International Journal of Humanities Social Sciences and Education (IJHSSE)
Volume 2, Issue 2, February 2015, PP 135-142
ISSN 2349-0373 (Print) & ISSN 2349-0381 (Online)
www.arcjournals.org

Improved Undergraduate Perceptions of Financial Mathematics by Using ICT in Teaching

Carlos A. Rojas-Kramer

Information Technology
Universidad Cristóbal Colón
Veracruz, México
crk@ucc.mx

Arturo García-Santillán

Administrative-Economic Research Center
Universidad Cristóbal Colón
Veracruz, México
agarcias@ucc.mx

Milka E. Escalera-Chávez

Multidisciplinary Unit of the Center Zone
Universidad Autónoma de San Luis Potosí
San Luis Potosí, México
milkaech@uaslp.mx

Abstract: *Information and Communications Technology (ICT) delivers diverse resources that can apply to teaching of mathematics. Deployment of such tools presents grounds to accept that they foster a more positive perception of this matter in higher education students. This research work aims to find the structure of variables that lead to understanding the undergraduate perceptions of financial mathematics, resulting from technology-assisted teaching. The Scale of Attitudes toward and Perceptions of Financial Mathematics (García and Edel, 2008) was used to gather data associated with the undergraduate perceptions of the variables building up the ICT-assisted teaching strategy. A survey was administered to 512 students at two Mexican universities, and factor analysis was conducted on the collected data. The results give evidence to conclude that, for these undergraduates, the involved variables (contents of history of mathematics, workshop-style class, computer platforms, programming in spreadsheet, design of financial simulators, and virtual communities) were conducive to positive perceptions of the financial mathematics. The workshop-style class and the design of financial simulators are the variables contributing the most to explain this phenomenon.*

Keywords: *undergraduate perceptions, financial mathematics teaching, technology-aided teaching*

1. INTRODUCTION

In the early sixties, several research works, such as Feierabend (1960) and others, were conducted for assessing the attitudes of students toward math. Those studies did not discuss the details that Fenemma and Sherman (1976) took into account in developing a scale for measuring the anxiety toward mathematics in men and women. On these bases, other studies focused on measuring the impact of Information and Communications Technology (ICT) in the teaching-learning of mathematics. For this purpose, various factors have been analyzed that describe the fundamental interactions of the student in this practice, such as: confidence, interaction between mathematics and computer, commitment, motivation, and utility, among others (Galbraith and Haines, 1998, 2000). Afterward, the number of explorations on this theme increased because many students perceive mathematics as a challenging, boring, and abstract matter, as Gil, Guerrero and White (2006) commented out.

In late years, ICT has been integrated into the new formative models of learning, now assisted by technological factors. Thus, the teaching-learning processes have varied, and those in mathematics are no exceptions. The proposal of García and Edel (2008), extended by García, Edel and Escalera (2010) comprises an educational model that has contributed to improving students' understanding of the topics on financial mathematics. This model deploys a more technological vision, based on financial simulators, to bring to the visual plane the concepts that students consider abstract. The simulators are designed by the undergraduates and serve as evidence for the got results.

Various authors have documented achievements of the students who took part in ICT-assisted processes for instruction in mathematics. This strategy has succeeded, because pupils can simulate scenarios and find out diverse economic settings to resolve (Dominguez, Hernández, Martin and Queiruga, 2008 cited in Maz, Bracho, Jimenez and Adamuz, 2012).

ICT provides different tools that can support teaching of mathematics. The use of the spreadsheet, simulators, and virtual platforms, among other instruments, may change the perception that the learner has of this matter and has improved the final grades of students (Benitez, Cruces and Sarrión, 2011).

The aim of this research work is to find the structure of latent variables that allow measuring the higher education students' perception of the financial mathematics. This study focuses on two fundamental questions. How do the higher-level students perceive the ICT-mediated teaching-learning of the financial mathematics? What are the variables in this model contributing the most to explain the phenomenon under study?

