

**STATISTICAL ANALYSIS  
OF PILOT STUDY  
INSTRUMENT FOR  
TEACHER READINESS  
TOWARDS STEM  
EDUCATION**

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The Teacher Readiness towards STEM Education instrument was administered to 348 Science and Mathematics teachers in the state of Selangor for the purpose of pilot study. The Teacher Readiness towards STEM Education instrument contains six dimensions namely Teachers' Concern towards STEM Education, Teachers' Skills in STEM Education, Attitude towards STEM Education, STEM Education Behavior Tendencies, STEM Education Support and Feasibility of STEM Education. The Items for Teachers' Readiness towards STEM Education are in the form of six point of Likert scale. One of the weaknesses of the Likert-scale items was the tendency for respondents to choose a scale that reflects a behavior accepted by society's norms even though the response did not really reflect the view of respondents' actually. This situation is known as the Social Desirability effect. One way to counteract the effects of Social Desirability is to ensure that the items in the instrument do not force the respondents to respond as required by society's norms. This is done by performing correlation analysis for each item on the Social Desirability scale. The analysis showed that one item from the STEM Education Behavioral Tendency and one item from the STEM Education Skills showed significant correlation with the Social Desirability scale. In addition, two items from the Feasibility of STEM Education dimension have significant correlations with the Social Desirability scale. The findings also showed that four items in the Concerns towards STEM Education dimension have significant correlations with the Social Desirability scale. The following shows the Spearman correlation coefficient values and p-values for items that show significant correlations with the Social Desirability scale.

Item	Dimension	P-value	Spearman Correlation Coefficient
1. I have the creativity to integrate STEM in T&L.	STEM Education Skills	.034	-.114*
2. I will innovate in various ways to integrate STEM in T&L.	STEM Education Behavior Tendencies	.008	-.143**
3. STEM integrated education is suitable with my teaching style.	Feasibility of STEM Education	.007	-.145**
4. STEM integrated education is suited with my belief with regards to effective teaching.	Feasibility of STEM Education	.010	-.138*
5. I am concerned that STEM integrated education might cause a decrease in students' achievement in Science.	Concerns towards STEM education	.028	.118*
6. I am concerned that STEM integrated education might cause a decrease in my students' achievement in Mathematics.	Concerns towards STEM education	.033	.115*
7. I am worried of my ability to implement STEM integrated education along with other tasks.	Concerns towards STEM education	.041	.110*
8. I am worried of my skills in to implementing STEM integrated education.	Concerns towards STEM education	.006	.148

## Results of Confirmatory Factor Analysis of Teachers' Readiness Measurement Model towards STEM Education

### Summary of Parameters for Measurement Models

New Parameter summary (Group number 1)

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	38	0	0	0	0	38
Labeled	0	0	0	0	0	0
Unlabeled	26	15	38	0	32	111
Total	64	15	38	0	32	149

### Computation of degrees of freedom (Default model)

Number of distinct sample moments: 560  
Number of distinct parameters to be estimated: 111  
Degrees of freedom (560 - 111): 449

### Result (Default model)

Minimum was achieved  
Chi-square = 1236.143  
Degrees of freedom = 449  
Probability level = .000

### Degrees of freedom calculation (Model default)

Quantity of sample moment: 377  
Estimated parameter: 84  
Degree of freedom (105 - 38): 293

This section will explain the results of the measurement model analysis of Teacher Readiness for STEM Education. The measuring model of Teacher Readiness for STEM Education was analysed based on six latent dimensions: -

- (i) Attitude toward STEM Education,
- (ii) Behavioral Tendencies of STEM Education
- (iii) Teachers' Skills in STEM Education,
- (iv) Feasibility of STEM Education, and
- (v) STEM Education Support
- (vi) Concerns about STEM Education

Referring to the analysis of Measurement Model of the Teacher Readiness towards STEM Education, a total of 84 parameters were estimated. Therefore, for the 111 parameters estimated, there are 26 regression weights, 15 covariants and 38 variants. As a result, chi square for goodness of fit test will be calculated based on 449 degrees of freedom (560-611).

