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Model and Simulation of Structural Equations for Determining the Student Satisfaction

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Abstract

Structural Equations Models (SEM) determine the dependence or independence relationship of the variables through the integration of linear equations. These models combine factorial analysis with linear regression to determine the data adjustment obtained with a proposed model by means of a path analysis, which represents the relationship between latent and observed variables. Observed variables are those that can be directly measured, usually through questionnaires. Latent variables are not directly measured and can be endogenous (dependent) or exogenous (independent). This research provides a model that allows to determine student satisfaction through the structural equations modeling by using the Technological Pedagogical Content Knowledge model (TPACK).

Keywords: Structural equations, maximum likelihood method, factor analysis, Learning Management System, TPACK model.

1. Introduction

The Technological Pedagogical Content Knowledge model (TPACK) was used to specify the proposed model that allows users' satisfaction to be analyzed when they use a learning management system to support their classroom classes at the University of Mumbai in India, which is explained in general terms below. The TPACK

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model in the LMS was developed by [1] [2] as a model focused on educational technology that studies the intersections between technological knowledge (TK), content knowledge (CK), and pedagogical knowledge (PK), which was called TPACK.

According to [3] [4] [5], this model makes it possible to integrate issues related to Information and Communication Technologies (ICT), curricular content, and pedagogical knowledge. This model helps to identify the different types of knowledge that teachers should have in the educational process. [6] comment that TPACK offers teachers an interesting way to integrate technology, pedagogy, and content knowledge into their educational activity. Their research is based on this model from a logic of competencies based on the demands of the 21st century [7].

For [8], the importance of the model lies in the knowledge that the teacher must acquire for integrating ICT in his or her teaching tasks, not just related to the three knowledge types (CK, PK, and CT), but also their intersections. [8] indicate that the TPACK model synthesizes the different knowledge types by applying an effective methodology for the use of ICT, since it uses pedagogical strategies and methods with respect to a discipline.

2. Method

The research adopts the strategy of developing a model by using structural equation systems, in which a model is proposed and improved through modification of its structure or measurement techniques [9] [10] [11]. With this strategy, a proposed model was reformulated to find a new one (see Table 1).

Table 1. Methodological procedure sheet

Technique or instrument for information gathering	Satisfaction survey. The instrument is a questionnaire consisting of 19 initial items related to the satisfaction of the students when the teacher uses the Learning Management System (LMS) for supporting the teaching activities.
Universe	Students from Engineering
Scope	University of Mumbai in India
Units of analysis	Fourth and eighth semester
Defined sample	5.231 students
Date	December 2018

Figure 1 contains the proposed causal model that evaluates the impact of FSC, technological pedagogical knowledge and content factors (TPACK) when the teacher uses an LMS as support in his teaching activity (SA). The latent and endogenous variables ($\eta 1$), such as SA, and exogenous variables, such as FSC ($\xi 1$) and TPACK ($\xi 2$) are indicated. Among the endogenous variables observed are $\lambda 11$ (age), $\lambda 12$ (gender), $\lambda 13$ (last year of studies) $\lambda 14$ (marital status), $\lambda 21$ (technological knowledge), $\lambda 22$ (pedagogical knowledge), and $\lambda 23$ (knowledge of curricular content). The relationships between constructs are determined by $\gamma 11$ (FSC-SA), $\gamma 12$ (TPACK-SA), $\gamma 21$ (FSC-TPACK), as well as $\gamma 22$ (TPACK-FSC). The structural model parameters that explain student satisfaction were estimated using IBM-SPSS Amos 22.0.0 software [12] [13].

This paper analyzes just the factorial loads as a necessary method to apply the structural equation model. There are different methods to obtain the common factors, such as the main components method, the main axes method and the maximum likelihood method. In this example, the maximum likelihood method is applied [14] [15] because of its advantage that the estimated values do not depend on the measurement scale of the variables. It also allows to select the number of factors based on the hypothesis contrast. The maximum likelihood method can be used in the AFC, in which the researcher proposes assumptions (for example, that some factor loads are null or that some variables are correlated with some factors, etc.) and, when applying the statistical tests, it determines whether they are true or false. There is a disadvantage of this method: if the variables are not normal, there may be problems in convergence.

