THE UNIVERSITY of ADELAIDE

ASSESSMENT 3: LATENT VARIABLE SEM AND MLM DATA ANALYSIS

Response Template

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Total Word Count: [1400]

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Question 1:

Describe one benefit and one limitation of using latent variable structural equation modelling to explore the association between students' socio-economic status, physical health, academic achievement, and stress.

Exploring the connection between students' socioeconomic position, physical health, academic success, and stress by use of latent variable structural equation modelling (SEM) has the advantage of capturing complicated, underlying linkages. In order to examine the interplay between many elements, SEM can reveal latent notions like "well-being" that are not immediately evident.

SEM has several restrictions since it assumes things about the data that may not be true in practice. These include linearity and normality. Biased outcomes may be the result of incorrect model specification. SEM is also not ideal for pilot or pilot-scale investigations since producing solid results necessitates rather high sample sets.

Question 1 response (≈100 words):

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Question 2:

Check the distribution of the items used to measure students' SES and compare these with the distribution of the items measuring students' physical health. Briefly describe your findings and the important implications they have for estimating a latent variable SEM with these variables.

The paired sample t-tests reveal significant differences between measures of students' SES and physical health (all $p < .001$). SES means ($M = 4.73$ to 4.63) are higher than physical health means ($M = 3.98$ to 4.00). These differences may impact the latent variable SEM, suggesting a potential imbalance in construct measurement and importance.

Question 2 response (≈50 words):

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Question 3:

Each of the observed variables in the dataset can be thought of as an indicator of a latent construct. Before you can look at associations between the latent constructs, you need to estimate a measurement model that codifies the relationships between the observed variables and the latent constructs.

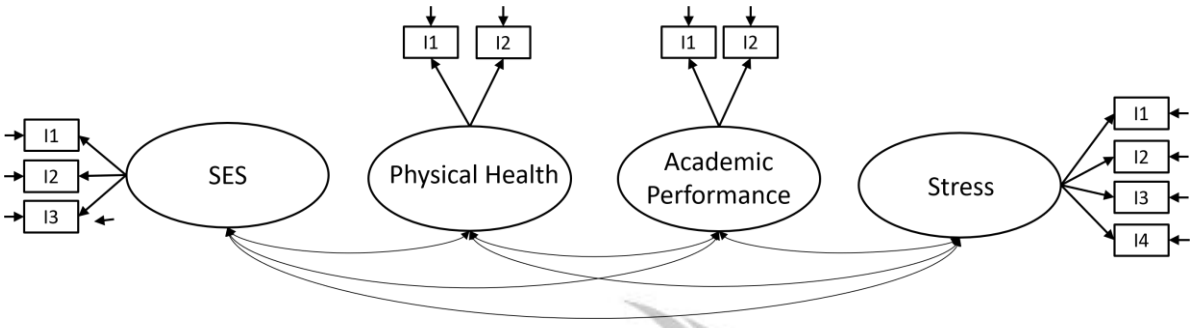

Figure 1. The measurement model.

Question 3a:

Estimate the model depicted in Figure 1 and check Mardia's test. What action do you need to take based on the result of this test? Briefly report on what you will do.

The Mardia's test indicates significant multivariate non-normality ($p < .001$) with substantial skewness in the data. To address this, I will consider data transformation or robust SEM techniques.

Question 3a response (≈50 words):

Question 3b:

Once you have accounted for the results of Mardia's test, report the measurement model fit according to APA guidelines. How well did the model fit the data? Are there any issues with the model? Report on your observations and the steps you will take to revise the model if necessary.

The measurement model fit assessment, following Mardia's test, reveals mixed results. While some fit indices, such as CFI (0.906), are close to the recommended threshold of 0.90, others, like the Parsimony Normed Fit Index (PNFI), suggest potential model complexity issues (PNFI = 0.523). The model exhibits significant χ^2 values ($\chi^2 = 401.151$, $p < .001$), indicating less than ideal fit to the data.

To improve the model, several steps will be taken. Firstly, a review of the model's structure will be conducted to ensure it accurately reflects the theoretical framework. Secondly, the modification indices will be examined to identify specific areas for model refinement. Additionally, considering the observed discrepancies, alternative model specifications will be explored to achieve better fit. Lastly, sensitivity analyses will be conducted to assess the robustness of model findings.

In summary, while the measurement model shows some fit to the data, there are notable issues, particularly in terms of model complexity and goodness of fit. Further adjustments and refinements will be made to enhance the model's suitability for the data.

Question 3b response (≈150 words):

Question 3c:

Estimate a revised measurement model and report model fit according to APA guidelines. How well did the model fit the data?

