

An Impact of Structural Equation Modeling Using Partial Least Squares on Multimedia Technology Studying of Students: A Case Study of Ratchaphruek College

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Abstract-- An objective of this research was to develop causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling: a case study of Ratchaphruek College. The research, an analysis of causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling: case study of Ratchaphruek College, was presented in the National Academic Conference. [1] Some indicators were listed from literature review, categorized in 7 factors which were teaching, personnel, instructional media, academic activity, curriculum, tools and equipment, and laboratory and location. The factors related to nonlinear result was adjusted the equation by using partial least squares to obtain a structural equation modeling tested the correlation in the model with acceptable goodness of fit while the values of GFI, AGFI, and RMR were 0.970, 0.936, and 0.095, respectively.

Key Words: *Structural Equation Modeling, Causal Factors Analysis, Partial Least Squares*

I. INTRODUCTION

The causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling: a case study of Ratchaphruek College is evaluated in order to discover what indicator in each factor influencing the multimedia technology subject. Hence, it will be useful for lecturers to understand this kind of information and then they can be well-prepared for their teaching. In this research, the important indicators impacting on the efficiency of teaching and studying were collected. Consequently, the questionnaire is created to collect data for factor extraction applying factor analysis method so as to know the factors consisting of a group of indicators relating to

teaching and studying and study the relationship among those factors by analyzing the Structural Equation Modeling (SEM). As a result, the structural equation modeling will present factors including indicators as well as cardinality, then direction of each factor and cardinality will be also found. That clearly illustrates the important factors affecting on the efficiency of teaching and studying. A technique, partial least squares, is applied for adjusting nonlinear value in the equation in order to make the equation more precise. Hence, a developed modeling will be monitored to reach accuracy and later a precision in finding the efficiency of teaching and studying will be discovered.

• Objectives of Research

-Firstly, it is to analyze causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling: a case study of Ratchaphruek College to discover that what indicators include in those factors.

-Secondly, it is to analyze the precision of casual factors impacting on the multimedia technology studying of students by applying a structural equation modeling: a case study of Ratchaphruek College.

• Scope of Research

In this research, the researcher aims to study only the causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling: a case study of Ratchaphruek College.

-A sampling group is 250 undergraduate students in business computer program (4-year curriculum), academic year 2010.

-Indicators applied in collecting data are from the results in related researches and they are also reference in many researches.

II. LITERATURE REVIEW

A. Factor Analysis

Factor Analysis [2] is a technique to arrange, combine, or collect the related variables into the same group or factor. The variables in the same factor will be much correlated. Their relationship may be positive direction (the same direction) or negative direction

(reverse direction). In addition, factor extraction has many methods such as PCA, MLE, etc.

A method, PCA (Principal Component Analysis), is the most popular to use. Its objective in factor extraction is to find a number of factors that can substitute all variables or extract components from variables to place in factor. The components included a large number of variables is contained in a few factors; all components from each variable are considered. A suitability of factor extraction is assessed from a statistical value, Kaiser-Meyer-Olkin: KMO, which it should be greater than 0.6. The rotation method is performed to test which factor should contain the empirical indicators or variables most. The rotation includes many types such as orthogonal rotation and oblique rotation. The suitable method is able to identify a value of factor loading which can obviously presents the importance of each factor. Besides, to test what level of accuracy of the extracted factor is, the value of explanatory power of the total variance explained and cumulative explained variance are assessed. If the value has high percentage, it shows that factor extraction can obtain the factors substituting all indicators. The factor value is calculated from an equation as the following.

$$F_j = W_{j1}X_1 + W_{j2}X_2 + \dots + W_{jp}X_p + e \quad (1)$$

Hence, F_j is factor score, W_{jp} is coefficient of “j” factor and “p” variable. The “e” is unique factor error.

B. SEM

The structural equation modeling: SEM [3] is intended to study the relationship and cardinality between factors or latent variables. The relationship value is utilized to indicate loading value in searching for satisfaction in the future. In addition, the adjusted model can utilize to predict efficiency estimation of factor impacting on efficiency of teaching and studying by developing structural equation modeling. First step is to indicate sample group with a suitable number at minimum 200 samples and apply modeling of Maximum Likelihood Estimation: MLE. Hence, it can obtain the data type. The structural equation analysis allows variables containing quantitative and qualitative data (Likert) with curvilinear according to normal data distribution, so data can be analyzed except the categorical data and data with missing value. The structural equation analysis applies correlation matrix as data for creating model. If a sample data in some variables or indicators has missing value, the matrix calculated will have errors. To solve this is to do list wise deletion of entire record or apply data imputation. There are many imputation techniques, for example, to substitute mean of MLE for the value. After getting the model, it must be tested goodness of fit by frequently used statistics such as Chi-square (χ^2) which should be non-significance, Goodness of Fit Index: GFI which should be greater than 0.9, Adjusted Goodness of Fit Index: AGFI which should be greater than 0.9, Root Mean Square Error of Approximation: RMSEA which should be less than or equal to 0.06, and Hoelter’s N

