Understanding Students' Perceptions to Improve Teaching of Mathematics

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Abstract

This study applies the Galbraith and Haines (1998) scale to identify students' attributes that are relevant where mathematics and computing interact. Hence, the aim of this work is tofind the structure of the underlying latent variables that would allow teachers to understand students' perception of mathematics and computers. The study was carried out at the "Telebachillerato Los Volcanes" and the "Telebachillerato Las Bajadas" in Veracruz, México. A Telebachillerato is an educational approach based mostly on the television to disseminate the contents of the local curriculum of high-school level. The sample comprised 200 college students, and the statistical method was a factor analysis with an extracted principal component. The results give evidence to assert that mathematics confidence, mathematics motivation, computer confidence, computer motivation, computer-mathematics interaction, and mathematics engagement, help to understandhigh-school students' attitudes toward mathematics and technology.

Keywords: mathematics teaching, student perceptions, student attitude, high-school education

1. - Introduction

The different educational models that have been used at all times have sought help to train students so they could achieve significant levels of learning. However, the results of the last evaluation of the Program for International Student Assessment 2012 (PISA), showed in its latest report (December 2013) that 55% of Mexicans students do not achieve the level of basic mathematics competence (OECD, 2013).Another result that confirms this problem is that 63.7% of young people attending the last grade of high school have inadequate math skills, according to the outcome of the National Assessment Test Academic Achievement in Schools 2013 (ENLACE) of the Mexican Public Education Ministry (SEP, 2013).

In trying to understand the importance of the relationship between students, mathematics and computer science, several theorists had focused their expertise on finding answers about this interaction that makes the difference regarding the results of learning.

Galbraith and Haines (1998) report that gaining knowledge about the attitudes and beliefs of students is important and crucial to understanding how the atmosphereis influenced when mathematics learning includes computers and other technologies.

It should be mentioned that the "*telebachillerato*" schools have the most important feature ongoing student interaction with technology to develop learning, either through television, computers or satellite communication systems. It differs from Mexican traditional high-schools, oftenconstrainedinusing technology in their classrooms.

The question that originates this study is: What is the attitude of telebachillerato students toward the use of computers to learn mathematics? Though, this interrogation may be extended to college students, and even to students of all levels in a wider sense. The scale of Galbraith and Haines (1998) is used to measure the students' interaction withmathematics and computer, to answer this question.

2 - Literature Review

There have been several theoretical approaches developed to study attitudes toward mathematics. Fennema and Sherman (1976) made a seminal work stating that through the study of the relationship between affective variables, such as confidence, motivation, and achievement, it is possible to predict how students perform.

Other studies focused on identifying the elements of attitude toward mathematics and achievement (Leder, 1985; Wise, 1985; Zan and Di Martino, 2007). Empirical studies of attitudes toward technology in teaching mathematics havea short history; the referenced in this subject was published by Galbraith and Haines (1998). They developed a scale to measure attitudes of students toward mathematics and the use of information technology in teaching mathematics.

Many empirical studies had used this scale to measure attitudes toward mathematics and technology. Some of them focused on undergraduates (Galbraith and Haines, 2000; Cretchley and Galbraith, 2002; Camacho and Depool, 2002; Gómez-Chacón and Haines, 2008; García-Santillán, Flores, Escalera, Chong and López, 2012), and some other focused on high school students (Gómez-Chacón, 2010; Pierce and Stacey, 2002; Forgasz, 2004, Brakatsas, 2005).All reached the same findings: there is a definite correlation between attitudes toward mathematics and attitudes toward the computer. The empirical data allow to emphasize that the use of computers to learn mathematics improves students' perception of mathematics. That is noticeable when measuring confidence and motivation toward mathematics and computers.

This study applies the Galbraith and Haines (1998) scale to identify students' attributes that are significant where mathematics and computing interact. This study aims to determine the structure of the underlying latent variables that would allow teachers to understand students' perception ofmathematics and computers. The above discussion motivates to the following hypothesis:

H_i: The latent variables: mathematics confidence, mathematics motivation, mathematics engagement, computer confidence, computer motivation, and computer-mathematics interaction help teachers to understand the students' attitudes toward mathematics and technology.

