Applying Structural Equation Modelling to Suggested Statistics and Information Outcomes- Attitudes Model: A Case of Sulaimani University Statistics and Information Students

Shaho Muhammad Wstabdullah
Statistics and Information Department/ University of Sulaimani/ Iraq

Dr Mohammad Mahmood Faqe
Assistant Professor
Statistics and Information Department/ University of Sulaimani/ Iraq

تطبيق نموذج معادلة الهيكلية للمخرجات والمعلوماتية المقترحة دراسة إحصائية على عينة من الطلاب في قسم الإحصاء والمعلوماتية في جامعة السليمانية

شاهو محمد وستا عبد الله د. محمد محمود فقي
جامعة السليمانية/ كلية الإدارة والاقتصاد

تاريخ استلام البحث 2019/6/20 تاريخ قبول النشر 2019/7/31

Abstract:

Structural Equation Modelling SEM is widely and highly used as statistical techniques in both social sciences and behavioural sciences. The purpose of this study is to determine the effect of students' attitude and perceptions with its variables (Enjoyment value, self-concept of student's abilities, Value, Difficulty, and Interest) on their statistics outcome using Structural Equation Modelling STM. Quantitative method was used; the data was collected from the students in statistics and information department at the college of administration and economic in the University of Sulaimani. 190 students at level (1, 2, 3, and 4) were randomly selected in which 156 questionnaires were returned. The response rate was 82.10%. It can be concluded that not all the hypothesis were confirmed and as well they were not statistically significant. Thus, firstly, a positive relationship was found between behaviour, difficulty and statistics-outcome, and value was found to not be a significant predictor of statistics-outcome in the structure equation model (SEM). These findings illustrate that increasing behavior also increase statistics-outcome. It is an expected situation that students who have a good behavior for statistics also have high levels of outcome of statistics. On the other hand, statistically there were no significant relationships between (Enjoyment value, self-concept, Interest) with statistical outcome. Moreover, there were significant relationship between (Difficulty, statistics attitudes) with statistics-outcome because the p-value were less than the common alpha 0.05 and the coefficient of statistics attitudes is (0.672). This indicates that for every addition in statistics attitudes, the statistics outcome will be increased by (0.672).

Key word: **Structural Equation Modelling SEM, Statistics and Information Department, Sulaimani.**

الملخص

يستخدم نمذجة معادلة الهيكلية كتكنيك الاحصائي على نطاق واسع للغاية في كلاً علوم الاجتماعي وعلوم الاخلاقية. يهدف هذا البحث الى تحديد ومعرفه تاثير مواقف واتجاهات الطلبه وتصوراتهم بابعادها (Enjoyment value, self-concept of student's abilities, Value, Difficulty, Interest)

على نتائجهم النهائية ونجاحهم باستخدام نمذجة المعادلة الهيكليه. واعتمد هذا البحث على استخدام بيانات كمية، حيث تم جمع البيانات من قبل الطلاب في قسم الاحصاء والمعلوماتيه في كلية الاداره والاقتصاد/جامعة السليمانيه. وتم توزيع 190 استمارة استبيان على طلبة جميع المراحل عشوائياً، وتم استرجاع 156 استبانة. حيث بلغت معدل الأستجابه 82.10% من استجابه الكليه. واظهرت النتائج عدم قبول جميع فرضيات الدراسة، يوجد هناك فقط وجود علاقه إحصائية معنويه بين (Difficulty, Behaviour) و(statistics-outcome). وقد تبين أن (value) ليست مؤشراً هامًا لنتائج الإحصاء في نموذج معادلة الهيكلية (SEM). بينت هذه النتائج أن السلوك المتزايد يؤدي أيضًا إلى زيادة مخرجات الاحصائية. وفي جانب الاخر لايوجد هناك علاقة معنوية ذو دلالة احصائية بين (Enjoyment value, self-concept, Interest) و(statistics-outcome) فضلا عن ذلك، تم التوصل الى وجود علاقه احصائيه معنويه بين (statistics attitudes) و (statistics-outcome) والسبب في ذلك يعود الى أن قيمه معنوية اقل من 0.05 وان قيمة بيتا للأتجاهات الاحصائية بلغت (0.672). وهذا يدل على انه كل زيادة في اتجاهات الاحصائية، يؤدي بدورها الى زيادة (statistics outcome) بمقدار (0.672).

الكلمات المفتاحية: نموذج المعادلات الهيكلية SEM ، قسم الإحصاء والمعلومات، السليمانية.

