Australian Journal of Basic and Applied Sciences, 9(1) January 2015, Pages: 323-331

AENSI Journals

Australian Journal of Basic and Applied Sciences

ISSN:1991-8178

Journal home page: www.ajbasweb.com

Financial Software Design, as Evidence in the Teaching-Learning of Financial Mathematics

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ARTICLE INFO

Article history:
Received 19 September 2014
Received in revised form
19 November 2014
Accepted 22 December 2014
Available online 2 January 2015

Keywords:
Strategic didactics, learning mathematics, use of spreadsheets, financial simulators
AMS: 97A30, 97A40

ABSTRACT

Background: In this research, the perceptions of two groups of students were measured: 36 of postgraduate and 49 graduate students taking a course in financial mathematics, from the scale proposed by Garcia and Edel (2008). In this course, the use of Excel spreadsheets was integrated as an educational tool. The hypothesis test is carried out using the statistical procedure Z-test to measure the proportions of affirmation. Objective: Measuring the perception of learning of financial mathematics with the use of simulators as a teaching strategy. Results: With the obtained results, it is possible to say that the student has more acceptance and liking towards financial mathematics, when using Excel spreadsheets for designing and simulation of financial mathematics. Conclusion: With this result, allows us to say that the student population today is performing better in both understanding and skill development of mathematical functions, using the spreadsheet and technologies computer itself, all compared to the student who performs teaching-learning process in the traditional system.

To Cite This Article: Arturo García-Santillán, Lucía Ríos-Álvarez, Alberto Portugal-Rincón, Teresa Zamora-Lobato, Felipe Pozos-Texon., Financial Software Design, as Evidence in the Teaching-Learning of Financial Mathematics. ***Aust. J. Basic & Appl. Sci.,*** *9(1): 323-331, 2015*

INTRODUCCIÓN

In the education processes in social sciences, humanities and in the exact sciences, a technology innovation phenomenon has surfaced. This has lead us to looking for new forms of teaching and learning in all the disciplines, for example in the process of teaching and learning mathematics.

Regarding this topic, the *Secretaría de Educación Pública* in Mexico *(SEP)*, and the *Instituciones de educación superior (IES)* and the managerial sector of the country, have been concerned for the high index of admonition and apparent rejection towards mathematics. It is in this process of education that an area of opportunity is displayed to propose a model for teaching mathematics based on a computing environment for designing a tool called financial simulators for creating virtual communities to share products generated as evidence of the teaching/learning process.

Some of the factors that have been identified among students are: complication in the teaching process of this subject, aversion and indifference, dubious and very little teacher interaction. The Decalogue of arguments, have been historically present since the creation of mathematical concepts and their evolution as stated by Clinard (1993), Chaves and Salazar (2007).

It is from these arguments that the *Universidad Cristobal Colon*, has set among its specific purposes, to generate a change in the teaching of mathematics in general (and for this specific case of financial mathematics) that favors a change in attitude of the student towards this matter, based on the historical background and evolution. This purpose has a serious theoretical and empirical contributions regarding Russ (1991), Pizzamiglio (1992), Barbin (1997) and Van Maanen Fauvel (1997), Furinghetti, (1997), Furinghetti and Somaglia (1997 and 1998) and Ernest (1998), cited in Chaves *et al* (2007) on the inclusion of the history of mathematics in the teaching-learning process, as a methodological resource that could facilitate such learning.

On the other hand the business sector in the country, has constantly applied to both public and private academic authorities, including the field of financial mathematics in the curriculum. They argue that in time such knowledge will enable students to acquire learning and ability to value money. This argument favors the

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inclusion of variables such as the use of information technology, collaborative work and workshop type class, the latter, with practical demonstration sessions to expose simulators supported by financial results, understanding the latter as the technological tool used in the teaching of financial mathematics.

Finally the head of the *Secretaria de Educacion Publica (SEP)* notes that the School Education Reform will join the high school curriculum, including the matter of financial mathematics cycle from 2008. The objective is the need for young people to learn how to appraise the value of money over time. In addition, *SEP* stated that learning mathematics and other disciplines, is more of memorizing or encyclopedic learning, and learning mathematics requires a more critical approach, and even renewed vision with knowledge of what we live today in Mexico, referring to cultural contextualization, the relationship of mathematics to human life and technological innovation.