3. Method

3.1. Population and Sample

The Galbraith and Haines surveywas administered to all students from "*Telebachillerato Las Bajadas*" and "*Telebachillerato Los Volcanes*" that had taken at least one mathematics-course. Table 1 shows the gender and the distribution of the sample.

3.2. Statistical Procedure

The statistical method was an exploratory factor analysis model. The variables to be measured are the attitude scales toward: mathematics confidence, mathematics motivation, mathematics engagement, computer confidence, computer motivation, and computer-mathematics interaction (Galbraith and Haines, 1998). These variables are identified as $X_1 \ldots X_{200}$ (latent variables ξ), giving the data matrix shown in Table 2.

4. Analysis and Discussion of Data

4.1 Test Validation

The test used to collect data was validated by Cronbach's Alpha coefficient (Table3).

The surveyed datahave a Cronbach's Alpha > 0.6,then the survey has the required consistency and reliability characteristics (Hair, Anderson, Tatham and Black, 1999). It is worth mentioning that the Cronbach's Alpha is not a statistical test, but rather a reliability coefficient. It can be expressed as a function of the number of items.

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

Where:

N = number of items (latent variables), ř = correlation between items.

4.2.- Data Analysis

Table 4 shows the results from the correlation matrix, which reflects the behavior of each variable regarding the others. A lower determinant value implies a higher correlation and vice-versa. Thus, the degree of inter-correlation between the variables can be predicted.

The determinant shown in Table 4 is high (0.489), showinga smallintercorrelation between the variables (<0.5). Though, if there is a positive correlation, it should be taken cautiously in drawing conclusions.

a) Bartlett´s Test of Sphericity

A contrasting was conducted, based on Bartlett's Test of Sphericity, with Kaiser (KMO) and Measure Sample Adequacy (MSA). It has the purpose of validating if the factor analysis technique can explain the phenomena under study. It is achieved by determining if a correlation between the studied variables exists.

The Bartlett's test of Sphericity assesses the hypothesis that the correlation matrix is an identity matrix so that all of the variables are uncorrelated. Its acceptance involves rethinking the use of principal component analysis as the KMO is < 0.5, in which case the factor analysis method is not suitable.

Table 5 shows the values of the Bartlett test of Sphericity, whose acceptance range should be higher than 0.5. The result (MSA > 0.778) indicates that the variables are intercorrelated.

The KMO value (0.778) is close to one, signifying that the data is adequate for performing factor analysis. Additionally, the results from Bartlett's test ($X^2 = 140.481$, with 10 degrees of freedom, with a p-value = 0.000), show that initial variables are correlated. For this reason, the statistical procedure of factor analysis is appropriate for answering the research question: *What is the structure of underlying latent variables that would allow teachers to understand students' perception of mathematics and computer*?

b) Measure of sampling adequacy (MSA)

MSA values, shown in Table 6, expose that each variable exceeds the threshold value of 0.5, which indicates the strength of relationships between variables and consequently support the appropriateness of factor analysis.

Measures of sampling adequacy for every variable are in the diagonal of the anti-image correlation matrix. To determine if the selected factorial model is appropriate to explain the collected information, each of the values on the diagonal of the anti-image correlation matrixshould be close to 1.00. Hence, the anti-image correlation coefficients that appear in diagonal, ranging from 0.764^a (MATHMOT) to 0.806^a (COMPUCON), are significant, and it confirms that factor analysis is optimal to explain the phenomenon.

c) Component Matrix, Communalities, Eigenvalue and total Variance

The percentage of variance that explains this case is got by removing the major components. It is achieved since the communalities represent the proportion of the extracted variance component (Table7) to be analyzedby the latent root condition (eigenvalues > 1). Only one component with eigenvalue > 1 was found, as exposed in Figure 1. Besides, the sum of the square roots of the loads of the initial extraction, the eigenvalues of each component, is provided in Table 8. Notice that the single removed component explains 45.176% of the variance of the phenomenon.