The theoretical model proposed by García, Edel and Escalera (2010) is replicated here for the purpose of answering these two questions. It is based on the variables of the scale of attitudes toward and perceptions of financial mathematics (EAPHMF) as shown in Fig. 1, where:

- CHM (HM): Contents of the history of mathematics
- WSC (CTT): Workshop-style class
- CP (PI): Computing platforms
- PS (PHC): Programming in spreadsheet
- DFS (DSF): Design of financial simulators
- VC (CV): Virtual communities

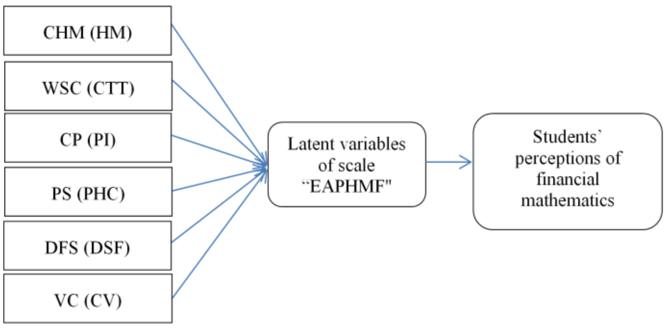


Fig1. *Variables of the scale "EAPHMF."*

The undergraduate perceptions of financial mathematics and the inclusion of ICT in the teaching processes are the two constructs that originate this research, from the following arguments.

1.1. Theoretical Framework

Furinghetti and Somaglia (1998) propose that including history of mathematics in math class promotes an attitude shift toward the matter; students perceive mathematics as an abstract matter existing merely in the teacher's mind. In addition, students believe that almost everything in mathematics is already discovered, and a tedious and insipid matter. Fauvel (1991), extending the conclusions of Gellert (2000), points out that the history of mathematics should be included in the teaching, learning and assessment in math, and recommends comparing implementations of this strategy in different cultural contexts (Pizzamiglio 1992, Bidwell 1993, Murugan 1995).

In the same line, Clinard (1993) and Fauvel (1991) support the argument for including the history of mathematics in math class due to its ability for improving the student learning process, and for its potential to enhance the teaching experience, as this allows teachers to view math from another perspective. The profit generated by this appeal is remarkable. In addition, Chávez and Salazar (2006) say they incorporated this strategy into an algebra class with remarkable results among students: development of oral and written expression skills, increased interest, cooperation, and willingness.

Nowadays, teaching of mathematics deploys technology tools (Goldenberg, 2003). For instance, spreadsheet use has simplified financial projection-making with the simple assignment of values, providing a favorable environment for modeling problems in business and social sciences (Moursund, 2003).

Another relevant mechanism that contributes to the success of the financial mathematics teaching-learning process is to deploy a workshop-style class, later creating a virtual community to offer a computer platform where students and tools (the means to learn) can be integrated. In the words of Pazos et al. (2001), virtual communities are web-based environments that bring together people related to a particular topic that, based on distribution lists (first node of the virtual community), share documents, resources and more.

Hunter (2002) argues that virtual communities have been created to analyze and solve problems, and its members support together building on the knowledge. If mathematics students belong to a virtual community formed for these purposes, that they will have greater involvement, active participation, autonomy, interdependence and responsibility for their learning; this would lead them in a collaborative and cooperative work. Salinas (2003) points out that there is a greater possibility of achieving virtual learning communities when there are individual interests and affinities between students who are studying the same matter. It requires a specialized infrastructure and a platform to build virtual classrooms, being Moodle one of the best choices, as it has an excellent setting. Moodle is a platform to create virtual courses on any subject. It is also a powerful tool that complements communications in the educational community, by providing unlimited space and time.

In the teaching-learning process, student's perceptions play a significant role because their interest in learning depends on the attributes of each student. Learning occurs through the interaction of earlier mindsets of the student and new information from the environment, since the new information in learning process replace no earlier knowledge of the student, but rather it has an interaction with those already present (Ausubel, 1968; Roca, 1991).