which should not be less than 75. The value of Hoelter’s N is utilized for indicating if case is sufficient for analysis of structural equation modeling.

C. The Evaluation Criterion

The model created must contain the model best fit to data used in creating the model. This model will be tested with another data set that the actual grade is known. A result of predicted grade will be calculated to find out Magnitude of Relative Error–MRE as this equation (2).

$$MRE_i = \frac{|Actual\ Grade_i - Predicted\ Grade_i|}{Actual\ Grade_i} \quad (2)$$

Each grade will be combined and then the mean will be discovered as the equation (3).

$$MMRE = \frac{1}{n} \sum_{i=1}^n \left[\frac{|Actual\ Grade_i - Predicted\ Grade_i|}{Actual\ Grade_i} \right] \times 100 \quad (3)$$

MMRE equals to 0, it means that the predicted grade is equal to every actual grade. Hence, the less MMRE is, the more precision will be. The precision value can be calculated by deducting from a hundred with MMRE.

D. Related Research

-According to a research by Penprapa Ranat [4], the purposes were to study causal relationship affecting self-reliance and monitor the fit between hypothesized causal relationship model and empirical data. The sample group is 540 students studying in secondary level 3 in Pranakonnua group under Bangkok metropolitan selected by stratified random sampling. A questionnaire was utilized as an instrument of the research including self-reliance assessment, instructing by authoritative parenting style, authoritarian parenting style, permissive parenting style, responsibility, perception of teacher’s teaching, achievement motive perceived, and self-efficacy. The reliability were .853, .700, .707, .720, .867, .880, .792, and .785, respectively. The data was analyzed by applying path analysis with LISREL.

-According to a research by Naterung Youcheroen [5], the purpose was to study model of causal relationship among working environment factors consisting of organization’s atmosphere, communication, and personal factors including attitude towards participation and motivation at work affecting participation in educational quality assurance. Selected by stratified random sampling, the sample group was 345 teachers in the colleges for vocational education in Bangkok and those were on duty in the first semester of academic year 2010. A questionnaire was employed as an instrument of the research including organization’s atmosphere, communication, motivation at work, attitude towards participation, and participation in educational quality assurance. In addition, the reliability of questionnaires were .903, .957, .949, .923, and .920, respectively. The path analysis with LISREL Version 8.52 was applied for analyzing data. The results were as following: 1) All factor variables had positive correlation on participation in educational quality assurance with

statistical significance at level .01. 2) The empirical data fitted the hypothesized model after adjusting. The prediction coefficient (R square) of participation in educational quality assurance was .59, so factor variables applied in the model could explain that the variance of educational quality assurance of teachers teaching in the colleges for vocational education in Bangkok was 59 percent.

-According to a research by Jaruwan Samakthai [6], the objectives of the research studying factors impacting on efficiency of teaching and studying in Ratchaphruek College students' opinions were to discover factors influencing efficiency of teaching and studying according to Ratchaphruek College students' opinion and precision evaluation of factors influencing efficiency of teaching and studying. The sample group was 203 students in business computer program. A questionnaire was employed as an instrument including 7 sections. To analyze the data, the frequency and quartile on SPSS7.5 program were used. In addition, AMOS program was utilized for create the model. Only 2 factors were found. Firstly, human factor included the indicators as followings: 1) Teachers-Lecturers can convey knowledge in interesting way. 2) Learning achievement test corresponds to subject's content. 3) Teachers-Lecturers utilize sample models to be instructional media. The second factor was location and building factor including indicators which were as followings: 1) Handouts and textbooks contain the knowledge corresponding to subject. 2) Classroom size is big enough for students. 3) A library is provided in the college in order to facilitate students in searching additional knowledge.

E. PLS

The Partial Least Square latent modeling: PLS [7], was a statistic technique applied for adjusting relationship value between two or above of exogenous latent variables; those had an interaction in a form of bidirection causing curvilinear relationship which the estimation of endogenous latent variable have error. PLS was employed to adjust mentioned relationship by creating interaction latent variable. Hence, empirical variables originated from matching every empirical variable with exogenous latent variables as figure 1.