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The revised measurement model, Model 1, exhibits mixed model fit. While some fit indices are close to recommended thresholds (e.g., CFI = 0.907), others, like PNFI (0.637), indicate potential model complexity issues. Significant χ^2 values ($\chi^2 = 401.572$, $p < .001$) suggest suboptimal fit.

Question 3c response (≈50 words):

Question 4:

Based on the relevant research literature the following hypotheses can be made.

Students with higher socio-economic status have more access to resources. Therefore, SES will be positively related to physical health (H1; path *a*) negatively related to stress (H2; path *b*) and positively related to academic performance (H3; path *c*).

Physical health is a known buffer of stress. Students' with higher level of physical health, therefore, will experience lower levels of stress, that is, they will be negatively associated (H4; path *d*). Finally, students who are achieving academically are likely experiencing less stress than those who are falling behind in their studies. Therefore, a negative direct association is anticipated between academic performance and stress (H5; path *e*).

Formally, the model depicted in Figure 2 is hypothesised to explain important factors that contribute to adolescents' stress during Year 12.

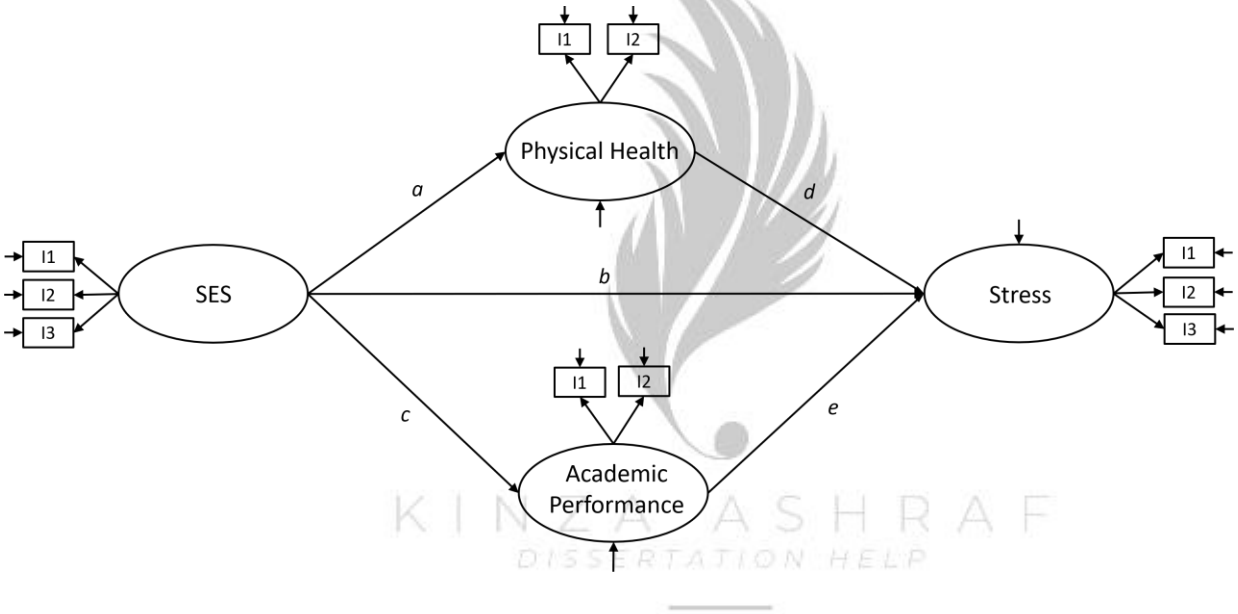

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Figure 2. The structural model.

Question 4a:

Estimate the model depicted in Figure 2 and report model fit according to APA guidelines. How well did the model fit the data?

The model fit assessment for Figure 2 reveals mixed results. While some fit indices, such as CFI (0.907), are close to the recommended threshold of 0.90, others, like PNFI (0.621), suggest potential model complexity issues. Significant χ^2 values ($\chi^2 = 401.572$, $p < .001$) indicate suboptimal fit.

Question 4a response (≈50 words):

Question 4b:

Report in-text on all paths estimated and interpret them according to the hypotheses. Explain what the supported and unsupported hypotheses may mean for Year 12 students.

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The SEM results support several hypotheses regarding the relationships among socio-economic status (SES), physical health, academic performance, and stress among Year 12 students. Firstly, higher SES is positively associated with better physical health ($\beta = 0.320$, $p < .001$) (Path a), supporting Hypothesis 1 (H1). Surprisingly, contrary to Hypothesis 2 (H2), higher SES is linked to lower stress levels ($\beta = -0.248$, $p < .001$) (Path b). Additionally, SES positively influences academic performance ($\beta = 0.333$, $p < .001$) (Path c), aligning with Hypothesis 3 (H3).