### Chi Square

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	111	1236.143	449	.000	2.753
Saturated model	560	.000	0		
Independence model	32	10995.391	528	.000	20.825

The results of the chi-square analysis showed that the p value is less than 0.05;  $\chi^2$  (N = 348, df = 449) = 1236.143,  $p < .05$ . The chi-square statistical value that minimises the effect of the sample size refers to  $\chi^2 / df$ . In this study, the value of  $\chi^2 / df$  was 2.753. This value is less than 5.0 which leads to the suggestion that the measurement model of fit the data (Wheaton et al, 1977; Hooper, Coughlan & Mullen, 2008).

### Baseline Comparison

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.888	.868	.925	.912	.925
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

It was found that the baseline comparison fitness indexes were within the acceptable range of 0.9. Baseline comparison fitness indexes refer to NFI, RFI, IFI, TLI and CFI. The value for NFI is 0.888, RFI is 0.868, IFI value is 0.925, TLI value is 0.912 and CFI value is 0.925. Any improvement in the fitness index for the model being hypothesised is not substantive for the value of 0.9 which is close to 1.0 (Ho, 2014). As such, these compatibility indices show good compatibility between the data and the measurement model.

### RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.071	.066	.076	.000
Independence model	.239	.235	.243	.000

The RMSEA value represents the goodness of fit when the measurement model is estimated in the population (Browne & Sugawara, 1996). In this study, the RMSEA value is 0.071. As such, this RMSEA value is accepted because its value is lesser than 0.08 (Bryne, 2001; Browne & Cudeck, 1993).

