Component	Eigenvalues			Sum from the saturation to the square of the extraction		
	Total	% de la variance	% accumulate	Total	% de la variance	% accumulate
1	3.478	69.543	69.543	3.477	69.543	69.543
2	0.579	11.588	81.131			
3	0.507	10.138	91.269			
4	0.287	5.734	97.003			
5	0.150	2.997	100.000			
Extraction method of principal components						

Source: Self made

Graph 1 Components and eigenvalues



Finally, the correlation matrix shown in Table 8 and the value of the determinant can help to detect if there is a high inter-correlation between the variables.

Table 8. Correlation Matrix

		HMCTT	PHC	DSF	PI	CV
Correlation	HMCTT	1.000				
	PHC	**0.800**	1.000			
	DSF	**0.726**	**0.744**	1.000		
	PI	**0.667**	**0.504**	**0.566**	1.000	
	CV	**0.629**	**0.512**	**0.562**	*0.422*	1.000
Sig.	HMCTT	0.000				
(Unilateral)	PHC	0,000	0.000			
	DSF	0,000	0,000	0.000		
	PI	0,000	0,000	0,000	0.000	
	CV	0,000	0,000	0,000	0,000	0.000

a. Determinant = .044

Source: Self made

As shown in the table above, the correlations in most cases are above 0.5 except one (*CV* versus *PI* is 0.422). Important data is the value of the determinant (0.044) that suggests that the variables are linearly correlated. Recall that the criteria for determining the correlation matrix (the determinant appears in a footnote below the table), the determinants are very close to zero, thus indicating that the variables used are linearly related, which means that the factor analysis was an appropriate technique to study the variables.

5. Results discussions

The results of this study, allowed to reject the null hypothesis *Ho*, therefore, accepting the research hypothesis *Hi*, which sustains that there is a set of variables that form a latent variable structure that enables the understanding about students' perception towards financial mathematics from the variables (HMCTT, PHC, DSF, PI and CV) proposed by Garcia and Edel (2008) and replicated in Garcia, Escalera and Edel (2010) and García-Santillán and Escalera-Chávez (2011).

This argument provides evidence for understanding the students' attitude in the field of financial mathematics. Students can better perceive the mathematical concepts that teachers explain through educational resources, if the teachers integrate the history of mathematics as a methodological resource. From the previous statement, there is empirical evidence from other studies, which suggest that the inclusion of this variable (HMCTT) facilitates to overcome certain obstacles presents in the teaching mathematics process (Fauvel, 1991, Clinard, 1993 and Furinghetti, 1997). They also point out the benefits of a broader and more profound argument; and the explanation to use the topics about history of mathematics as a teaching technique. They also emphasize its use at the time in which they develop mathematical exercises and also even suggest placing them in other scenarios to address and implement the teaching of this discipline. It is very important to establish, that meaningful learning experience in the student take place around the time that student advantage optimally teaching of financial mathematics, i.e., when the contents of the course are placed in real scenarios in order to find solution to financial problem-solving. In this sense, it is important to set aside the traditional teaching process.

Besides, the ways the student will learn more uplifting, imaginative and critical through motivation, lies in the incorporation of the student's in actively collaborative work, which is the objective of the workshop-type classes (HMCTT). This constructivist collaborative work is referred by Bruner (1966, cited by Coll, 1998) emphasizing the importance of building students' enthusiasm to deepen the understanding of the history of mathematics as a didactic technique.

Other findings in this research allow us to establish the relevance to include in the teaching process, the variable programming spreadsheet as refer Lewis (2003) and Goldenberg (2000). Also, the variable design of simulation and simulators (Garcia et al 2007; Mousround, 2007), the variable virtual learning communities (Wallace, 2001) and variable computing platforms, an example of this is *Moodle*, version 1.9 (2007). It is important to state the interest shown by students toward these variables involved in the proposed model by Garcia and Edel (2008), by the conviction to achieve a different and more meaningful learning that it can bring about transformation in their cognitive structure and consequently a more favorable perception of financial mathematics (Ausebel, et al., 1998, cited by Coll, 1998).

In this way, getting a greater contribution of all the variables, we can infer from the students' perspective, that these tools strengthen the learning of financial mathematics. This empirical evidence is also consistent with the principles outlined by Bruner (1966) cited by Aguerrondo (1999), centralizing on the issue that learning is an active process where students build new ideas or concepts based on past and present knowledge.

The teacher must stimulate the students to discover new principles in mathematical theorems, new management styles and formulas, and above all to transform theorems into computer languages. This leads students to design their own financial tools, which will serve to create simulated scenarios in finding specific solutions to financial problems. They must a redefine their learning: the past, present, future of educational agents as they indicated Choua, Chanb & Linc, (2002).