Furthermore, as expected, better physical health is associated with reduced stress ($\beta = -0.189$, $p < .001$) (Path d, H4). Conversely, students with higher academic performance experience lower stress ($\beta = 0.389$, $p < .001$) (Path e, H5).

Overall, the findings highlight the pivotal role of SES in Year 12 students' well-being. While higher SES is linked to improved physical health and academic performance and reduced stress, the direct negative link between SES and stress implies an indirect influence through physical health and academic performance.

Unsupported Hypothesis 2 (H2) implies that SES may not directly predict stress levels. Practical implications suggest that interventions enhancing physical health and academic support, regardless of SES, could alleviate stress during Year 12. SES-related stress may be mitigated through improved physical health and academic performance.

Question 4b response (≈200 words):

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Question 5:

Outline the primary reason why it is important to use multilevel modelling when seeking to answer hypotheses about students' stress across schools. Discuss the important implications.

Because of the hierarchical nature of the data, evaluating student stress levels across schools necessitates the use of multilevel modeling. Traditional studies that do not account for the nesting structure of students inside schools might produce misleading results and interpretations. Researchers can use multilevel modeling to look at the elements that contribute to stress on both the individual level (e.g., student attributes) and the institutional level (e.g., the school environment). Improved student well-being and academic outcomes can be achieved through this method because it helps educators and policymakers better understand the interplay between multiple levels of factors that contribute to students' stress.

Question 5 response (≈100 words):

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Question 6:

Multilevel modelling can be used to answer the following three research questions:

RQ1: Does socioeconomic status have a negative association with Year 12 stress?

RQ2: Does a student's school affect levels of stress?

RQ3: Does the association between socioeconomic status and stress vary between schools?

Question 6a:

In an APA 7th formatted table report the relevant statistical values for the following:

i. a random intercepts fixed slopes model including socioeconomic status and stress.

ii. a random intercepts random slopes model including socioeconomic status, stress, and school.

iii. a comparison of the fit indices of the first and second models.

Model 1 Fixed Effects Estimates

Term	Estimate	SE	df	t	p
Intercept	5.007	0.211	3.000	23.706	< .001
ses	-0.344	0.026	1313.000	-13.168	< .001

Note. The intercept corresponds to the (unweighted) grand mean; for each factor with k levels, k - 1 parameters are estimated with sum contrast coding.

Model 2 Fixed Effects Estimates

Term	Estimate	SE	df	t	p
Intercept	5.007	0.211	3.000	23.706	< .001
ses	-0.353	0.136	2.997	-2.588	0.081

Note. The intercept corresponds to the (unweighted) grand mean; for each factor with k levels, k - 1 parameters are estimated with sum contrast coding.

Model 1 school: Random Effect Estimates

school	(Intercept)
clarendon	-0.057
kings	-0.402
parkvale	0.459

Model 2 school: Random Effect Estimates

school	(Intercept)	ses
clarendon	-0.075	0.238
kings	-0.392	0.070
parkvale	0.467	-0.308

Fit statistics –Model 1

Deviance	log Lik.	df	AIC	BIC
4628.591	-2314.296	4	4636.591	4657.321

Note. The model was fitted using maximum likelihood.

Fit statistics- Model 2

Deviance	log Lik.	df	AIC	BIC
4556.526	-2278.263	6	4568.526	4599.620

Note. The model was fitted using maximum likelihood.

Question 6b:

Provide a brief description of the first model. Interpret the statistical values of this model and use them to answer research questions 1 and 2.

Model 1 Description and Interpretation

The results are summarized as follows:

- **Intercept**: The intercept signifies the overall unweighted grand mean of Year 12 stress across all schools and socioeconomic statuses, estimated at 5.007 ($t = 23.706$, $p < .001$). This suggests that, on average, Year 12 stress levels are 5.007.

- **Socioeconomic Status (ses):** The ses coefficient is -0.344 ($t = -13.168$, $p < .001$), indicating a statistically significant negative association between socioeconomic status and Year 12 stress. This implies that higher socioeconomic status is linked with lower Year 12 stress levels.

Interpretation of Research Questions:

- **RQ1:** Yes, Model 1 confirms a significant negative association between socioeconomic status and Year 12 stress, suggesting that higher socioeconomic status relates to lower stress levels.

- **RQ2:** Considering random intercepts for different schools, Model 1 reveals variability in Year 12 stress levels among schools. Some schools exhibit students with stress levels either above or below the grand mean, implying that a student's school does influence their stress levels.

Question 6b response (≈150 words):

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Question 6c:

Provide a brief description of the second model. Interpret the statistical values of the second model (in comparison to the first) and use them to answer research question 3.