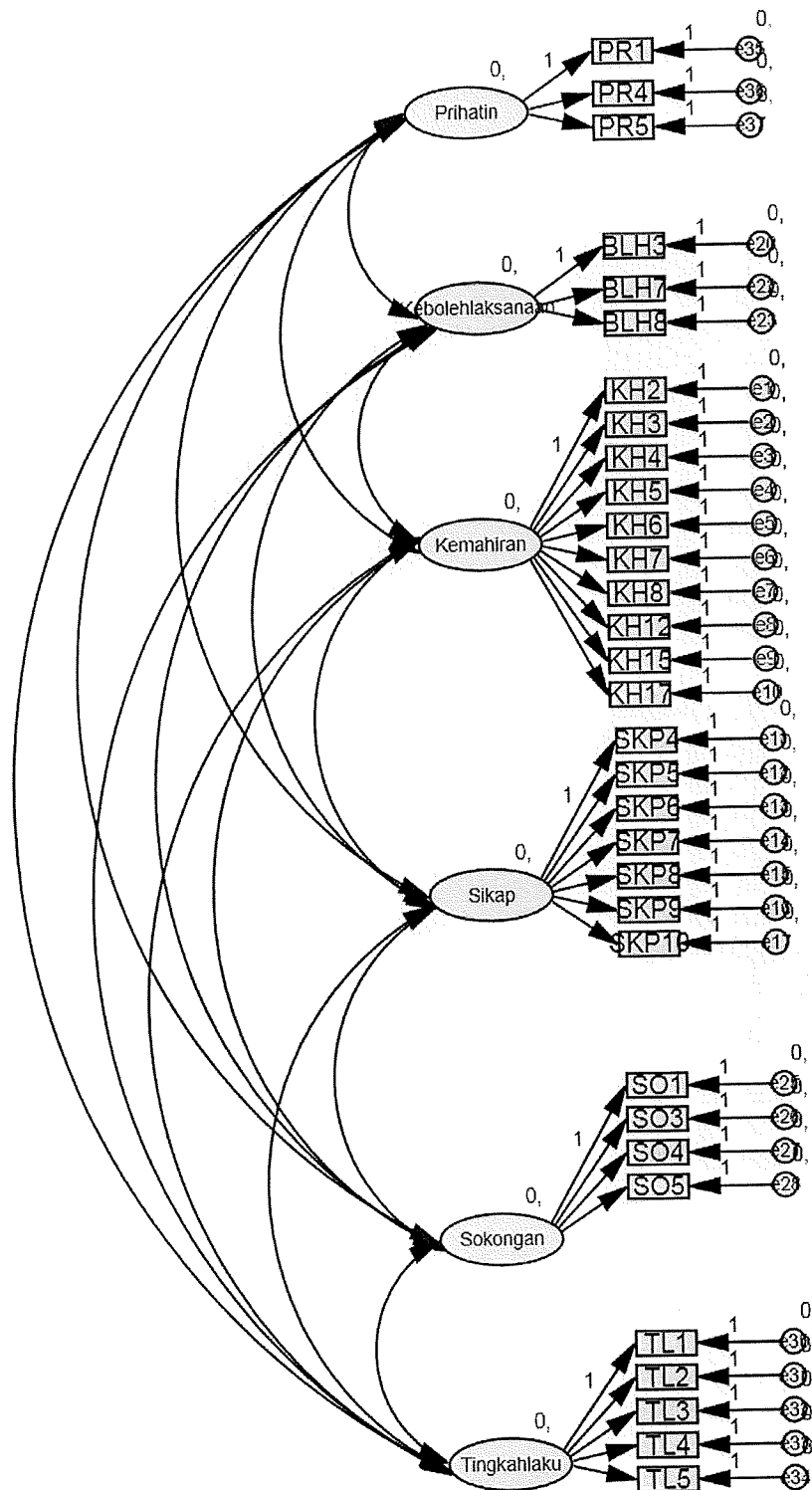


Figure 1.0: Measurement Model for Teacher Readiness towards STEM Education

The confirmatory factor analysis (CFA) was performed on items representing specific latent variables. Figure 1.0 shows the measurement model tested using a validation factor analysis approach. Arrows pointing from the latent dimension to the items represent the causal effect of latent variables on observed measurements (Hair et al., 2010). Statistically this direct impact estimate is called factor loading. Factor loadings in CFAs are generally described as regression coefficients that can be non-standardised and standardised.

**Non-standardised regression coefficient for Measurement Model**

	Estimate	S.E.	C.R.	P
KH2 <--- Skills	1.000			
KH3 <--- Skills	1.051	.045	23.269	***
KH4 <--- Skills	1.042	.042	24.864	***
KH5 <--- Skills	1.088	.044	24.503	***
KH6 <--- Skills	1.093	.048	22.687	***
KH7 <--- Skills	.985	.044	22.359	***
KH8 <--- Skills	.961	.043	22.421	***
KH12 <--- Skills	.962	.047	20.266	***
KH15 <--- Skills	.921	.046	20.170	***
KH17 <--- Skills	.920	.047	19.480	***
SKP4 <--- Attitude	1.000			
SKP5 <--- Attitude	1.063	.057	18.696	***
SKP6 <--- Attitude	.996	.056	17.767	***
SKP7 <--- Attitude	1.018	.052	19.586	***
SKP8 <--- Attitude	1.000	.055	18.265	***
SKP9 <--- Attitude	1.070	.056	19.012	***
SKP10 <--- Attitude	1.010	.054	18.542	***
BLH3 <--- Feasibility	1.000			
BLH7 <--- Feasibility	1.081	.065	16.603	***
BLH8 <--- Feasibility	1.051	.058	18.250	***
SO1 <--- Support	1.000			
SO3 <--- Support	1.179	.062	19.054	***
SO4 <--- Support	1.162	.062	18.719	***
SO5 <--- Support	1.038	.068	15.190	***
TL1 <--- Behaviour	1.000			
TL2 <--- Behaviour	.907	.052	17.395	***
TL3 <--- Behaviour	.818	.043	19.104	***



			Estimate	S.E.	C.R.	P
TL4	<---	Behaviour	.886	.046	19.082	***
TL5	<---	Behaviour	.739	.047	15.726	***
PR1	<---	Concern	1.000			
PR4	<---	Concern	1.593	.110	14.447	***
PR5	<---	Concern	1.478	.102	14.463	***

### Standardised Regression Coefficient for Measurement Model

			Estimate
KH2	<---	Skills	.880
KH3	<---	Skills	.871
KH4	<---	Skills	.897
KH5	<---	Skills	.891
KH6	<---	Skills	.860
KH7	<---	Skills	.854
KH8	<---	Skills	.855
KH12	<---	Skills	.812
KH15	<---	Skills	.810
KH17	<---	Skills	.795
SKP4	<---	Attitude	.794
SKP5	<---	Attitude	.863
SKP6	<---	Attitude	.832
SKP7	<---	Attitude	.891
SKP8	<---	Attitude	.849
SKP9	<---	Attitude	.873
SKP10	<---	Attitude	.858
BLH3	<---	Feasibility	.829
BLH7	<---	Feasibility	.788
BLH8	<---	Feasibility	.843
SO1	<---	Support	.764
SO3	<---	Support	.932
SO4	<---	Support	.917
SO5	<---	Support	.772
TL1	<---	Behaviour	.827
TL2	<---	Behaviour	.799
TL3	<---	Behaviour	.850
TL4	<---	Behaviour	.850
TL5	<---	Behaviour	.744
PR1	<---	Concern	.664
PR4	<---	Concern	.939
PR5	<---	Concern	.915