Introduction

According to Shaughnessy (2007), “Students’ attitudes toward statistics have a very recent research background. This is partly because of the fact that statistics education is a new research area". In the current study, the affective learning domain, cognitive learning domain is of special interest on the relationship among attitudes toward statistics of students and statistics outcomes. The definition of statistics is the department of study that has for its object arrangement of numerical facts of data and the collection of data, whether relating to natural phenomena or human affairs (Oxford English dictionary, n.d.) or basically as the " science of learning from data" (Moore, 2005). According to Raykov, Tenko & Marcoulides (2006) that Structural Equation Modelling SEM is widely and highly used as statistical techniques in both social sciences and behavioral sciences. The advantages of Structural Equation Modelling SEM over traditional multivariate techniques are that it can estimate (unobserved) latent variable via observed

variable; the test of the model where a stricture can be assessed and imposed to fit of the data and it can be used for assessment of measurement error (Byrne, 2011). Most of multivariate techniques ignore unintentionally measurement error by not modelling of it openly whereas Structural Equation Modelling estimates these error variance parameters for both response and explanatory variables (Byrne, 2011). Additionally, Structural Equation Modelling permits the estimation of latent (unobserved) variables via observed variables. As a result, the formation of complex takes into account measurement error. Using Structural Equation Modelling as a theoretical structure or conceptual or model can be tested fully developed models against the data and it can be used to evaluate for fit of the sample data. As an advanced statistical technique, large sample would be required for more complex models in order to achieve statistical power. However, Structural Equation Modelling (SEM) would not require large sample to examine basic models (Byrne, 2011).

Literature Review

According to Roberts, Thatcher and Grover (2010), structure equation modelling is a technique used to estimate, evaluate and specify models of linear model between smaller number of latent (unobserved) variables via a set of observed variables. Structure equation modelling may be used to test or build theory when selecting structure equation modelling, care should be consider as the stage of theory of development. The relationship between reasoning abilities and attitudes were investigated by estimating a full structural equation modelling SEM (Tempelar et al., 2007). Structural equation modelling was used in the information technology's area for software project risk management (Thomas and Bhasi , 2011). Structural equation modelling was used in the retail supply chain's area (Singh et al., 2010). Structural equation modelling approach was employed to understand the relationship between organizational performance and TQM (Zukuan et al., 2010). Mohamad et al., (2011) used structural equation modelling to study empirically and test a model to examine the relationships between destination loyalty and service recovery satisfaction in the hotel industry. Structural equation modelling was used to throw light on different types of stress symptoms, stress factors and their effect of stress on students collage (Jayakumar and Sulthan, 2013). structural equation modelling was demonstrated in the field of education technology as comprehensive statistical analysis and it can be explained how interventions

examine the indirect impact of related psychological constructs and affect learning, the advantages of structural equation modelling over traditional MANCOVA/ MANOVA are: 1) examining the mediating process; and 2) removing and estimating both correlated and random measurement errors (Lee, 2011). According to Martin Castor, GEISTT, Stockholm (2018), structural equation modelling is a second generation statistical analysis method and quantitative that combines the benefits of multiple regression analysis, factor analysis, and path analysis and the common software packages are LISREL and AMOS offering the computational capability of structural equation modelling. It is based on statistical correlation like all statistical methods, structural equation modelling has several statistical requirements on the dataset (e.g. independent measures and normal distribution) and assuming those requirements are fulfilled structural equation modelling offers influential capabilities for analysing datasets with diverse variables, e.g. different kinds of measures (e.g. observer measures, self-observations, system-generated measures) and different scales (e.g. interval scales and ordinal).

Aims and Importance of the Research

The main objective of this study is to build a model that addresses the relationship between students' attitude and their statistics outcome as well as investigate the direct and indirect effects among the variables of the model. It can be supposed in agreement with this target that this paper is:

- Original because it examines the relationship between students' attitude and their statistics outcome.
- Actual because examines the variables ((Enjoyment value, self-concept of student's abilities, Value, Difficulty, Interest, Statistics-outcome) and the relationships between them through Structural Equation Modelling SEM.
- Functional because it leads the way for students at the statistics department of learning statistics techniques.
- Necessary because it mentions structural equation modelling which is increasingly popular both across the world and in our country.

Hypothesis of the study

H_1: There is positive relationship between self-concept of student's abilities and Enjoyment value.

H_2: self-concept of student's abilities has positive relationship with Difficulty.

H_3: Behaviour has positive relationship with Difficulty.

H_4: Behaviour has positive relationship with Value.

H_5: Interest has positive relationship with Value

H_6: Interest has positive relationship with Behavior.

H_7: There is positive relationship between self-concept of student's abilities and Interest.

H_8: There is positive relationship between self-concept of student's abilities and Statistics outcome.

$H_{9:}$ There is positive relationship between Interest and Statistics outcome.

H_{10}: There is positive relationship between Value and Statistics outcome.

H_{11}: There is positive relationship between Behavior and Statistics outcome.