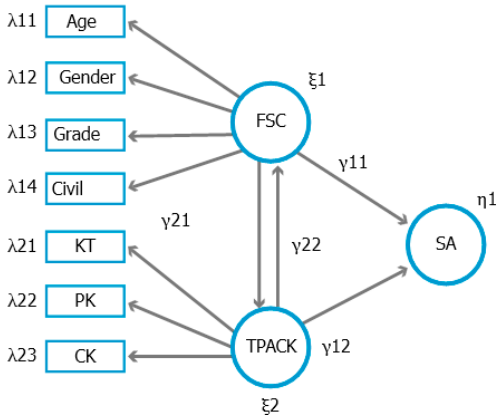

Fig 1. Student´s satisfaction when the teacher uses LMS for supporting the teaching activity.

3. Results

For determining the items that belong to each latent variable, the standardized values of factorial loads are analyzed with respect to each of the variables shown in Table 2, choosing the criterion of accepting those that have a minimum value of 0.4. Regarding the factorial loads of the items of the TPACK latent variable, all present a value greater than 0.5 [16] [17]; therefore, they present an acceptable factorial load and all items are accepted. The same happens with the SA1 variable.

The item related to semester studied does not present an acceptable load because it is 0.254, so it was decided to remove it. The original model showed the campus variable where the participant studies, but since this test was performed in a single institute, the statistical test considered it a constant; therefore, it was eliminated and the number of items or variables observed reduced from 19 to 17. As for the relationship between latent variables, the analysis was based on covariance and correlation. Regarding covariance, Table 3 contains the non-standardized values among latent variables. It is important to remind that when the values are not standardized, the estimated values between the latent variables are the covariances. In this case, the value between FSC1 and TPACK1 is negative (-0.017) and the same happens between FSC1 and SA1 (-0.024). On the other hand, the value between TPACK1 and SA1 is positive (0.084), therefore, there is only a relationship between these two variables.

Respecting to the analysis based on correlation, Table 4 shows the standardized values, so the values between the latent variables are the correlations. The correlation between the variable FSC1 and TPACK1 is negative, the same happens with FSC1 and SA1, not so between TPACK1 and SA1. This indicates that there is only one relationship between the latent variables TPACK1 and SA1. This assertion is obtained with both covariance and correlation values (see Figure 2).

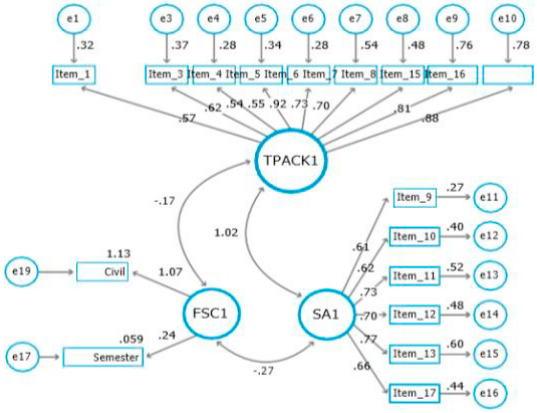

Fig 2. Diagram with non-standardized values

Table 2. Standardized values of each of the factorial loads

		Estimate
Item_1	<--- TPACK1	.578
Item_3	<--- TPACK	.632
Item_4	<--- TPACK	.557
Item_5	<--- TPACK	.594
Item_6	<--- TPACK	.523
Item_7	<--- TPACK	.741
Item_8	<--- TPACK	.689
Item_15	<--- TPACK	.814
Item_16	<--- TPACK	.875
Item_9	<--- SA1	.623
Item_10	<--- SA1	.645
Item_11	<--- SA1	.775
Item_12	<--- SA1	.710
Item_13	<--- SA1	.765
Item_17	<--- SA1	.662
Semestre_curs	<--- FSC1	.251
Edo_civil	<--- FSC1	1.085

Table 3. Estimated values of the covariance

	estimate	s.e.	C.r.	p	label
TPACK1 <--> SA1	.081	.034	2.239	.030	par_15
FSC1 <--> TPACK1	-.027	.073	-.341	.741	par_16
FSC1 <--> SA1	-.044	.126	-369	.722	par_17

Table 4. Estimated values of the correlations

	estimate
TPACK1 <--> SA1	1.023
FSC1 <--> TPACK1	-.175
FSC1 <--> SA1	-.285

4. Conclusions

This study allows to establish a contribution for the combination of the structural equation model with the TPACK model to determine the correlation of the factors involved in student satisfaction when using a learning management system as a technological tool for learning, as the main objective of this research. It can be concluded that there is a strong correlation between technological, pedagogical, and content factors with student satisfaction; however, satisfaction has a low correlation with students' socio-cultural factors. Similarly, sociocultural factors have little

correlation with technological, pedagogical, and content factors. Based on the above, it is important to point out that a learning management system in an educational institution must take into account the technological, pedagogical, and content factors, on which the TPACK model is based, in order to achieve the learning satisfaction of the student.

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