Authors such as Bidwell (1993), Katz (1997) and Ernest (1998) provide evidence of these arguments about the need to place the student in the context in which they develop mathematics and how it is present in many aspects of life. Furthermore, this foundation rests theoretically in studies such as Lewis (2007) who notes that in the teaching of mathematics and the development of new methodologies to transfer and acquire the knowledge necessary to adopt the use of information technologies and communication technologies (ICTs).

We also have Goldenberg (2003) and Moursund (2003), who report that at present, the teaching-learning process are favorably influenced in its evolution and growth of information and communication technologies, which significantly favors the learning process of mathematics in general.

On the use of technology to support the teaching process, we return to the words of Crespo (1997) cited in Poveda and Gamboa (2007) who relate that though you are "buying and selling" the idea that technology is the magic formula to transform classrooms into authentic perfect learning scenarios, in reality this is not so, however Gómez and Meza (2007) indicate that although the technology is not a magic formula, nor the probable solution to all educational problems, what is beyond doubt is that technology is an instrument of change that favors the learning process of mathematics in general. Thus the teaching of mathematics integrates variables like: teacher, students, computer programming environment, the environment (ICT), the product (tools-financial simulators). Now, with these arguments, the following question arises:

Research question:

How student perceive the learning of mathematics with the use of simulators as a teaching strategy?

Objective:

Measure the perception of learning of financial mathematics with the use of simulators as a teaching strategy.

The Hypothesis:

H_1: The students that uses a spreadsheet to make a financial simulation, favorably perceives learning financial mathematics.

Justification:

The importance of the study is the accumulation of reasons why an investigation is warranted, this leads to contributing knowledge and ability to solve problems. In this research, theories related to teaching processes based on the use of ICT, educational technology in relation to the variable "simulation and simulators" where authors such as Barbin (1997), Goldenberg (2003), Lewis (2007), Mousround (2007), Nies (2007) among others, suggest the use of ICT in the teaching process, in fact propose to construct mathematical tools using spreadsheet Excel.

With the result of the discussion, it helps validate theoretical innovation in the process in question. With the operationalization of variables and the generation of indicators for measurement, it is necessary to design an instrument for data collection in the field research, thus contributing to the methodology and propose an instrument with construct validity for further research.

Finally, the importance and social relevance, originated from the necessity of demonstrating to different social sectors of Mexico, the results of this research, as stated earlier in this study, both Mexican educational authorities (SEP), business and higher educational institutions need for innovative process in the teaching and learning process of mathematics in general.

Methodology:

This research took four groups of students: 2 graduate students and 2 undergraduate students. A questionnaire was designed with indicators derived from the operationalization of the variables "PHC y DSF (Excel spreadsheet and design simulators) and the student's perception towards this teaching method. Thirty-seven students from the MBA (16 from MA2007-09 and 21 from MA2008-10) and 49 undergraduate students (35 from LAE and 14 from LAET) were surveyed. These subjects previously took a course in financial

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mathematics using a computer (Excel, flash, visual basic, others), and whose product derived a tool design: financial software.

To test the hypothesis, an assertion test took place and it states that *p>0.5* and its representation is: *Ho*: p=0.5, *Hi*: p>0.

So the null hypothesis and the alternate are represent as:

H_o: The use of simulators does not generate more acceptation.

H_a: The use of simulators generates a mayor student acceptation.

RESULTS AND DISCUSSION

The data collection instrument for all pupils identified above was applied. Only one questionnaire was not given, so it was removed from MA2008-10 program, so that the total was 36 (n) for the graduate group, and 49 (n) for the postgraduate group. The questionnaire was designed with a Likert scale and included as response options: SD = Strongly Disagree, D = Disagree, I = do not know or cannot answer, indifferent, A = Agree, TA = Strongly Agree.

The PHC Items (spreadsheet program) and DSF (design of financial simulators), had a frequency of 31 cases (36) leaned towards TA (totally agree), in the case of the population and 33 graduate cases (49) leaned towards to TA and A (strongly agree and agree).