Research Model

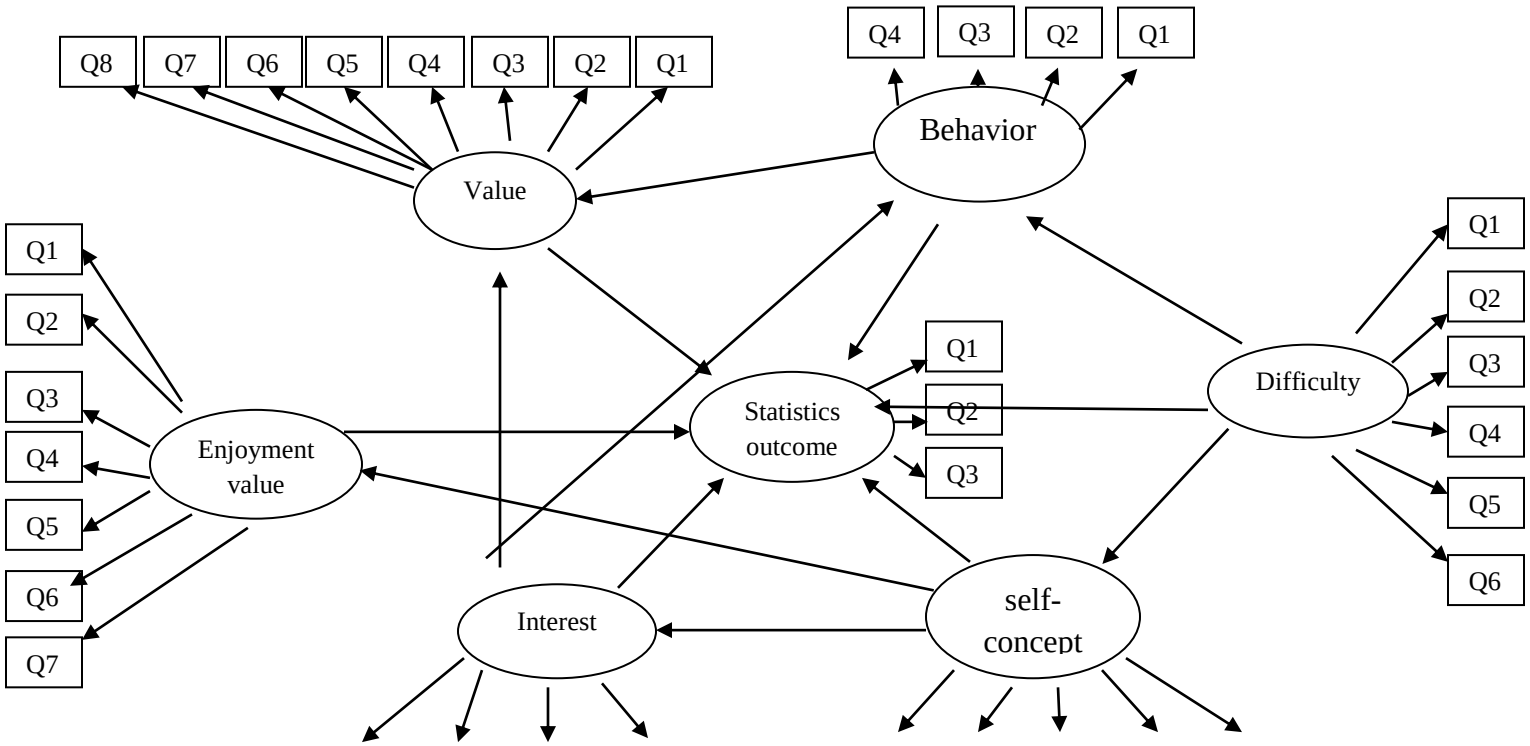

Figure (1): Structure Equation Research Model

Research Design

Methodology and data collect

340 students studying using statistics of the University of Sulaimani during 2018-2019 academic year comprise the population of the research. 190 students at level (1, 2, 3, 4) were selected which 156 questionnaire were returned. The response rate was 82.10%. Quantitative research question were used, the data was gathered from Students' statistics and information department at the college of administration and economic in the University of Sulaimani. Of the total respondents, 33.3% were male, 66.7% were female. 63.5% expected to receive 75% to 100% in this course, 34.0% expected to receive 50% to 74% in this course, only 0.6% expected to receive 0% to 49% in this course, 1.9% do not think they will pass this semester. Moreover, the data were randomly selection in order to be analysed and the variable of the study were statistics attitude including (Enjoyment value, self-concept of student's abilities, Value, Difficulty, and Interest), Statistics outcomes and behaviour. Likert scale was used for each question: SPSS and Amos were used as statistical programs in order to analysis data.

Structure Equation Model

In 1980, structure equation model were used by Peter Bentler held "the greatest promise for furthering psychological science" then many significant practical and theoretical advances were found in this field (Bentler 1980). In fact, "second generation of this model were announced" by Muthe in 2001 (Muthen 2001). The definition of structure equation model is a class of methodologies that seeks to represent hypothesis of the study about covariance, mean and variances of observed data for a small number of structural parameters. Structural equation model can be divided into two separate statistics traditions. First of them is factor analysis improved in the disciplines of psychometrics and psychology. Second of

them is simultaneous equation modelling improved mostly in econometrics (Joreskog, 1973)