Table 1 displays the variables involved in the study and its theoretical basis that focuses on the teaching-learning process of mathematics, although this study is delimited to financial mathematics.

This theoretical foundation ratifies the research question as follows: What is the structure of variables that identify undergraduates' perceptions of the financial mathematics when ICT assists teaching? Then, the hypothesis is:

$\boldsymbol{Hi_1}$ **=** There is a set of variables forming a structure that allow to identify the undergraduates' perceptions of financial mathematics when ICT assists teaching.

It is: *Ho:* r = 0 *Hi:* r ≠ 0

Table1. *Variables and theoretical foundation*

Variable	Relationship	Theoretical and empirical basis that supports the relationship
CHM: Contents of the history of mathematics (specific case of financial mathematics)	Methodological resource for the teaching, learning and assessing of mathematical procedures.	Fauvel (1991), Russ (1991), Moreno and Waldegg (1992), Pizzamiglio (1992), Clinard (1993) Toumasis (1995), Barbin (1997), Fauvel and Van Manen (1997), Furinghetti (1997), Ernest (1998), Nuñez and Servat (1998).
WSC: Workshop-style class		
PS: Programming in spreadsheet	Construction of mathematical tools in Excel spreadsheet for mathematical simulation	Barbin (1997), Goldenberg (2003), Lewis (2003), Moursund (2003), Nies (2007), García et al. (2010).
DFS: Design of financial simulators	Knowledge transfer, in virtual environments.	Rheingold (1996, 2001), Hagel and Armstrong (1997), Jonassen, Pech and Wilson (1998), Salinas (2003).
VC: Virtual Communities	Virtual communities for learning and their application in teaching processes	Hagel and Armstrong (1997), Jonassen, Pech and Wilson (1998), Rheingold (2001), Wallace (2001), García Aretio (2003), Salinas (2003), Cabero et al. (2004), Cabero and Llorente (2005).
CP: Computing Platform	Platforms for Distance Education	Dougiamas (2002), Barnabas and Adell (2006).
Source: García-Santillán et al. (2010)		

2. METHODS

2.1. Research Study

This study is non-experimental and descriptive. It conducts principal components factor analysis of data from a survey of non-probabilistic working sample. The survey was administered to 512 students: 298 from Universidad Cristóbal Colón, of Veracruz, and 214 from Universidad Autónoma de San Luis Potosí. Selection criteria was to include students available at the time of the survey, from the careers of Accounting, International Businesses, Business Management, Economics, Marketing, and Tourism Management, who have completed at least one course in financial mathematics, economics or financial engineering.

2.2. Instrument

The used test is based on a scale developed by García and Edel (2008) and amended by García, Edel and Escalera (2010). A survey collects information about student's perception of the: contents of history of mathematics, workshop-style class, computer platforms, programming in spreadsheet, design of financial simulators design, and virtual communities. The instrument design deploys a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

2.3. Data Analysis Procedure

Multivariate statistical analysis was performed for summarizing the information in a minimum number of factors, aiming to predict. The Statistical Package for Social Sciences (SPSS) version 19 was deployed as an instrument for performing the principal components factor analysis.

3. RESULTS AND DISCUSSION

Table 2 displays the descriptive analysis of the variables: gender, career and belonging University of the surveyed students. Of the sample, 65.8% were women, 58.2% were from the UCC, and there are more students from the Bachelor in Business Management (23.9%) than in any other career.

Table2. *Descriptive analysis*

Variable	%
Gender	
Men	34.1
Women	65.8
University	
UCC	58.2
UASLP	41.8
Career	
Accounting	21.3
Economics	3.9
Business Management	23.9
Marketing	21.1
International Businesses	16.4
Tourism Management	13.5

Source: own

Tables 3 and 4 display the factor analysis outcomes. Table 3 presents the values of the correlation between variables and reveals that they are significant. Moreover, the value (KMO = 0.877; α = 0.00) allows to compare the pattern of correlations. Table 3 also shows the estimation of the expected range (MSA) in the variables under study; they are all greater than 0.5. Applying the criteria of latent root (value greater than 1), the number of components got in the analysis was just one. With an eigenvalue of 3.73, the factor is 62.22% of the variance of the six variables (Table 4).