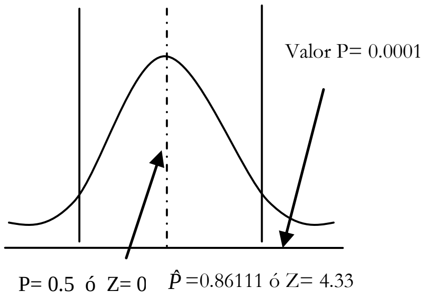
With these data, the Z test statistic gives the following results for each of the samples:

Consider for both X = proportion of sample cases, n = sample

For postgraduate

$$\hat{P} = \frac{x}{n} = \frac{31}{36} = .86111$$

$$Z = \frac{\hat{P} - p}{\sqrt{\frac{pq}{n}}} = \frac{0.86111 - 0.50}{\sqrt{\frac{(0.5)*(0.5)}{30}}} = \frac{0.36111}{0.08333} = 4.33$$



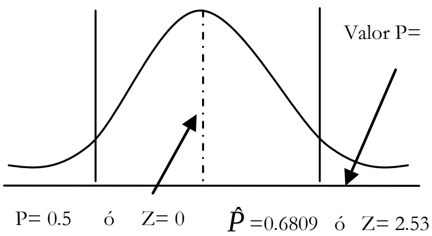
Z value of 4.33 is obtained.

The value of 0.9999 for Z> 3.50 is taken then 1-9999 = .0001 P value = 0.0001. The computed test statistic (Z = 4.33) is greater than the critical (Z = 3.50) and since the P value of 0.0001 is less than the significance level α = 0.05 the null hypothesis is rejected. This allows us to infer that after students took the financial mathematics course, which was held involving Excel spreadsheets for simulation and design of financial simulators, the students found it more interesting, that is, their perception towards this method generated more acceptances towards mathematics.

For graduate

$$\hat{p} = \frac{x}{n} = \frac{33.00}{49} = 0.6809$$

$$Z = \frac{\hat{P} - p}{\sqrt{\frac{p*q}{n}}} = \frac{0.6809 - 0.5}{\sqrt{\frac{0.5*0.5}{49}}} = \frac{0.1809}{0.071428} = 2.53$$



Z value of 2.53 is obtained.

The value of 0.9943 for Z = 2.53 is taken then 1-9943 = 0053 obtaining the P value of 0.0053. The computed test statistic (Z = 2.53) is greater than the table and since the P value of 0.0053 is less than the significance level α = 0.05 the null hypothesis is rejected. Again we can infer that after undergraduates took the financial mathematics course, which was held involving Excel spreadsheets for simulation and design of financial simulators, the students seemed more interesting, that is, their perception towards this modality will generated greater acceptance and interest in financial mathematics.

Proposal For Intervention:

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Under consideration, the proposed intervention could encourage greater acceptance of students towards financial mathematics and also contribute to educational innovation is the path adapted model "ST / SIMTRACOVI" (Edel & García, 2008). The structure of the proposal could be developed according to the following steps:

a.- Traditional Session (every formula of financial mathematics is explained)

b.- Using ICTs proceed to programming the formulas seen in class, in a computer environment (Excel, Flash, Visual Basic and others)

c.- The student designs simulators using the software tool

d.- virtual communities (The products generated are disseminated through virtual communities)

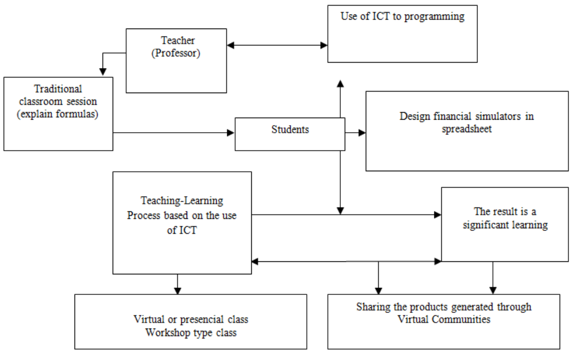

Fig. 1: Path Model. Source: Adapted from García and Edel 2008.