The General Model

The outlined of general structural equation model were taken from Joreskog in 1973 which consists of two parts: the first part is latent variables to each other variable via simultaneous equations' systems. The second part is latent variable to observe variables limited confirmatory factor model. The model of structure can be written as

$$\boldsymbol{\eta = B\eta + \Gamma\xi + \zeta}\text{.....(1)}$$

Once B is a matrix of regression coefficient relating the relationship among latent endogenous variables to other, Γ is matrix of path coefficient describing endogenous variables to exogenous variables, η is a vector of endogenous latent variables, ξ is a vector of exogenous latent variables and ζ is a vector of error of endogenous variables. The measurement model component is written as

$$\boldsymbol{x = \Lambda_x \xi + \delta}\text{,.....(2)}$$

$$\boldsymbol{y = \Lambda_y \eta + \varepsilon}\text{,.....(3)}$$

When x is a vector of observed exogenous variables, Λ_x and Λ_y are matrix of factor loadings, δ and ε are vector measurement error of endogenous variables and exogenous variables and η is a vector of endogenous latent variables. Respectively are two variance- covariance matrixes associated with second equation and third equation. $\Theta_\delta \; and \; \Theta_\varepsilon$. Where, Θ_δ is a matrix of variance- covariance among measurement errors $\boldsymbol{\delta}$ and Θ_ε is a matrix of variance- covariance among measurement errors$\boldsymbol{\varepsilon}$. Moreover, there are two variance and covariance matrix with the first equation: Ψ is a matrix of covariance among error of exogenous variables and Φ is a matrix of variance and covariance of latent exogenous variables (Zakuan, 2010).

$$\textbf{min } \boldsymbol{f}(\boldsymbol{\Sigma}, \boldsymbol{S})\text{..... (4)}$$

where **Σ** is model implied variance and covariance which is expected from non-causal and causal associations in the model and ***S*** is the observed variance and covariance matrix which is expected observed data. In addition, $f(\Sigma, S)$ is a generic function. The matrix of **Σ** is written as

$$\Sigma = \begin{pmatrix} \Lambda_y A\left(\Gamma\Phi\acute{\Gamma} + \Psi\right)\acute{A}\acute{\Lambda}_y & \Lambda_y A\Gamma\Phi\acute{\Lambda}_X \\ \Lambda_X\Phi\acute{\Gamma}\acute{A}\acute{\Lambda}_y & \Lambda_x\Phi\acute{\Lambda}_x + \Theta_\delta \end{pmatrix}$$

where $A = (\mathrm{I} - \mathrm{B})^{-1}$, A estimates parameters in **Σ** which is maximum likelihood and the derivation of **Σ do not** involve the latent endogenous variables and latent exogenous variables.

Description of the variables

Variables	Description
Statistics outcome	Performance and related choices achievement
Enjoyment value	affective reactions
self-concept of student's abilities	Expectations of success
Difficulty	Task demands
Interest	Enjoyment- interest value
Behavior	Self- efficacy
Value	Utility values and attainment

by research

Data analysis and Result

Spss and Amos is used to analysis of data

Table (1): Enjoyment value

Questions	None	Low	Moderate	High	Materiality
Do you feel insecure when I have to solve statistics problems	13	21	85	37	73.4
	8.3	13.5	54.5	23.7	
Do you enjoy taking statistics courses	27	42	62	25	62.9
	17.4	26.9	39.7	16.0	
Am I scared by statistics	49	43	40	24	56.2
	31.4	27.6	25.6	15.4	
Do you get frustrated with my statistics tests results	15	42	69	30	68.3
	9.6	26.9	44.2	19.3	
Am I under stress during statistics class	21	43	44	48	69.1
	13.4	27.6	28.2	30.8	
Do you feel anxious when taking a statistics test or examination	24	30	39	63	72.5
	15.4	19.2	25.0	40.4	
Do you feel anxious when interpreting statistical results to a friend or the lecturer	32	26	56	42	67.7
	20.5	16.7	35.9	26.9	
Total	**181**	**247**	**395**	**269**	**67.2**
	16.5	**22.6**	**36.1**	**24.8**	

As per data collected for Affect, result illustrates that on average 16.5% were none of affect and 22.6% were low of affect. However, there are 36.1% moderate of affect and 24.8% high of affect. Moreover, the high result of materiality were " Do you feel insecure when I have to solve statistics problems" which equals to 73.5% and the less result of materiality were " Am I scared by statistics " which equals to 56.2% means students are less scared of the statistics.

Table (2): self-concept of student's abilities

Questions	None	Low	Moderate	High	Materiality
Do you understand equations related to statistics	12	38	87	19	68.5
	7.7	24.4	55.8	12.1	
Do you make a lot of mathematical errors in statistics	11	57	58	30	67.5
	7.1	36.5	37.2	19.2	
Do you find it difficult to understand statistical concepts	10	42	85	19	68.5
	6.4	26.9	54.5	12.2	
Do you have trouble understanding statistics because of the way I think	15	38	74	29	69.1
	9.6	24.4	47.4	18.6	
can I understand most of the statistical ideas	10	36	88	22	70.0
	6.4	23.1	56.4	14.1	
Total	**58**	**211**	**392**	**119**	**68.7**
	7.4	**27.1**	**50.1**	**15.4**	

in self-concept of student's abilities section of this study the respondents were distributed as 7.4% none of self-concept of student's abilities as 27.1% low with the questions related to self-concept of student's abilities. Though, 50.1% were moderate and 15.4% high with the questions related to self-concept of student's abilities. In addition, the high result of materiality were " can I understand most of the statistical ideas " which equals to 70.0% and the less result of materiality were " Do you make a lot of mathematical errors in statistics " which equals to 67.5%.