Table3. *Correlation and Significance*

Variables	CHM	PS	WSC	CP	DFS	VC	MSA	KMO	Barlett test (x^2 $_{df\ 15}$)
CHM (HM):	1	.499 .000	.633 .000	.449 .000	.491 .000	.482 .000	.890		
PS (PHC):		1	.593 .000	.583 .000	.642 .000	.449 .000	.865		
WSC (CTT):			1	.555 .000	.634 .000	.598 .000	.864		
CP (PI):				1	.532 .000	.437 .000	.909		
DFS (DSF):					1	.594 .000	.865		
VC (CV):						1	.885	.877	1446.632 (α = 0.00)
Source: own									

Table4. *Components and variance matrix*

	Component 1	Commonalities	Eigenvalue	Variance %
CHM (HM):	0.748	0.559		
PS (PHC):	0.799	0.638		
WSC (CTT):	**0.854**	**0.730**		
CP (PI):	0.747	0.559		
DFS (DSF):	0.829	0.686		
VC (CV):	0.749	0.561		
			3.733	62.22
Source: own				

Table 4 shows that when each of these elements is present, students' perceptions of mathematics is positive for students of both universities. The factor that contributes most to enhance the perceptions is the workshop-style class (WSC (CTT) = 0.854) followed by the design of financial simulators (DFS (DSF) = 0.829).

The six factors that define the structure of variables that influence student's perceptions of mathematics are indicators with practical and statistical significance. It means that the teachers of the matter can take them into account to design teaching and learning strategies to increase students' interest in financial mathematics and simultaneously decrease the dropout rate in class.

4. CONCLUSION

It exists a structure of variables influencing the perceptions of college students of financial mathematics. The results show that teaching this matter gains in dynamics thanks to ICT, which lead to a different way of teaching and foster in students an improved perception of the theme.

Each of the proposed tools helps to improve the students' perceptions of financial mathematics. Favorable attitude shifts in students have been observed in workshop-style classes. In addition, use of financial simulators has a positive effect on student learning, and it can be inferred that it increases the attractiveness of the course. The same applies to programming in spreadsheet, and to the virtual platforms and communities. If the activities program integrates the history of the mathematics being studied, students will understand the importance that mathematics has in everyday life.

These results match those by Salinas (2003), and Pazos et al. (2002), who argue virtual communities are places for learning; with Goldenberg (2003) by considering ICT can be deployed in math classes to enhance the impression that students have of the discipline; with Moursund (2003), who states that programming the worksheet provides a primary environment for problem-solving and representation of numerical data; and with Clinard (1993) and Fauvel (1991), who support the argument to include the history of mathematics as a major part of teaching, learning and assessing of the matter, and argue that this strategy additionally helps extend students' perception of its importance and usefulness.

It results convenient for the teacher of a financial mathematics course to include ICT support for related themes and activities, to improve the students' perception of the matter by achieving a positive disposition to learn it.

REFERENCES

Ausubel, D. (1968). *Educational psychology: a cognitive view*. New York: Grune and Stratton.

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

Barnabas, I. & Adell, J. (2006). Moodle as an environment for the development of WebQuest activities in higher education. *Department of Education, Universitat Jaume I*. Working paper

Benitez, M. D., Cruces, E. M. & Sarrión, M. D. (2011). The role of the virtual platform for teaching in the classroom teaching of subjects of Statistics. *Magazine for Formation and Educational Innovation University*, 4(1), 1-12.

Bidwell, J. (1993). Humanize your classroom with the History of Mathematics. The mathematics teacher. *An Official Journal of the National Council of Teachers of Mathematics*, 86(6), 461-64.