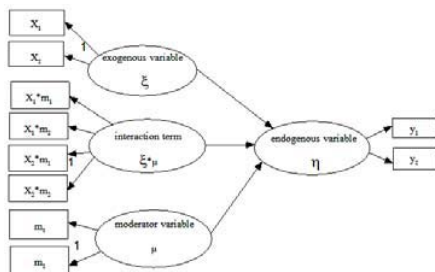


Figure 1 structural equation modeling, PLS

From figure 1, exogenous latent variable ξ had correlation in two directions with exogenous latent variable μ (no picture shown). Therefore, latent variables with new interaction was created, $\xi*\mu$, and there were 4

empirical variables which were $X1*m1$, $X1*m2$, $X2*m1$, $X2*m2$ as shown in the figure. Then, normal analysis to discover structural equation was done until obtaining a structural equation modeling that had goodness of fit corresponding to data used in model creating. Lastly, the calculation was applied to find out value of endogenous latent variables as equation presented.

III. METHODOLOGY

The analysis of causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling, a case study of Ratchaphruek College was done in three methods:

A. Literature review was studied in order to collect indicators cited in books and related researches.

B. Needed instruments in data collection for the analysis of causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling, a case study of Ratchaphruek College were made as the following:

-To contact experts who had experience in teaching could help in identifying variables related to the causal factor impacting on efficiency of teaching and studying. The expert had to have working experience at least 3 years. To understand in the method of identifying variable concerning causal factor impacting on efficiency of teaching and studying, a suitable number of experts were fixed to 20 people.

-The questionnaire for data collection was created as the instrument of the research. Delphi technique was employed for combining opinions in teaching and studying from experts. The questionnaire was categorized into two sets. The first questionnaire was for expert to discover consensus and then collected opinions were concluded to create the second questionnaire. Hence, the second questionnaire was for collecting analysis of causal factors impacting on the multimedia technology studying of students by applying a structural equation modeling, a case study of Ratchaphruek College and monitoring experts' opinions. The last questionnaire was made to analyze data collected from experts for the third time. After every expert confirmed their same opinion, the questionnaire for the third time was the last one.

C. The questionnaire about satisfaction was presented to the expert. Then, the evaluation was made according to evaluation form in analysis table to find IOC (Index of Item Objective Congruence) of the questionnaire. The values of IOC from analysis table of the expert were calculated and items with index from 0.50 and above were selected. IOC was equal to 0.90.

D. An improvement of evaluation form was made to obtain complete and correct information before sending to print out and using as data collection instrument in the future.

E. The main purpose of factor analysis was to monitor relationships among variables so as to categorize

variables into each factor. After that, variable was identified for factor analysis and the results were as the followings: Varimax, it was found that KMO = “0.922,” Bartlett’s test of Sphericity was non-significant ($\alpha=0.000$), and Cumulative variance explained = “48.975%.” Hence, factor extraction reached the credible criteria and the results were presented in table I.

TABLE I. Data After Factor Extraction

Factors	Description
1. F1 (Factors in Teaching)	f3_13-Give examples to explain content of subject for students. f3_4-Provide learning assessment according to teaching plan. f3_2-Arrange mutually acceptable conditions while studying and teaching between teacher and students before teaching. f3_7-Inform students about quiz in advance. f3_1-Provide opportunity of class participation for students. f3_5-Learning achievement test corresponds to subject’s content. f3_3-Teachers-lecturers teach students by following organized topics. f3_6-Provide opportunity on resitting when students cannot pass the criteria. f3_9-Apply the questioning method. f3_12-Inquire methods of content organizing. f3_8-Apply the lecture method. f3_14-Review teaching content before beginning class. f3_10-Apply method of demonstrating or practicing. f1_5-Provide appropriate theory. f3_11-Arrange projects for field trip. f1_6-Provide appropriate practice. f1_10-Knowledge provided should be up-to-date.

Table 1. Data After Factor Extraction (Cont.)