Table (3): Value

Questions	None	Low	Moderate	High	Materiality
Do you use statistics in my everyday life	39	58	48	11	55.3
	25.0	37.2	30.8	7.0	
Is statistics irrelevant in my life	23	48	66	19	63.4
	14.7	30.8	42.3	12.2	
Will Statistical skills make me more employable	26	42	60	28	64.8
	16.7	26.9	38.5	17.9	
Is statistics required in my professional training	32	44	49	31	63.1
	20.5	28.2	31.4	19.9	
Does not have Statistical thinking applicable outside my career/profession	51	48	38	19	54.3
	32.7	30.8	24.3	12.2	
Does not have statistics useful in my daily routine	20	58	42	36	65.4
	12.8	37.2	26.9	23.1	
Does not have statistics is not useful at the workplace	23	37	52	44	69.2
	14.7	23.7	33.3	28.2	
Do not have application for statistics in my future profession	17	48	68	23	65.9
	10.9	30.8	43.6	14.7	
Total	**231**	**383**	**423**	**211**	**62.6**
	18.5	**30.6**	**33.8**	**17.1**	

In response to value questions, 18.5% of total respondents said none of value as 30.6% said low with all recommended questions. In the meantime, moderate of value were 33.8% and high value were 17.1%. Additionally, the high result of materiality were " Does not have statistics is not useful at the workplace “which equals to 69.2% and the less result of materiality were” Does not have Statistical thinking applicable outside my career/profession " which equals to 54.3%.

Table (4): Difficulty

Questions	None	Low	Moderate	High	Materiality
statistics is a complicated subject	5	25	65	61	79.2
	3.2	16.0	41.7	39.1	
Statistics involves massive computations	6	27	60	63	78.8
	3.8	17.3	38.5	40.4	
Learning statistics requires a great deal of discipline	10	41	68	37	71.2
	6.4	26.3	43.6	23.7	
Statistics is a subject quickly learned by most people	8	68	70	10	63.1
	5.1	43.6	44.9	6.4	
Statistics formulas are easy to understand	19	56	67	14	62.2
	12.2	35.9	42.9	9.0	
Most people have to learn a new way of thinking to do statistics	10	29	50	67	77.8
	6.4	18.6	32.1	42.9	
Total	**58**	**246**	**380**	**252**	72.05
	6.2	**26.2**	**40.5**	**27.1**	

Difficulty section illustrates 6.2% as none and 26.2% were low with all recommended questions. On the other hand, 40.5% were moderate of difficulty and 27.1% were high of difficulty. Furthermore, the high result of materiality were "statistics is a complicated subject" which equals to 79.2% and the less result of materiality were "Statistics formulas are easy to understand "which equals to 62.2%.

Table (5): Interest

Questions	None	Low	Moderate	High	Materiality
I am interested in understanding statistical information	25	43	48	40	66.5
	16.0	27.6	30.8	25.6	
I am interested in learning statistics	5	11	37	103	88.1
	3.2	7.1	23.7	66.0	
I am interested in being able to communicate statistical information to others	16	26	70	44	72.7
	10.3	16.7	44.9	28.1	
I am interested in using statistics	15	37	61	43	71.1
	9.6	23.7	39.1	27.6	
Total	**61**	**117**	**216**	**230**	74.6
	9.7	**18.7**	**34.6**	**37.0**	

The section concerning the Interest of statistics' students 9.7% were none of Interest as well as 18.7% was low with the questions presented to them while 34.6% of the total respondents were moderate of Interest and 37.0% were high Interest. Besides, the high result of materiality were “I am interested in learning statistics” which equals to 88.1% and the less result of materiality were “I am interested in understanding statistical information “which equals to 66.5%.

Table (6): Behaviour

Questions	None	Low	Moderate	High	Materiality
Can read a value from any statistical table	21	22	32	81	77.7
	13.5	14.1	20.5	51.9	
Can select the correct statistical procedure to be used to answer a question	29	41	69	17	70.0
	18.6	26.3	44.2	10.9	

I am confident that I have mastered introductory statistics material up to this point in the present academic year	19	35	59	43	70.2
	12.2	22.4	37.8	27.6	
Can identify the scale of measurement for a variable	12	40	91	13	66.8
	7.7	25.6	58.3	8.4	
Total	**81**	**138**	**251**	**154**	71.2
	12.9	**22.1**	**40.2**	**24.8**	

In response to self- efficiency section 12.9% were none of it and 22.1% were low of Behavior while 40.2% of the total participations were moderate of self-efficiency and 24.8% were high of self- efficiency. Moreover, the high result of materiality was "Can read a value from any statistical table "which equals to 77.7% and the less result of materiality were "Can identify the scale of measurement for a variable" which equals to 66.8%.