Cabero, J. & LLorente, M.C. (2005). Las plataformas virtuales en el ámbito de la teleformación, *Revista Electrónica Alternativas de Educación y Comunicación*. Retrieved from: http://www.ealternativas.edu.ar

Cabero, J., Llorente, M. & Roman P. (2004) Las herramientas de comunicación en el aprendizaje mezclado, *Pixel-Bit. Revista de medios y educación*, 23, 27-41.

Chávez B. & Salazar S. (2006). *The role and some of the conditions for the use of the History of Mathematics as methodological resource in the teaching-learning process of Mathematics*. Paper presented at the I Congress of Mathematics Education, UNED, Spain. Retrieved from: http://www.uned.ac.cr/MemEncMate/ponenciasprocesoE.htm [consulted in April of 2013.

Clinard, M. (1993). Enseignement et histoire des mathematiques. *Regional Bulletin des APMEP of Poitiers and Limoges et Orleans- Tours*, (64-65), 8-11.

Dougiamas, M. & Taylor, P.C. (2002) *Interpretive analysis of an internet-based course constructed using a new courseware tool called Moodle*, Curtin University of Technology, URL: http://www.ecu.edu.au/conferences/herdsa/ main/ papers/nonref/ pdf/Martin Dougiamas.pdf

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

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

Fauvel, J. & Van Manen, J. (1997). *The role of the history of mathematics in the teaching and learning of mathematics*. Discussion document for an ICMI study (1997-2000).

Fennema, E. & Sherman, J. (1976) Mathematics Attitudes Scales: Instruments designed to measure attitudes toward the learning of mathematics by females and evils. *Journal for Research in Mathematics Education*, 7(5).

Feierabend R. L.(1960), Review of research on psichologycal problems in mathematical education. *Cooperative Research Monograph*, 3, 3-46.

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.

Furinghetti, F. & Somaglia, A. (1998). History of mathematics in school across disciplines. *Mathematics in School*, 27(4), 48-51.

Galbraith, P. & Haines, C. (1998). Disentangling the nexus: Attitudes to mathematics and technology in a computer learning environment. *Educational Studies in Mathematics*, 36, 275-290.

Galbraith, P. & Haines, C. (2000). Mathematics-computing Attitude Scales. *Monographs in Continuing Education*. London: University city.

García Aretio, L. (2003). Comunidades de aprendizaje en entornos virtuales. La comunidad iberoamericana de la CUED, en Barajas, M. (coord): *La Tecnología Educativa en la Enseñ* *anza Superior*, Madrid, McGraw-Hill, 171-199.

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

García A., Edel, R. & Escalera, M. (2010). *The teaching of financial mathematics: a model teaching ICT mediated*. Retrieved from: http://www.eumed.net/libros/2010f/867/ index. htm Malaga ISBN-1:978693 PM -8 record in the National Library of Spain No. 11/4918

Gellert, U. (2000). Mathematics instruction in safe space: Prospective elementary teachers'views of mathematics education. *Journal of Mathematics Teacher Education*, 3, 251–270.

Gil, N., Guerrero, E. & White, L. (2006). Domain agectivo in the learning of mathematics. *Electronic Journal of Psychoeducational Research*, 4 (1), 47- 72.

Goldenberg, P. (2003). Thinking *(and talking) about technology in math classrooms*. Published by Education Development Center, Inc. Retrieved from: http://www2.edc.org/ EDUTEKA

Hagel III, J. & Armstrong, A. G. (1997). Net *Gain: Expanding Markets through Virtual Communities*. Harvard Business School Press.

Hunter, J. (2002). *Design and support strategies for learning virtual communities of practice.* Alberta, Athabasca University.

Jonassen v., D. , Pech, K. & Wilson, B. (1998). *Learning with technology. A constructivist perspective*, Prentice may Upper Saddle River (NJ).