6. Conclusions

The students' perception towards the teaching of financial mathematics is very favorable; this is demonstrated by the empirical evidence obtained in this research. The variables proposed by Garcia and Edel (2008) for an ICT-mediated learning model, are perceived as positive by students' preferences. This allows a glimpse of transcendence that the tools associated with the teaching of financial mathematics to develop new and better ways to perform the mathematical calculations, but especially for conducting financial simulations with different scenarios to solve math problems. The importance of recommending changes in the teaching-learning process is essential for all higher education institutions, both public and private, to integrate in the curricula the financial mathematics courses. The students must familiarize with the value of money over time, a situation that will be appreciated and will have a great impact in their major, regardless of the profession.

Aknowledgement

The authors are very grateful to the anonymous reviewer for suggestions and *Universidad TEC Milenio del Tecnológico de Monterrey Campus Veracruz* for all their help and support. Also, with our grateful to Miss Sagrario Flores Baena, for all suggestion in the grammatical review process

References

Abramovich, S. (2003). Spreadsheet-Enhanced Problem Solving in Context as Modeling. *Spreadsheets in Education*. 1 (1). Retrieved February 21, 2011 from http://www.sie.bond.edu.au/

Aguerrondo, I. (1999). El nuevo paradigma de la educación para el siglo. Organización de Estados Iberoamericanos para la Educación, la Ciencia y la Cultura (OEI). Retrieved February 17, 2012 from http://www.campus-oei.org/administracion/aguerrondo.htm.

Barbin, E. (1997) "Histoire et enseignement des mathematiques: Pourquoi? Comment?". *Bulletin AMQ, 37*(1): 20-25, March.

Clinard, M. (1993) "Enseignement et histoire des mathematiques." *Plot. Bulletin des Regionales APMEP de Poitiers, Limoges et Orleans-Tours. (64-65):* 8-11, December.

Coll, C. (1998). Significado y sentido en el aprendizaje escolar. Reflexiones en torno al concepto de aprendizaje significativo. *Infancia y aprendizaje,* 41, 131-142.

Ernest, P. (1998). "The history of mathematics in the classroom." *Mathematics in School, 27*(4): 25-31, September.

Fauvel, J. (1991) "Using History in Mathematics Education." *For the Learning of Mathematics, 11(2):* 3-6, June.

Fauvel, J. y Van Maanen, J. (1997) "The role of the history of mathematics in the teaching and learning of mathematics. Discussion document for an ICMI study (1997-2000)." *Zentralblatt fuer Didaktik der Mathematik, 29(4):* 138-140, August.

Fauvel, J. (1991) "Using History in Mathematics Education." *For the Learning of Mathematics, 11*(2): 3-6, June.

Furinghetti, F. (1997) "History of mathematics, mathematics education, school practice: case studies in linking different domains." *For the Learning of Mathematics, 17*(1): 55-61, February.

Furinghetti, F. y Somaglia, A. (1997) "Storia della matematica in classe". *L'Educazione Matematica, 18*(1): 26-46, February-May.

Garcia-Santillán, A. and Edel-Navarro R. (2008): Education-learning of the financial mathematics from the computer science platforms (Simulation with ICT). *Main Theme: Application of ICT (information and communications technologies), in education-learning process.* Annual Meeting Nova Southeastern University "Beyond the Classroom" Fischler School of Education & Human Service. NOVA EDUC@2008. March 17-19, 2008. Miami Beach, Florida USA.

García Santillán A., Edel Navarro R., Escalera Chávez M. (2010) "La enseñanza de la matemática financiera: Un modelo didáctico mediado por TIC" Eumed Editores. University of Malaga Spain. Retrieved September 19, 2011 from: http://www.eumed.net/libros/2010f/867/index.htm

García-Santillán, A. y Escalera-Chávez, M. (2011). IT applications as a didactic tool in the teaching of math's (using of spreadsheet to programming) *Journal of Knowledge Management, Economics and Information Technology*, 1(6), 122-138.

Goldenberg, P. (2000). Thinking (And Talking) About Technologyin Math Classrooms. *Education Development Center*, Inc. http://www2.edc.org/mcc/iss_tech.pdf Publication in EDUTEKA: September 6, 2003. Retriever February 12, 2012 from http://www.eduteka.org/Tema19.php

Cho, K., & Jonassen, D. (2002). The effects of argumentation scaffolds on argumentation and problem solving. *Educational Technology: Research & Development*, 50 (3), 5-22.

Choua, C., Chanb T. & Linc C. (2002). Redefining the learning companion: the past, present, future of educational agents, *Computer & Education*, 40(3), 255-269.

Hagel, J. y Armstrong, A.G. (1997): Net gain. Expanding markets through virtual communities, Harvard Bussines School Press.

Hair**,** J. F. Jr.; Anderson, R. E.; Taltham, R. L. Y Black, W. C. (1999). *Análisis multivariante***.** Madrid: Prentice Hall.

Jonassen, D., Pech, K. y Wilson, B. (1998): Learning with technology. A constructivist Perspective, Prentice may Upper Saddle River (NJ).