Table (7): Statistics- Outcome

Questions	None	Low	Moderate	High	Materiality
As I complete the remainder of my degree program ,I will often use statistics	10	44	90	12	66.6
	6.4	28.2	57.7	7.7	
If I could, I would choose to take another statistics module	9	33	90	24	70.6
	5.8	21.2	57.7	15.3	
In the field in which I hope to be employed when I finish school, I will use statistics	12	41	81	22	68.1
	7.7	26.3	51.9	14.1	
Total	**31**	**118**	**261**	**58**	68.4
	6.6	**25.2**	**55.7**	**12.5**	

As per data collected for statistics- outcome, result shows that on average 6.6% were none of statistics out come and 25.7% were low of statistics outcome. However, 55.7% of the total participations were moderate with statistics- outcome related questions and 12.5% were high with the question related to statistics outcome. Additionally, the high result of materiality were "If I could, I would choose to take another statistics module "which equals to 70.6% and the less result of materiality were" As I complete the remainder of my degree program, I will often use statistics" which equals to 66.6%.

Table (8): Means, Standard deviations, correlation coefficient and reliability

Variable	Mean	SD	X_1	X_2	X_3	X_4	X_5	X_6	X_7
1 Enjoyment value	2.68	.53	(.58)						
2 self-concept	2.73	.42	.37**	(.32)					
3 Value	2.49	.65	.32**	.38**	(.83)				
4 Difficulty	2.88	.43	.40**	.42**	.45**	(.48)			
5 Interest	2.98	.69	.40**	.38**	.53**	.55**	(.74)		
6 Behavior	2.76	.69	.40**	.36**	.61**	.49**	.77**	(.72)	
7 statistics outcome	2.73	.63	.29**	.39**	.53**	.56	.58**	.58**	(.78)

p*<0.05 p<0.01**

It can be seen in the table (8) that the result of mean and standard deviation illustrates that participation of the research were agreed with questions in Enjoyment value, cognitive competence, value, difficulty, effort, Behaviour and statistics outcome. Moreover, each variable are positively correlated with others and statistically significant relationship with each other. Finally, the result of reliability was more than 0.30 means that the questionnaires were reliable.

Table (9): result of regression analysis

Variables	Model (Statistics outcome)
Intercept	**0.002**
Enjoyment value	**-0.071**
self-concept	**0.154**
Value	**0.178****
Difficulty	**0.385*****
Interest	**0.151**
Behavior	**0.183***
R	**0.79**
R Square	**0.58**
F change	**23.46*****

P*<0.05 P<0.01 p***<0.001**

Model

Statistics-outcome= 0.002 - 0.071 Enjoyment value + 0.154 Self-concept + 0.178 Value + 0.385 Difficulty + 0.151 Interest + 0.183 Behaviour. (Significance model)

Statistics-outcome= 0.002 + 0.154 self-concept + 0.151 Interest (non Significance model)

It can be seen in the table (9) that there were statistically significant relationship between (Value, Difficulty, Behaviour) with statistics-outcome because the p-value were less than the common alpha 0.05 and the coefficient of Value is (0.178). This

indicates that for every addition in Value, the statistics outcome will be increased by (0.178). On the other hand, there was no statistically significant relationship between (Enjoyment values, self-concept, Interest) with statistical outcome because the p-value was greater than the common alpha 0.05.

Table (10): Result of Regression Analysis

Variables	Model (Statistics outcome)
Intercept	**0.171**
Difficulty	**0.373*** **
Statistics Attitudes	**0.672*** **
R	**0.77**
R Square	**0.57**
F change	**65.39*** **

P*<0.05 P<0.01 p***<0.001**

As shown in the table (10) that there were statistically significant relationship between (Difficulty, statistics attitudes) with statistics-outcome because the p-value were less than the common alpha 0.05 and the coefficient of statistics attitudes is (0.672). This indicates that for every addition in statistics attitudes, the statistics outcome will be increased by (0.672).

Table (11): Regression Weights: (Group number 1 - Default model)

			Estimate	S.E.	C.R.	P	Verdict
Behavior	<---	Difficulty	-1.368	.509	-2.689	.007	Supported
Behavior	<---	Interest	.771	.108	7.170	***	Supported
Self-Concept	<---	Difficulty	-2.025	.704	-2.875	.004	Supported
Value	<---	Interest	-.527	.182	-2.899	.004	Supported

			Estimate	S.E.	C.R.	P	Verdict
Value	<---	Behaviour	1.005	.251	4.010	***	Supported
Statistics Outcome	<---	Interest	-.591	.285	-2.071	.039	Supported
Enjoyment Value	<---	Self-Concept	-.317	.137	-2.325	.020	Supported
Statistics Outcome	<---	Self-Concept	.139	.075	1.851	.047	Supported
Statistics Outcome	<---	Value	-.011	.253	-.043	.965	Unsupported
Statistics Outcome	<---	Behavior	1.113	.543	2.051	.040	Supported

Table (11) illustrates estimation of path coefficients, T-test and the level of significance for all hypothesized paths. The use of path analysis is to determine the hypotheses are supported or not supported. The analysis illustrates that Difficulty (path coefficient= -1.368, t=-2.689, p-value<0.01) and Interest (path coefficient= 0.771, t=7.170, p-value<0.01) were significantly negatively and positively respectively correlated with Behavior. Interest (path coefficient= -0.527, t=-2.899, p-value<0.01) and behaviour (path coefficient= 1.005, t=4.010, p-value<0.01) were significantly negatively and positively respectively correlated with value. In addition, behavior (path coefficient= 1.113, t=2.051, p-value<0.05), and self-concept (path coefficient= .139, t=1.851, p-value<0.05) were significantly positively correlated with statistics outcome and Interest (path coefficient= -0.591, t=2.071, p-value<0.05) were significantly negatively correlated with statistics outcome. However, Value (path coefficient= -.011, t=-.043, p-value>0.05) were not significantly correlated with statistics outcome. Therefore most of the hypotheses in the research have been supported by the data and just one hypothesis has not been supported by the data.