The Route Description Process (Teaching And Learning Of Financial Mathematics)

The first step is to explain each formula and solve the problems on the blackboard by hand solving for each variable. For example: the following formula of equivalent equations for restructuring debts (Pastor, 1999).

$$V_{D_n} = \sum_{0=n}^{aff} S_{1_{aff}}\left(1+\frac{i_1 t_1}{365}\right)^m + \ldots. S_n\left(1+\frac{i_n t_n}{365}\right)^m + S_{ff} + \sum_{0=n}^{pff} \frac{S_{1_{pff}}}{(1+\frac{i_1 t_1}{365})^m} + \ldots. \frac{S_{n_{pff}}}{(1+\frac{i_n t_n}{365})^m}$$

The subject in financial mathematics is developed, after that the student designs the digital environment using computer software to transform the formulas, viewed in class, creating a tool called financial simulators. For example:

$$V_{D_n} = \sum_{0=n}^{aff} X_{1_{aff}}\left(1+\frac{i_1 t_1}{365}\right)^m + \ldots. X_n\left(1+\frac{i_n t_n}{365}\right)^m + X_{ff} + \sum_{0=n}^{pff} \frac{X_{1_{pff}}}{(1+\frac{i_1 t_1}{365})^m} + \ldots. \frac{X_{n_{pff}}}{(1+\frac{i_n t_n}{365})^m}$$

Each item is programmed in Excel (for example):

=SI(D7=”1”,(1*POTENCIA(1+(K13*(D7/12)),D7)),0)+SI(F7=”1”,(1*POTENCIA(1+(K13*(F7/12)),F7)),0)+SI(H7=”1”,(1*POTENCIA(1+(K13*(H7/12)),H7)),0)+SI(J7=”1”,(1*POTENCIA(1+(K13*(J7/12)),J7)),0)+SI(L7=”1”,(1*POTENCIA(1+(K13*(L7/12)),L7)),0)+K19+SI(D11=”1”,(1/POTENCIA(1+(D11/12)),D7)),0)+SI(F11=”1”,(1/POTENCIA(1+(F11/12)),F7)),0)+SI(H11=”1”,(1/POTENCIA(1+(H11/12)),H7)),0)+SI(J11=”1”,(1/POTENCIA(1+(J11/12)),J7)),0)+SI(L11=”1”,(1/POTENCIA(1+(L11/12)),L7)),0)+

A financial simulator is designed in Excel, and as an option, different languages can be added (English and French).

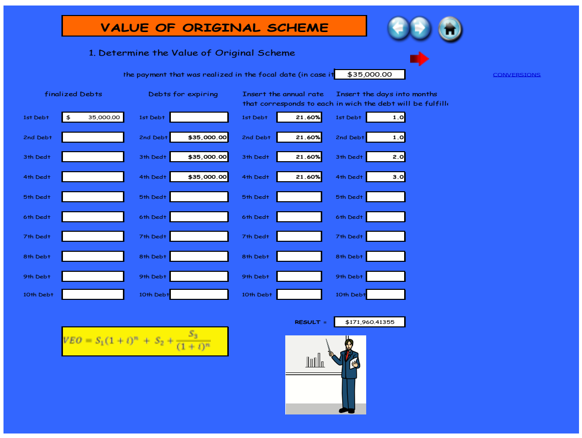

Fig. 1: Value of original scheme

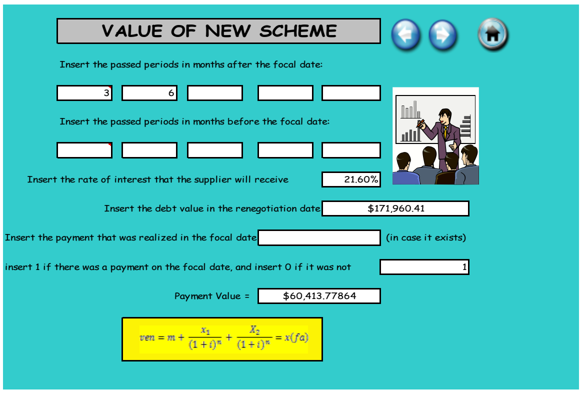

Fig. 2: Value of new scheme.

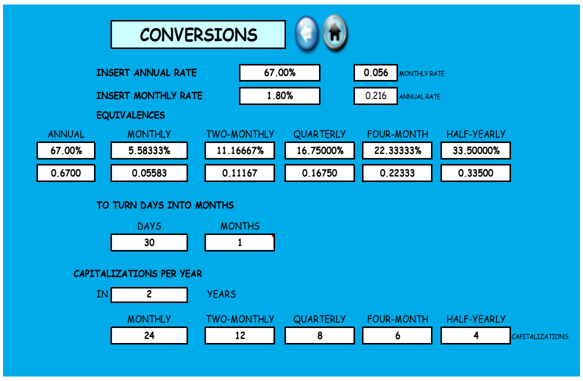

Fig. 3: Conversions.