Table 7 shows just one factor that incorporates five variables and their explanatory power expressed by its eigenvalue (2.259). In the first column are the factor loadings of the variables, and the second column shows how much the components explain each of the variables.

Thus, MATHMOT (motivation mathematics-motivation) has the biggest weight, followed by the MATHCON (mathematics-confidence), and COMAINT (computer and mathematic interaction) and the lowest weight is of the MATENGA (mathematics-engagement) followed by the COMPUCON (computer-confidence).

Additionally, as can be seen in Table 7, MATHMOT (mathematics-motivation) followed by MATHCON (mathematics-confidence) show a substantial factorial weight (0.713 and 0.695 respectively). The remaining variables: COMAINT followed by the MATENGA and COMPUCON, also measuring the influence of attitude toward mathematics, show a good factorial weight (0.671: .647 and 0.631). The highest communalities are: MATHMOT (0.509); MATHCON (.483); and COMAINT (0.451). These results are statistically significant and of practical use, because the 74.801% shows that students' attitude toward mathematics and technology may be explained by the proposed variables and sample size.

Table 8exposes that the first component (>1), which has an eigenvalue of 2.259,can explain the phenomenon studied up to 45.176%. Although the remaining components are not greater than 1 (0.750; 0.732; 0.674; 0.586), however, the three first (2.259; 0.750; 0.732) can explain 74% (cumulative %) of the total variance of the phenomenon under study.

5. Discussion

Based on the theory behind this work, and on the empirical results, it can be said that factor analysis technique, when applied to the observed variables, explain with only one component (>1), explain 45.176% of the total variation, as reflected in the scree plot.

It is worth mentioning that even when a significant correlation between the variables of this study does exist, careful consideration is suggested. For example, significant correlations were taken from MATHCON vs. MATHMOT and correlated (0.375); MATHCON vs. COMAINT (0.357). In addition, the rest of the variables are presented in order from 0.265 to 0.317 with their respective correlations among the variables involved in this study.

Regarding the observed variance, Table7 shows that the first component may explain the phenomenon with 45.176%. Thus, it can be said that, the variables involved in the model proposed by Galbraith and Haines (1998) are the factors that make a difference when students learn mathematics mediated by computers. This evidence helps teachers to understand the environments in mathematics learning and how they are improved by the introduction of computers and technology.

6. Conclusions

With this research work, it has been demonstrated the implication of: confidence, motivation, engagement and interaction among mathematics with technology in the environment of the learning process as suggested Galbraith and Haines (1998). The conclusion is that latent variables: mathematics confidence, mathematics motivation, mathematics engagement, computer confidence, and computer and mathematics interaction help teachers to understand students' attitudes toward mathematics and technology interaction.

Furthermore, it was observed that the result got in this study, show similarities with studies of García-Santillán et al. (2012), and García-Santillán, Escalera, Boggero and Vela (2012).In this regard, some significant data were obtained in this study: the level of reliability (Cronbach's alpha) is 0.706, while in the above-mentioned studies were: 0.629 and 0.581 = 0.6, respectively. In both cases AC> 0.6 (Hair et al., 1999), which confirms that the test have all the characteristics of consistency and reliability required.

Another important result is the measure of sampling adequacy Kaiser-Meyer-Olkin (KMO coefficient) got in this work of0.778. The comparison with results of previous works confirms 0.703 and 0.668 respectively similarly, indicating that factor analysis is appropriate for this study.

In terms of the total variance, it has been strengthened that a single component can explain the phenomenon strongly. In this work, the extracted component explains 45.176% of the phenomenon while the other studies' findings were 38.579% and 35.091%.

The resultsfound in this and the previous studies, allow to know that there is a strong relationship in the process of learning mathematics when it includes the use of computer and other technologies in students from Mexican southeast.In addition, some common aspects identified minimal differences;this fact highlights the complexity of the technology when it is introduced to mathematics teaching at different levels.