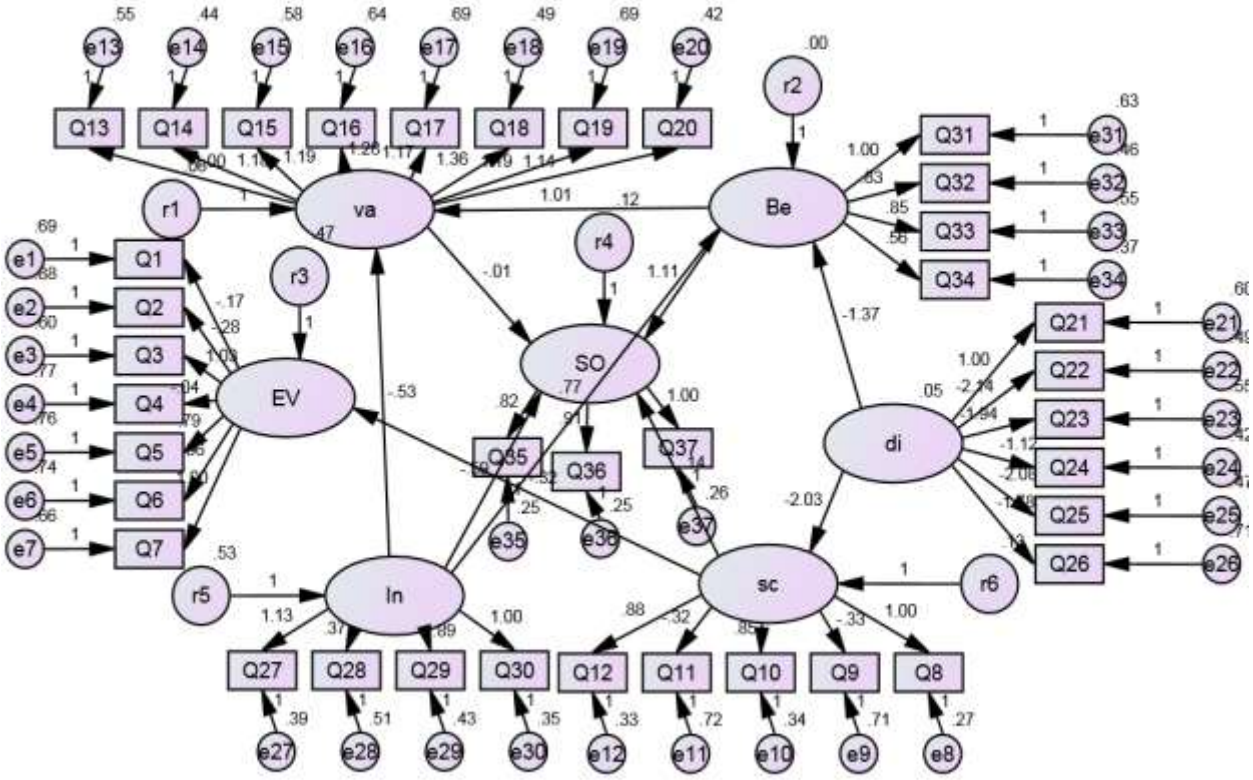

Figure (2): Standardized Path Coefficients in Measurement Model using Amos

Conclusion

This study applied structural equation model to analyse the hypothesis and to determine attitudinal relationship. The results discovered that not all hypotheses were found to be significant relationship. The relationship among statistics-outcome, value, difficulty, behaviour was found. In accordance with this purpose, firstly a positive relationship was found between behaviour, difficulty and statistics-outcome, and value was found to not be a significant predictor of statistics-outcome in the structure equation model (SEM). These findings illustrate that increasing behaviour also increase statistics-outcome. It is an expected situation that students who have a good behaviour for statistics also have high levels of outcome of statistics. Moreover, there were statistically significant

relationship between (Difficulty, statistics attitudes) with statistics-outcome because the p-value were less than the common alpha 0.05 and the coefficient of statistics attitudes is (0.672). This indicates that for every addition in statistics attitudes, the statistics outcome will be increased by (0.672). Finally, the effects of Structural equation model's result are follows: difficulty to behavior, self-concept was significance. also interest to behavior, value, statistics outcome were significance, and behavior to value, statistics outcome were statistically significance. And self-concept to statistics outcome, enjoyment value was statistically significance. Contradictions of study findings with other literature were noted and assessed. Further methodological research is suggested to determine the effect of sample size, number of constructs and observed variables on the fit of the model.

References

American Statistical Association (2010). Guidelines for assessment and instruction in statistics education: College report.

