Improve Undergraduate Perceptions of Financial Mathematics by Using ICT in Teaching

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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 (Domínguez, Hernández, Martín 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 (Benítez, 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

![Fig. 1. Variables of the scale “EAPHMF.”](image)

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,
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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:

\[ H_{1} = \text{There is a set of variables forming a structure that allow to identify the undergraduates’ perceptions of financial mathematics when ICT assists teaching.} \]

It is: \[ H_{0}: r = 0 \quad H_{1}: r \neq 0 \]

<table>
<thead>
<tr>
<th>Variable</th>
<th>Relationship</th>
<th>Theoretical and empirical basis that supports the relationship</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSC: Workshop-style class</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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.

Table 2. Descriptive analysis

<table>
<thead>
<tr>
<th>Variable</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>34.1</td>
</tr>
<tr>
<td>Women</td>
<td>65.8</td>
</tr>
<tr>
<td>University</td>
<td></td>
</tr>
<tr>
<td>UCC</td>
<td>58.2</td>
</tr>
<tr>
<td>UASLP</td>
<td>41.8</td>
</tr>
<tr>
<td>Career</td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td>21.3</td>
</tr>
<tr>
<td>Economics</td>
<td>3.9</td>
</tr>
<tr>
<td>Business Management</td>
<td>23.9</td>
</tr>
<tr>
<td>Marketing</td>
<td>21.1</td>
</tr>
<tr>
<td>International Businesses</td>
<td>16.4</td>
</tr>
<tr>
<td>Tourism Management</td>
<td>13.5</td>
</tr>
</tbody>
</table>

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).
## Table 3. Correlation and Significance

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

Source: own

## Table 4. Components and variance matrix

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Commonalities</th>
<th>Eigenvalue</th>
<th>Variance %</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHM (HM):</td>
<td>0.748</td>
<td>0.559</td>
<td></td>
</tr>
<tr>
<td>PS (PHC):</td>
<td>0.799</td>
<td>0.638</td>
<td></td>
</tr>
<tr>
<td>WSC (CTT):</td>
<td>0.854</td>
<td>0.730</td>
<td></td>
</tr>
<tr>
<td>CP (PI):</td>
<td>0.747</td>
<td>0.559</td>
<td></td>
</tr>
<tr>
<td>DFS (DSF):</td>
<td>0.829</td>
<td>0.686</td>
<td></td>
</tr>
<tr>
<td>VC (CV):</td>
<td>0.749</td>
<td>0.561</td>
<td></td>
</tr>
</tbody>
</table>

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.

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