Factors	Description
2. F2 (Human Factors)	f2_9 –Be on time. f2_8-Support good students to meet achievement. f2_2 –Be responsible for teaching. f2_15 –Focus on practice rather than theory. f2_12 –Improve teaching methods and apply something new. f2_13-Provide students IT media such as E-Mail, online chatting, webboard, etc. for questions. f2_1-Possess knowledge and teaching ability corresponding to subjects. f2_10 –Be able to convey the knowledge in interesting way for students. f2_14 –Offer opportunity for students to express opinion on studying. f2_4 –Give detail about subject to students before class. f2_16 –Have self-development on new technology relating to teaching subject. f2_11 –Educational qualifications of teachers-lecturers f2_7 –Assign students to discover for additional knowledge other than in class. f2_6 –Arrange additional class for students who cannot understand what they learn in class and have problems. f2_5 –Provide guidance. f2_3- Inform objectives of subject before teaching.
3. F3 (Instructional Media Factors)	f5_8 –Utilize sample models to be instructional media. f3_17-Content of subject assist students in problem solving. f5_7-Apply real material to be instructional media. f3_18-Students are satisfied in learning every subject. f3_19-Exam covers all topics in the subject. f3_20 –Provide evaluation after learning for theory learning. f5_9 –Utilize video to be instructional media. f3_15 –Students can understand what they learn. f3_16-Students like to do exercises.

4. F4 (Tools and Equipment Factors)	f5_12-Media used should be easy for learning and understanding. Multimedia or animation should be applied in complicated content. f5_11 –Students can use notebook computer in class. f5_10 –Use Power Point program for presentation in class as instructional media. f6_2 –Tools and equipment used in class must have high quality and be advanced. f6_5 – Tools/Equipment should be developed to be advanced. f6_4- Tools/Equipment have high quality for teaching.
5. F5 (Laboratory, Building, and Location Factors)	f7_5 –Library is provided in college for students to research additional information. f7_6- Computer room is provided in college for students to research additional information. f7_2 –Classroom provide a sufficient capacity for students. f7_3 –Classroom is clean and tidy. f7_4 –Lighting in classroom is appropriate. f7_7 – Laboratory is provided in college for students working in groups. f7_1 –A number of classrooms are sufficient for students. f6_1- Tools and equipment for practice are sufficient for students. f6_3- Tools/Equipment are sufficient for students.
6. F6 (Academic Activity Factors)	f4_4-Academic service is provided for community and people who are interested in. f4_2 –Provide outside activity for students. f4_3 –Arrange Open House activity. f4_1-Provide academic training, for example, training with expert.

TABLE II. Data After Factor Extraction (Cont.)

Factors	Description
7. F7 (Curriculum Factors)	f1_9 –Subject content should be in line through curriculum. f1_1-Subject has repetition. f1_2 –Students can choose subject they desire. f1_3 - Students can choose class schedule they desire. f1_8 –Curriculum contains content that students can research by themselves. f1_4 –Subject is suitable for class schedule. f1_11- Curriculum provide animation content with easy understanding.

F. Structural Equation Model Creating

The seven factors obtained from factor analysis were used in creating a default structural equation model according to the researcher’s concept shown in figure 1. The latent variable expected in this research was GPA, the factor set by the researcher along with empirical variable, grade, used as substitute for efficiency of teaching and studying (in the form of standard score-log10) of factor impacting on efficiency of teaching and studying later. The variable was set to be the endogenous latent variable according to expectation of this research. The model of structural equation modeling was analyzed for significance, correlation, and covariance.

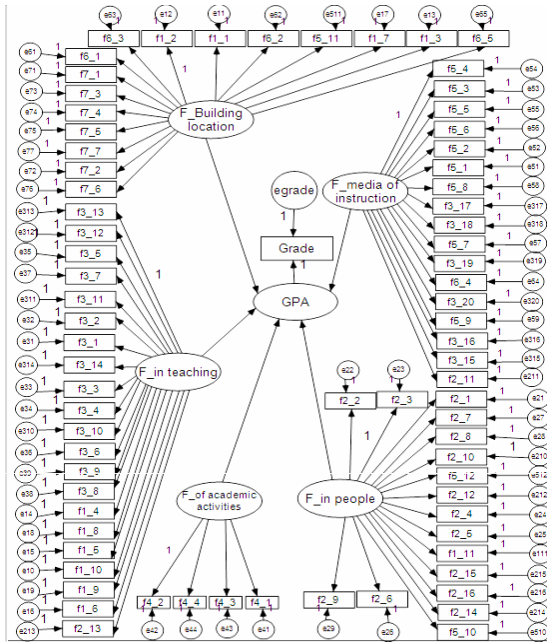


Figure 2 Default Model

The rest of factors and indicators was added correlation lines and calculated for the most suitable cardinality and relationship direction by testing goodness of fit between model and sample data with Chi-square (χ^2), RMSEA, and sample case as presented in table 2.