Bentler, P. (1980) Multivariate analysis with latent variables: causal modelling. Annual Review of Psychology. 31(1), pp. (419–56).

Byrne, D (2011), Applying Social Science: The Role of Social Research in Politics, Policy and Practice. Bristol: Policy Press. Journal of Social Policy. 41 (2), pp. 429-430.

Chiesi, F., & Primi, C. (2009). Assessing statistics attitudes among college students: Psychometric properties of the Italian version of the Survey of Attitudes toward Statistics (SATS). Learning and Individual Differences, 19(2), pp. (309–313).

Dogan, N. (2009). The effect of computer-assisted statistics instruction on achievement and attitudes toward statistics. Education and Science, 34(154),pp. (3-16).

Emmioglu, E. (2011). The relationship between mathematics achievement, attitudes toward statistics, and statistics outcomes: A structural equation model

analysis. Unpublished doctoral dissertation. Middle East Technical University, Ankara, Turkey.

Emmioglu, E., & Capa-Aydin, Y. (2011, August). A meta-analysis on students' attitudes toward statistics. Paper presented at the 58th World Statistics Congress of the International Statistical Institute, Dublin, Ireland.

Greer, B. (2000). Statistical thinking and learning. Mathematical Thinking and Learning, 2(1), pp.1-9.

Hand, D. (1998). Breaking misconceptions - statistics and its relationship to mathematics. The Statistician, 47(2), pp. (245-250).

Joreskog, K. (1973). A general method for estimating a linear structural equation system. In: Goldberger A S, Duncan O D (eds.) Structural Equation Models in the Social Sciences. Academic Press, New York, pp. (85–112).

Jayakumar, G. S., & Sulthan, A. (2013). Stress symptoms: Structural equation modelling. SCMS Indian Journal of Management, (July-September), 95-109.

Lubienski, S. Lubienski, C. & Crane, C. (2012). Achievement differences and school type: The role of school climate, teacher certification, and instruction. American Journal of Education, 115(1), pp. (97–138).

Lee, H.W. (2011). An application of latent variable structural equation modelling for experimental research in educational technology, TOJET, 10(1), 15-23.

Martin Castor, GEISTT, Stockholm. (2018). Structural equation modelling for analysis of human and organizational factors in nuclear power plant control rooms [online]. Variable at < www.stralsakerhetsmyndigheten.se>.

Moore, D. (2005). Quality and relevance in the first statistics course. International Statistical Review, 73(2), pp. (205-206).

Mohamad, M., Abdullah, A. R., & Mokhlis, S. (2011). Examining the infl uence of service recovery satisfaction on destination loyalty: A structural Equation Modelling. Journal of Sustainable Development, 4(6), 3-11.

Muthen, B. (2001). Second-generation structural equation modelling with a combination of categorical and continuous latent variables: New opportunities for

latent classlatent growth modelling. In: Sayer A, Collins L (eds.) New Methods for the Analysis of Change. American Psychological Association, Washington, DC, pp. (291–322).

Poffenberger, T., & Norton, D. (1959). Factors in the formation of attitudes toward mathematics. The Journal of Educational Research, 52(5), pp. (171–176).

Shaughnessy, J (2007). Research on statistics learning and reasoning. In F. K. L. Jr (Ed.), Second handbook of research on mathematics teaching and learning (pp. 957-1009). Greenwich, CT: Information Age Publishing, Inc. Charlotte, NC: NCTM.

Singh, S. & Imam, A. (2013). Effect of personal and institutional variables on mathematics achievement of secondary school students. IOSR Journal of Humanities and Social Science, 10(3), pp. (22–33)

Schau, C. (2003). Students' attitudes: The "Other" important outcome in statistics education. Paper presented at the Joint Statistical Meeting, Section on Statistics Education, San Francisco, CA

Sizemore, O. J., & Lewandowski, G. (2009). Learning might not equal liking: Research methods course changes knowledge but not attitudes. Teaching of Psychology, 36(2). pp (90-95).

Raykov, Tenko & Marcoulides, G.A. (2006). A first course in structural equation modelling (2nd ed.). NJ : Lawrence Erlbaum Associates, Inc

Thomas, S., & Bhasi, M. (2011). A software model for project risk management Vilakshan. XIMB Journal of Management, (March issue), 71-84

Tempelar, D. K., Loeff, S. C. V. D., & Gijselaers, W. H. (2007). A structural equation model analyzing the relationship of students' attitudes toward statistics, prior reasoning abilities and course performance. Statistics Education Research Journal, 6(2), 78-102

Thatcher, J and Grover, V. (2010). Advancing operations management theory using exploratory structural equation modelling techniques. International Journal of production Research. 48 (15). pp. 4329- 4353.

Verhoeven, P. S. (2009). Quality in statistics education determinants of student outcomes in methods & statistics education at universities and colleges. Unpublished doctoral dissertation, Utrecht University, Amsterdam, The Netherlands

Zakuan, N. M., Yusof, S. M., Laosirihongthong, T., & Shaharoun, A. M. (2010). Proposed relationship of TQM and organizational performance using structured equation modelling. Total Quality Management, 21(2), 185-203