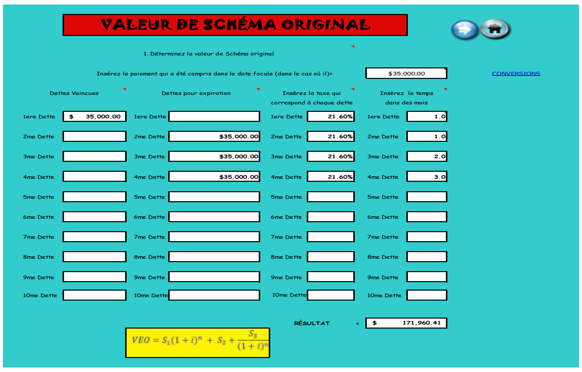

Fig. 4: Value of original scheme (French version).

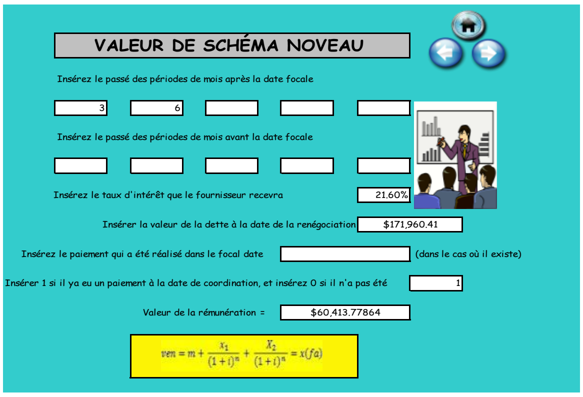

Fig. 5: Value of new scheme (French version).

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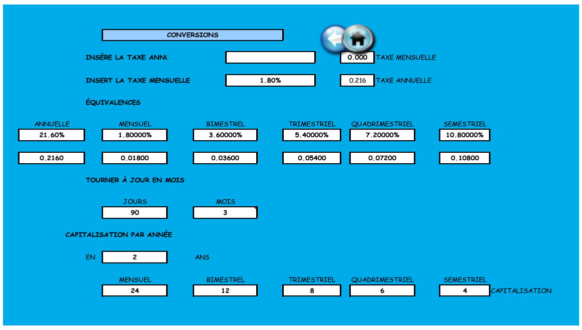


Fig. 6: Conversions (French version).

Creating Virtual Communities:

As part of this proposal, it is important to create learning virtual communities where these products can be interchanged, there for contributing to the teaching-learning process in financial mathematics (García 2003, Cabero 2005 and Rheingold, 1996).

Sharing In Virtual Communities:

Upon entering the discussion of this topic, you can again point out the importance and relevance that he has been giving to the use and application of ICT in teaching and learning processes. Hence now is relevant to analyze and discuss the variable "virtual communities" and their use in the teaching. In this regard we can define that the community is "a group or congregation of people living under one set of rules, where converge the particular interest of its members, but also to emphasize that these interests are common. On the other hand, the variable "virtual" Levy (1999, cited in Almenara Cabero 2005) notes the term in common usage, "as the outright absence of existence" where presumed reality as tangible material part (something you have) and virtual places it in the illusion (something you have).

For the sake of the state of affairs, Cabero Beacon (2006), enters an empirical-theoretical concept and conceptual discussion verbatim quote arguments Mercer (2001), Pazos *et al* (2002) Jimenez and Martinez (2002) and Salinas (2003) concluded that it is feasible to understand that while the term virtual has been causing confusion, so pointing Baym (2002), as to the meaning of "no tangible or illusion" and Levy (1999) referred to term in common use, and similarly explains it as "reality", that is, what you have and moreover the virtual, what is not there, in education has used the term, associating non-contact classes, or even better, otherwise the face is commonly chair exercise into educational institutions at any level (public and private) sector.