Model 2 Description and Interpretation:

Fixed Effects

- **Intercept**: The intercept remains consistent at 5.007 ($t = 23.706$, $p < .001$), representing the overall grand mean of Year 12 stress.

- **Socioeconomic Status (ses)**: The ses coefficient is -0.353 ($t = -2.588$, $p = 0.081$), indicating a significant negative association between socioeconomic status and Year 12 stress. This reaffirms that higher socioeconomic status relates to lower stress levels.

Random Effects

- Model 2 introduces random intercepts and random slopes for schools, which allow us to explore whether the association between ses and stress varies between schools.

Interpretation of Research Question RQ3

- **RQ3:** The random effect estimates for schools in Model 2 provide valuable insights. Clarendon has a random intercept of -0.075 and a random slope of 0.238 for ses. Kings has a random intercept of -0.392 and a random slope of 0.070, while Parkvale has a random intercept of 0.467 and a random slope of -0.308.These random effects suggest that the association between socioeconomic status (ses) and Year 12 stress varies across schools. Clarendon shows a positive association, Kings demonstrates a negative association, and Parkvale has a different pattern altogether.

Comparison to Model 1

Model 2 expands upon Model 1 by considering school-specific associations. While Model 1 provided a general relationship between ses and stress, Model 2 unveils the nuanced variations in this relationship between different schools. Therefore, Model 2 provides a richer understanding of how the impact of socioeconomic status on Year 12 stress differs across schools.

Question 6c response (≈250 words):

Question 7:

Graph the random intercepts random slopes model. Provide an interpretation of the graph. What additional insight can be gained about the model from graphing it? What is one practical insight or recommendation you can make based on your findings? Include a copy of the image you have produced as a part of your response.

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Interpretation

The graph illustrates a negative link between stress and SES, indicating lower SES students report higher stress levels. The black line signifies the overall average relationship, while the shaded area is the 95% confidence interval around this average.

The red lines signify random slopes for each school, demonstrating variations in the stress-SES relationship. For instance, "Clarendon" has a steeper slope compared to "Parkvale," implying a stronger connection between stress and SES at Clarendon.

Additional Insights

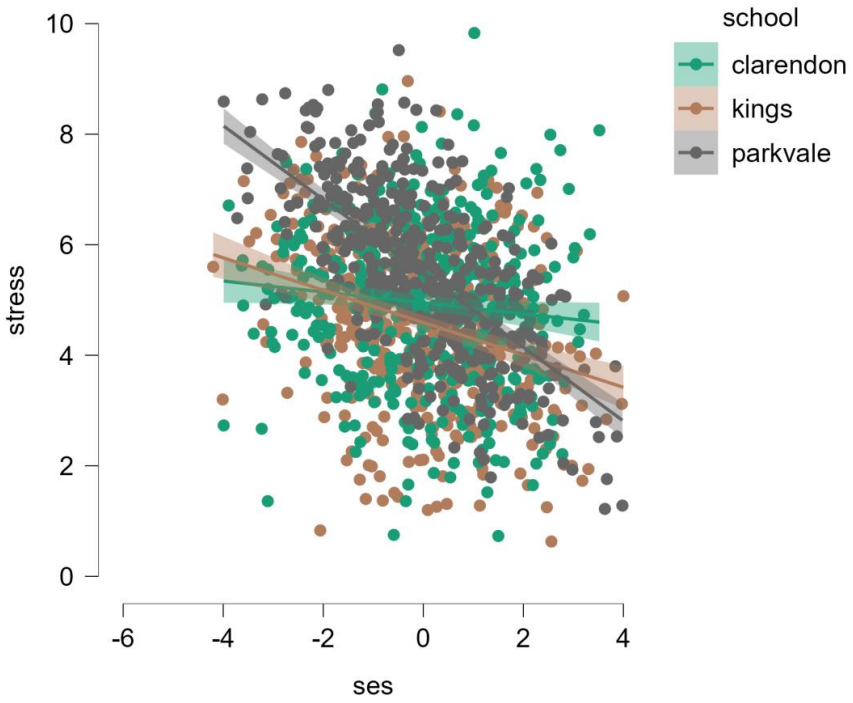
1. Variation Across Schools: Significant variations exist in the stress-SES relationship among schools, implying school-level factors influence this connection.

2. Socioeconomic Vulnerability: Lower SES students exhibit a stronger stress-SES link, suggesting they may be more susceptible to stress's adverse effects.

Practical Insight

Schools should implement stress reduction interventions, particularly for lower SES students. These could involve social-emotional learning, stress management training, and fostering supportive environments. Addressing socioeconomic disparities in education, healthcare, and housing is also crucial to reducing stress for all students.

Graphical Representation



Question 7 response (≈150 words):