Based on the results of the non-standardised regression coefficient analysis for the Teachers' Skills in STEM Education, the value of critical ratio in the regression between the latent dimension Teacher Education Skill and items (KH2, KH3, KH4, KH5, KH6, KH7, KH8, KH12, KH15 and KH17) is outside the range of  $\pm 1.96$ . The results of the standardised regression coefficient analysis show that the values of the standardised regression coefficients range from 0.795 to 0.897. Therefore, the items displayed on the Measurement Model are significant indicators of the latent dimension of Teachers' Skill in STEM Teacher Education.

Referring to the results of the non-standardised regression coefficient analysis for the dimension of Feasibility of STEM Education, the value of the critical ratio in the regression between the latent dimensions of Feasibility of STEM Education and the items (BLH3, BLH7 and BLH8) is beyond the range of  $\pm 1.96$ . The result of the standardised regression coefficient analysis shows the values of standardised coefficient regression falls in the range from 0.788 to 0.843. Hence, the items displayed on the Measurement Models are significant indicators of the latent dimension of Feasibility of STEM Education.

Based on the results of the non-standard regression coefficient analysis for the STEM Education Support dimensions, the value of the critical ratio in the regression between the STEM Education Support latency dimensions and the items (SO1, SO3, SO4 and SO5) is outside the range of  $\pm 1.96$ . The results of the standardised regression coefficient analysis showed that the values of the standardised regression coefficients ranged from 0.764 to 0.932. Therefore, the items displayed on the Measurement Model are significant indicators latent dimension of the STEM Education Support.

Based on the results of the analysis of non-standardised regression coefficients for Attitude towards STEM Education dimensions, the value of critical ratios in the regression between the latent dimensions of Teachers' Skill dimensions and items (SKP4, SKP5, SKP6, SKP7,

SKP8, SKP9 and SKP10) is outside the range of  $\pm 1.96$ . The results of the standardised regression coefficient analysis show that the values of the standardised regression coefficients range from 0.794 to 0.891. Therefore, the items displayed on the Measurement Model are significant indicators of the latent dimensions of Attitude towards STEM Education.

Based on the results of the analysis of non-standardised regression coefficients for the Attitude towards STEM Education dimension, the value of the critical ratio in the regression between the latent dimensions of Teachers' Skills in STEM Education and items (PR1, PR4 and PR5) is outside the range of  $\pm 1.96$ . The results of the standardised regression coefficient analysis show that the values of the standardised regression coefficients range from 0.664 to 0.939. Therefore, the items displayed on the Measurement Model are significant indicators of the latent dimension of Concern for STEM Education.

Based on the results of the non-standardised regression coefficient analysis for the STEM Education Behavior dimensions, the value of the critical ratio in the regression between the latent dimensions of Teacher's Skills in STEM Education and items (TL1, TL2, TL3, TL4 and TL5) was outside the range of  $\pm 1.96$ . The results of the standardised regression coefficient analysis show that the values of the standard regression coefficients range from 0.744 to 0.850. Therefore, the items displayed on the Measurement Model are significant indicators of the latent dimension of STEM Education Behavioral.

### **Multipurpose Correlation Square**

	Estimate
PR5	.838
PR4	.881
PR1	.441
TL5	.554
TL4	.722
TL3	.723
TL2	.638
TL1	.684

	Estimate
SO5	.596
SO4	.842
SO3	.869
SO1	.584
BLH8	.711
BLH7	.620
BLH3	.687
SKP10	.736
SKP9	.762
SKP8	.720
SKP7	.795
SKP6	.692
SKP5	.745
SKP4	.631
KH17	.632
KH15	.657
KH12	.660
KH8	.732
KH7	.730
KH6	.740
KH5	.795
KH4	.805
KH3	.758
KH2	.775

Multipurpose correlation provides information on the variance explained by the 26 items in the Measurement Model of Teacher Readiness for STEM Education. The results show the range of the percentage of variance as explained is from 0.441 or 44.1% (PR1) to 0.881 or 88.1% (PR4).