For this study, we use the term virtual community such as:

Web space or environment where people converge share the same theme of financial mathematics, and also share resources such as; financial tools designed for themselves, power point materials, electronic books, text documents, among others. All related to financial or mathematical topics (for this specific case study), with a well-defined and clear as it is, sharing individual interests and affinities, to help in their learning purpose.

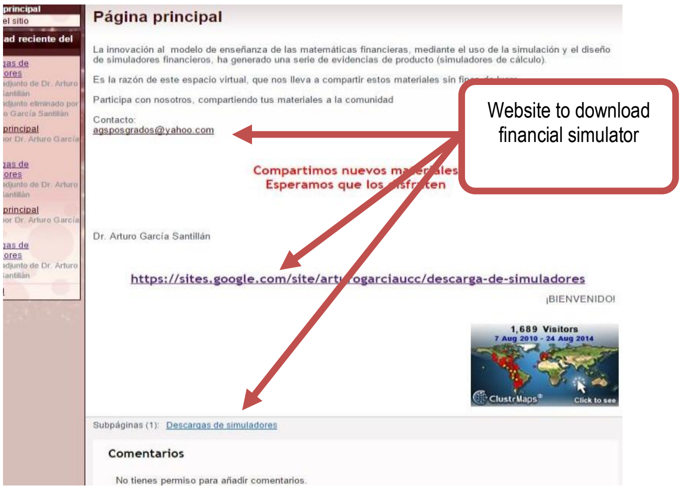
With this argument, now the question is: How virtual community variable is related to the process of teaching and learning of mathematical finance? The answer is associated with a purpose, and the latter is precisely: Creating and sharing knowledge from teaching and innovation of the process, considering that the subject seeks to solve problems that lie within any sector in the context economic, ie, used for valuing money over time, because from its history and has been constructing "mathematical building," as noted by Clinard (1993).

Furthermore Hunter (2002) notes that virtual communities are created to solve and analyze problems and possible solutions, which also helps in building knowledge together in their members, so that students would have a greater involvement, active participation, autonomy, interdependence and responsibility, all with regard to the learning process, culminating in a collaborative and cooperative work, say Martinez (2003).

With the inclusion in the process of financial mathematics teaching, of variables such as: simulation tools and simulators which are generated in the "Class Type Workshop", it is pertinent that these tools are shared to other people, institutions, or anyone interested in obtaining them, this is to create a virtual community where they can share. In fact a way to validate its usefulness, it is sharing these products with others who may well be, students of the subject in your area, or across borders. In this regard it is relevant in terms of Salinas (2003), when he notes that there is a greater likelihood of achieving virtual learning communities, when they have individual interests and affinities between students who are studying the same subject (matt-financial).

Considering both Ardizzone and Rivoltella (2004) cited by Cabero (2006) on the role of students in the virtual community, it is necessary that this perceived QOL as a strategy to be able to work collaboratively as a whole in a more organized way, besides this, curiosity, commitment and the need to cross borders, but also curious to meet and exchange views with others arises, which culminates in a sense of belonging to say Salinas (2003).

Virtual community of Financial Math:
https://sites.google.com/site/educacionvirtualucc/Home/descargas-de-simuladores
and
https://sites.google.com/site/arturogarciaucc/descarga-de-simuladores



Final Considerations:

As discussed, a significant trend in the teaching of mathematics is concerned, comes to be through the use of ICTs. That is, computing platforms have opened new avenues in education, with specific case, in the teaching of mathematics.

Studies conducted provide evidence that allows us to say that the student population today is performing better in both understanding and skill development of mathematical functions, using the spreadsheet and technologies computer itself, all compared to the student who performs teaching-learning process in the traditional system.

The use of ICT promotes mathematical manipulation of information or data variables that are used to develop a mathematical formula or model. The graphical representation, modeling and other benefits of these applications is that ICTs offer developing exercises, as we know, some practical cases solve complex math it manually using only pencil and paper.

Likewise, it is necessary to break old habits and paradigms in the teaching-learning process, so it is recommended that teachers design their session plan supported by information technology, with the specific case, the inclusion of the spreadsheet.

Finally, the use of computer platforms, as it is in this case the Moodle platform is an excellent choice for transferring low virtual learning environments, and to create virtual communities where they can share the generated product (in this case are simulators) with the global community.

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