Lewis, P. (2003). Spreadsheet magic. La magia de la hoja de cálculo, *EDUTEKA*, Retreived from: http://www.eduteka.org/hojacalculo2.php

Maz, A., Bracho, R., Jimenez, N. & Adamuz, N. (2012). The forum in the Moodle platform: a resource for the cooperative participation for the learning of mathematics. *Journal of Media Education and ICT*, 2(1), 30-47.

Moreno, L. & Waldegg, G. (1992). Constructivism and Mathematics Education. In Castillo, T. & Espeleta, V. *Mathematics, their teaching and learning*. San José, Costa Rica: Editorial UNED.

Moursund, D. (2003). Editorial: The Spreadsheet. *Journal Learning & Leading with Technology*, 26(5). Retrieved from: http://www.iste.org/LL

Murugan, U. (1995). Using history of mathematics in the senior primary phase. *Doornik*, 38, 7-13.

Nies, M. (2007). Using Computer Spreadsheets to solve equations. *Journal Learning & Leading with Technology* 3(26).

Núñez, J. & Servat, J. (1998). The historic resources in mathematics education: the treaty of Los Alarifes of Diego López de Arenas. *Mathematics Education*, 10(2) 121-132.

Pazos M, Pérez A & Salinas J. (2001). Comunidades virtuales: De las listas de discusión a las comunidades de aprendizaje. Retrieved from: wttp://www.uib.es/depart/gte/ambientes.html

Pizzamiglio, P. (1992). Ruolo Didattico della storia della Mathematics. Part I. The storia della mathematics to servizio della affairs. *IMSI*, 15(5), 287-300.

Rheingold, H. (1996). *The virtual community. A society without borders*. Barcelona, tr. Constanine Boundas.

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

Roca, J. (1991). Percepción: Usos y teorías. *Apunts: Educació Fisica I Esports*, 25(9), 9-14.

Russ, S. (1991). The experience of history in Mathematics Education. *For the Learning of Mathematics*, 11(2), 7-16.

Salinas, J. (2003). Virtual Communities and digital learning. Conference presented to *Edutec*. Retrieved from: http://www.edutec.es

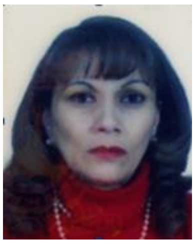
Toumasis, C. (1995). Let's put history into our mathematics classroom. *Mathematics in School*, 24(2), 18-19.

Wallace, P. (2001). *The psychology of the Internet*, Barcelona, Paidos.

AUTHORS' BIOGRAPHY

Dr. Carlos Alberto Rojas-Kramer is a Researcher Professor, and Information Technology Director at Universidad Cristóbal Colón, of Veracruz, México. He has a Ph.D. in Information Technologies and Decision Analisis (*Universidad Popular Autónoma del Estado de Puebla*), a Master in Networking and Telecommunications (*Universidad Cristóbal Colón*) , and a Bachelor in Computer Systems Engineering (*Instituto Tecnológico de Veracruz*). His current research focuses on decision analysis and technology application to education.

Dr. Arturo García-Santillán is a Researcher Professor at Universidad Cristóbal Colón and a member of the National System of Researchers in Mexico. He has Postdoctoral Studies in Mathematics (*Escuela Superior de Economía del Instituto Politécnico Nacional* ESE-IPN), Ph.D. in Management (major) Financial (minor), MBA (*Universidad Autónoma de Ags.*-México) and Bachelor in Financial Management. He obtained the Fischler award in USA for his research and publications on Financial Mathematics teaching, among others. He published more than seventy papers in indexing journals.



Dr. Milka Elena Escalera-Chávez is a Researcher Professor at Universidad Autónoma de San Luis Potosí and a member of the National System of Researchers in Mexico. She has Postdoctoral Studies in Mathematics (*Escuela Superior de Economía del Instituto Politécnico Nacional* ESE-IPN), Ph.D. in Management (major) Financial (minor), MBA (*Universidad Autónoma de SLP,* México). She published more than ten papers in indexing journals.