TABLE III. Statistical Values of the Model After Structural Equation Modeling Analysis

Statistics	Value
Chi-square (χ^2)	8.9
Degree of Freedom (df)	9
P-Value for Test of Close Fit	0.445
Root Mean Square Error of Approximation (RMSEA)	0.047
Root Mean Squared Residual (RMR)	0.014
Goodness-of-fit indices (GFI)	0.991
Adjust GFI (AGFI)	0.967

The statistical values reaching minimum criteria were Chi square (χ^2), RMSEA, and HOELTER's N. Therefore, the acceptable goodness of fit between the

model and analyzed sample data was made. The analysis of the structural equation modeling was illustrated in figure 2.

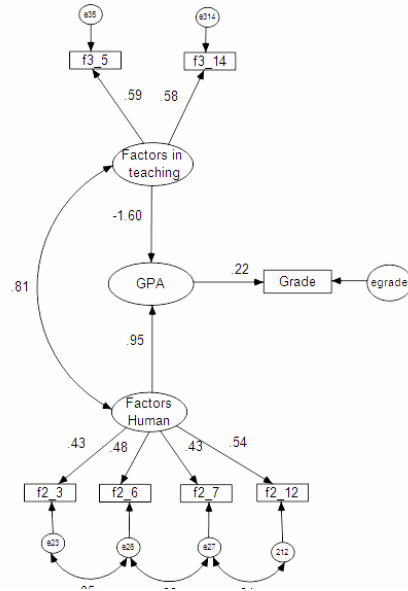


Figure 3 Final Model After Analysis of Goodness of Fit

G. PLS

The partial least squares technique was employed to adjust curvilinear. As the structural equation modeling in figure 3, it was found that building factors and human factors had interaction with bidirection, so PLS was used to solve this problem until getting new default model as demonstrated in figure 4. Every interaction empirical variable was adjusted to have normal curve and standard score was adjusted to be 8. Then, analyze structural equation modeling of the new default model by using unweighted least squares until obtaining structural equation modeling tested goodness of fit of the model with sample data and getting GFI, AGFI, RMR, and sample case. The result of analysis was shown in table 3.

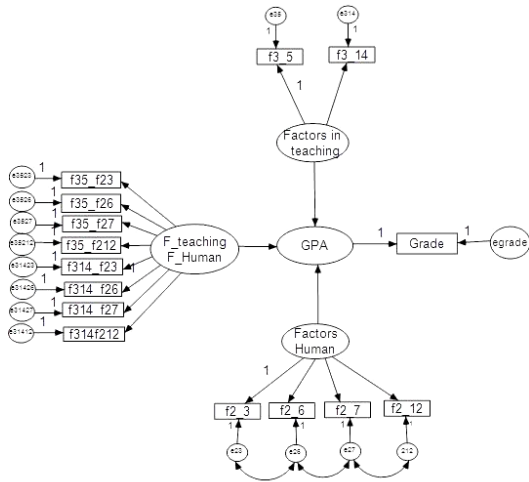


Figure 4. PLS adjusted Default Model

This was new structural equation model which was adjusted curvilinear with PLS and well-fitted.

TABLE IV. Statistical Values of Default Model with Adjusted Interaction After Analyzing Structural Equation Modeling

Statistical Method	Values
Degree of Freedom (df)	21
GFI, AGFI	0.970, 0.936
RMR	0.095

Structural Equation Modeling with Adjusted Curvilinear and Tested Appropriateness Shown in Figure 5

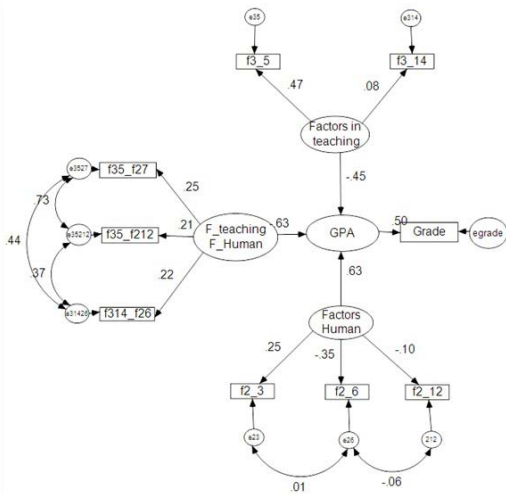


Figure 5 Structural Equation Modeling Adjusted Interaction After Analyzing Appropriateness

For the latest structural equation modeling, the 8 interaction empirical variables set in the model of figure 4 were deleted and left some empirical variables with interaction to exogenous latent variable obtained from the model using normal method (No curvilinear adjusting) as shown in figure 5 only.