Table 1: Population

College	Total by college	Females	Males	Total
“Las Bajadas”	106	19	28	47
(3 groups)		20	15	35
		16	8	24
“Los Volcanes”	94	36	35	71
(2 groups)		12	11	23
		103	97	200

Source: own

Table 2: Data Matrix

Students	Variables X_1, X_2...X_p
1	X_{11} X_{12} … X_{1p}
2	X_{21} X_{22} … X_{2p}
…	...
200	X_{n1} X_{n2} …X_{np}

Source: own.

Table 3: Case Processing Summary

	N	%	Cronbach's Alpha		N of Items
Valid Cases	200	100.0	Overall	0.706	40
Excluded[a]	0	.0	MATHCON		5
Total Cases	200	100.0	MATHMOT MATENGA COMPUCON COMAINT	0.683	

a) Listwise deletion.

Source: own

Table 4: Correlation Matrix

Variables	MATHCON	MATHMOT	MATENGA	COMPUCON	COMAINT
MATHCON	1.000				
MATHMOT	**.375**	1.000			
MATENGA	.269	**.352**	1.000		
COMPUCON	.308	.317	.265	1.000	
COMAINT	**.357**	.313	.312	.272	1.000

a. Determinant = .489

Source: own

Table 5: Bartlett’s test of Sphericity

Measure of Sampling Adequacy Kaiser-Meyer-Olkin.		0.778
Bartlett’s Test of Sphericity	Chi-square approximated	140.481
	Degrees of freedom	10
	Significance	0.000

Source: own.

Table 6.Anti-image Correlation Matrix

Variables	MATHCON	MOTHMOT	MATENGA	COMPUCON	COMAINT
MATHCON	**.765**[a]				
MATHMOT	-.227	**.764**[a]			
MATENGA	-.081	-.218	**.784**[a]		
COMPUCON	-.160	.166	-.121	**.806**[a]	
COMAINT	-.222	-.128	-.177	-.117	**.782**[a]

Source: own

Table7: Component, Eigenvalue, Communalities, and Variance

Factors	Component 1	Communalities
MATHCON	.695	.483
MATHMOT	**.713**	**.509**
MATENGA	.647	.418
COMPUCON	.631	.398
COMAINT	.671	.451
Eigenvalue	**2.259**	
Variance Total		.45176

Source: own

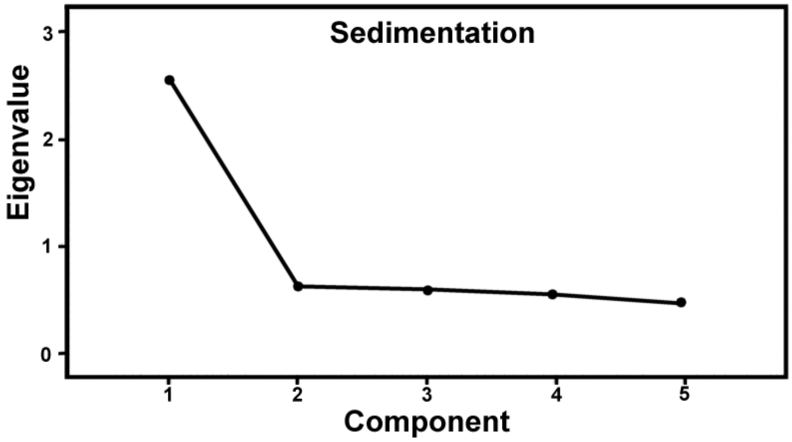
Table 8: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of SquaredLoadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**2.259**	45.176	45.176	2.259	45.176	45.176
2	0.750	14.992	60.168			
3	0.732	14.634	74.801			
4	0.674	13.484	88.286			
5	0.586	11.714	100.000			

Extraction Method: Principal Component Analysis.

Source: own

Figure 1: Scree plot



Source: own.

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