Lewis, P.: (2003) "Spreadsheet Magic" Publication in EDUTEKA: September 6, 2003. Retriever February 12, 2012 from: http://www.eduteka.org/HojaCalculo2.php

Moreno, L. y Waldegg, G. (1992): Constructivismo y Educación Matemática. En Castillo, T. y Espeleta, V. (1995) La matemática; su enseñanza y aprendizaje. Tomo I San José, Costa Rica: Editorial UNED.

Moursund, David; "Editorial: The Spreadsheet"; Journal Learning & Leading with Technology; Vol. 26, Issue 5. Retrieved February 12, 2010 from: http://www.iste.org/LL/

Nies, M. (2007) "Cómo utilizar las hojas de cálculo para resolver ecuaciones", Traduction spanish by EDUTEKA from original article "Using Computer Spreadsheets to Solve Equations" write by Margaret L. Nies and Published in Issue 3, Vol. 26 Journal of Learning & Leading with Technology. Retrieved January 11, 2012 from: http://www.eduteka.org/HojaCalculo1.php (http://www.iste.org).

Núnez; J. y Servat, J. (1998) "Los recursos históricos en la educación matemática: el tratado de Alarifes de Diego López de Arenas." Educación Matemática, 10(2): 121-132, Agosto.

Pizzamiglio, P. (1992) "Ruolo didattico della storia della Matematica. Parte I La storia della Matematica a servizio della didattica." IMSI,15(5):287-300.

Pizzamiglio, P. (b, 1992) "Ruolo didattico della Storia della Matematica. Parte II. La comprensione storica della matematica come finalita' didattica". IMSI, 15(5): 475-491.

Rheingold, H. (1996): La comunidad virtual. Una sociedad sin fronteras, Barcelona, Gedisa.

Rheingold, H. (2001): Mobile virtual communities. Retrieved January 11, 2012 from: http://www.rheingold.com.

Russ, S. (1991) "The Experience of History in Mathematics Education." For the Learning of Mathematics, 11(2): 7-16, Jun.

Tarín, L. (1997). El aprendizaje en las organizaciones: de la formación a las organizaciones que aprenden. *Alta dirección, 191,* 8-16.

Toumasis, C. (1995) "Let's put history into our mathematics classroom." *Mathematics in School, 24*(2): 18-19, March 14.

Wallace, P. (2001): La psicología de Internet, Barcelona, Paidós.

Attitude and Perception toward Financial Mathematics Scale (Aptfms)

(García-Santillán, A. and Edel-Navarro, E. 2008)

In this questionnaire there are not correct and incorrect questions, we only wish to know if the students are agree or disagree, with each of the statement. **TD =** totally disagree (1); **D** = disagree (2); **I** = don't know, indifferent (3); **A** = Agree (4); **TA** = totally agree (5)

(FM= financial mathematics)

Ítem	Code
1. - The FM are fun and challenging when the teacher explains their history.	
2- The FM is a valuable and necessary course because we can learn to value money in the time.	
3.- I think that I could study harder FM if I used Excel.	
4. - The FM usually make me feel uncomfortable and nervous, but the use of the ICT reduces this bad feeling.	
5. - I'm more interested in FM, when the teacher explains how it has been used in daily activities of society.	
6.- I enjoy FM when the teacher explains how we can work out a problem in several ways.	
7. - The FM course teaches me how to think; also we can propose some alternatives of solution.	
8.- The terms and symbols used in the financial math are never difficult to understand and handle, because the teacher encourages me to generate new forms of coding	
9. - I encouraged by the trust placed in me from the teacher who teaches the subject FM.	
10. - It is motivating to conduct a workshop-type class.	
11.- I encouraged the trust in me, the teacher who teaches the course of FM	
12. - To know the history of FM, it helps me to generate a higher interest in the course.	
13.- When the teacher explains to me how was the evolution of the FM, it helps me to overcome doubts.	
14.- I like to involve my family when study the FM course.	
15. – We are motivated when the teacher asks for realistic-cases exercises based on our family as homework.	
16. – I apply the FM to calculate mortgage, loans, financial leasing and savings.	
17. – It generates more interest and expectation when I relate real cases with FM and I precedent it in class.	
18. - I learn better when the subject of FM is taught using other didactics techniques.	
19. - Use the ICT in the learning process of FM generates more interest in me.	
20.- The use of an excel spreadsheet helps me with my FM learning process.	
21.- I learn better FM, when I'm programming the formulas in excel.	
22. - Programming formulas in Excel spreadsheet and working in a workshop classroom, helps me learn.	
23.- Designing financial tool in an excel spreadsheet, complements my learning.	
24.- Designing simulators generates added value to me in my teaching and learning process of FM.	
25.- Programming in Excel and the design of simulators, helps me not to reject the teaching and learning process of FM.	
26.- I believe that programming in Excel strengthens my learning in FM.	
27. - I would really like to learn the FM, if I could transform the formulas seen in class, into financial simulators.	
28.- It is motivational when the teacher encourages competition to the best design of simulators.	
29.- The course of FM generates more expectation in me, because I can share the products generated.	
30.- I like to share with other people my mathematics projects, to get a feedback.	
31.- It seems a good alternative for our education to use the website for knowledge sharing.	