The structural equation modeling with adjusted curvilinear presented size and direction of factors impacting on GPA factor.

$$\text{GPA} = (-0.45) * \text{Factor in teaching} + 0.63 * \text{F_teaching F_Human} + 0.63 * \text{Factors Human} \quad (4)$$

$$\text{Grade} = 0.50 * \text{GPA} + \text{egrade} \quad (5)$$

Score of factor in teaching and human factor was shown in equation (6) and (7).

$$\text{Factor in teaching} = 0.47 * f3_5 + 0.08 * f3_14 \quad (6)$$

$$\text{Factor Human} = 0.25 * f2_3 + (-0.35 * f2_6) + (-0.10 * f2_12) \quad (7)$$

IV. CONCLUSION AND SUGGESTION

A. The conclusion is as following.

A. In the model with non-adjusted curvilinear, it was found that factors influencing causal factor analysis of the multimedia technology studying of students by applying a structural equation modeling, case study of Ratchaphruek College including the first factor which were F1: Factors in Teaching with standard score of '-0.45' (it should not over ± 3.0), indicators: indicator of learning achievement test corresponds to subject's content (f3_5) with standard score of '0.47,' the second indicator: Review teaching content before beginning class (f3_14) with standard score of '0.08.' The second factor was F2: Human Factors with standard score of '0.63' including the first indicator: Inform objectives of subject before teaching (f2_3) with standard score of '0.25,' the second indicator: Arrange additional class for students who cannot understand what they learn in class and have problems (f2_6) with standard score of '-0.35,' and the third indicator: Improve teaching methods and apply something new. (f2_12) with standard score of '-0.10.'

B. In the model with non-adjusted curvilinear, it was found that factor relation between factors in teaching and human factors had positive bidirection ('+0.81').

B. Research Suggestion

In this research, it presents that teaching and studying management can focus on importance of indicators impacting on the efficiency of teaching and studying according to students' opinion. If there is a desire to increase efficiency, it must be known that which indicator needs to be controlled. In case, some indicators have value changes, data processing can be done from developed model. It shows that the management of teaching and studying should focus on which factor or indicator, so development can be done in better way. In this research, curvilinear of structural equation modeling was adjusted by applying partial least squares which still had limitation in data distribution. If data could not be adjusted to be in normal distribution, it may cause the result prediction have error calculation on curvilinear adjusting. A distribution analytic approach [8] may provide an answer with accuracy and precision better than partial least squares approach (PLS).

REFERENCES

[1] An Analysis of Causal Factors Impacting on the Multimedia Technology Studying of Students by Applying a Structural Equation Modeling: Case

Study of Ratchaphruek College, the 4th National Conference on Applied Computer Technology and Information Systems, 2012.

[2] Sakkhee Chaiyaphruek. **Using Structural Equation Modeling in AMOS Program to Study Relationship between Attitude and Suffering of Cancer Patients in Thailand.** (2006). Retrieved June 9, 2009, from <http://www.science.cmu.ac.th/department/statistics/sanan/208793/Paper248/sugkhee%20-2007.doc>

[3] Garson David. **Structural equation modeling.** North Carolina state university: USA. 2007.

[4] Penprapa Ranat. (2009). **An Analysis of Causal Relationship Variables Affecting Self-Reliance of the Secondary Level 3 Students in Pranakonnua Group Under Bangkok Metropolitan.** Master thesis, M.Ed. (Educational Measurement). Bangkok: Graduate School. Srinakharinwirot University.

[5] Naterung Youcheroen.(2010). **Causal Relationships of Factors Effected to Personal Participation in Educational Quality Assurance of Teachers in Vocational Colleges in Bangkok.** Maser thesis, M.Ed. (Educational Research and Statistics). Bangkok: Graduate School. Srinakharinwirot University.

[6] Jaruwan Samakthai and Assist. Prof. Dr. Somchai Prakancharoen.(2008).**Factors Impacting on Efficiency of Teaching and Studying in Ratchaphruek College Students' Opinions.** Nonthaburi: Ratchaphruek College.

[7] Somchai Prakancharoen, **Web based application maintenance time modeling,** Proceedings 2009 7th International conference on ICT and Knowledge Engineering, Siam University Bangkok, Thailand.

[8] Karin Schermelleh. **Non Linear Structural Equation Modeling.** Goethe University. Frankfurt, Germany, 2009.