## Reliability Index of Instructional Dimensions for Teacher Readiness towards STEM

### Education

Dimension	Quantity of Item	Reliability Index
Dimension	10	0.964
STEM Education Skill	7	0.948
Attitude towards STEM Education	3	0.856
Feasibility of STEM Education	4	0.908
STEM Education Support	5	0.905
STEM Education Attitude	3	0.874

It is found that the reliability index value for items representing six dimensions was greater than 0.7 which allowed them to be used for research purposes. In conclusion, the findings of the pilot study show that the Teacher Readiness instrument for STEM Education is valid and reliable. The following is the latest version of the Teacher Readiness towards STEM Education instrument.

### The revised version after pilot study of Instrument for Teacher Readiness towards STEM Education

Code	Dimension	Item
KH2	STEM Education Skill	I know how to integrate STEM in T&L
KH3	STEM Education Skill	My knowledge of STEM Education is sufficient to integrate STEM in T&L
KH4	STEM Education Skill	I can effectively integrate STEM in T&L

Code	Dimension	Item
KH5	STEM Education Skill	I have sufficient skills to integrate STEM in T&L
KH6	STEM Education Skill	I have mastered pedagogical content knowledge for all STEM discipline
KH7	STEM Education Skill	I am able to produce students with tendencies to follow STEM integrated learning
KH8	STEM Education Skill	I have creativity to integrate STEM in T&L.
KH12	STEM Education Skill	I have the skills to assess student performance in STEM integrated education.
KH15	STEM Education Skill	I understand the relevance of STEM integrated education to the existing curriculum syllabus.
KH17	STEM Education Skill	I am good at engaging students in STEM integrated learning.
SKP4	Attitudes towards STEM Education	I think STEM integrated education is important for students' cognitive development.
SKP5	Attitudes towards STEM Education	I think STEM integrated education is important to make students more involved in the scientific issues that occur in the real-world.
SKP6	Attitudes towards STEM Education	I think STEM integrated education in schools is important in helping students make good choices about their future science-related careers.
SKP7	Attitudes towards STEM Education	I think STEM integrated education is relevant to 21st century education.
SKP8	Attitudes towards STEM Education	I think STEM integrated education enables students to become effective members of society.
SKP9	Attitudes towards STEM Education	I think STEM integrated education enables students to understand the real world in a more systematic way.
SKP10	Attitudes towards STEM Education	I think STEM integrated education is capable of producing citizens who contribute to the country's development.
BLH3	Feasibility of STEM Education	STEM integrated education enables a variety of blended teaching methods.
BLH7	Feasibility of STEM Education	STEM integrated education can be implemented during school hours.

Code	Dimension	Item
BLH8	Feasibility of STEM Education	STEM integrated education allows classroom learning to be combined with out of classroom learning.
SO1	STEM Education Support	Students' parents are aware of the importance of the STEM integration education being carried out in schools.
SO3	STEM Education Support	The reference materials to integrate STEM in T&L is sufficient.
SO4	STEM Education Support	The teaching aids to integrate STEM in T&L are sufficient.
SO5	STEM Education Support	There are many meetings that allow me to voice my views on STEM integrated on education.
TL1	STEM Education Behaviour	I will actively involve in promoting STEM integrated education in schools.
TL2	STEM Education Behaviour	I believe that STEM integrated education is suitable for students of all abilities.
TL3	STEM Education Behaviour	I will ensure that STEM integrated education is implemented according to students' needs.
TL4	STEM Education Behaviour	I will not hesitate to integrate STEM in T&L.
TL5	STEM Education Behaviour	I will increase my knowledge about STEM integrated education.
PR1	Concerns towards STEM Education	I am concerned about the relevance of STEM integrated education to the existing curriculum.
PR4	Concerns towards STEM Education	I am concerned that STEM integrated education will make the syllabus difficult to complete.
PR5	Concerns towards STEM Education	I am concerned about the duration it would take for STEM integrated education to take place.

## References

- Browne, M.W. & Cudeck R. (1993) Alternative ways of assessing model fit. *In Bollen KA, Long JS editors. Testing structural equation models*. Newbury Park, CA: Sage, 1993, pp 136-162.
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