Sensorveiledning MAE4011 - Principles of measurement

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Exam 20/12 2018

Task 11

a

i) Give the correct expression for the variance:

$$\text{Var}(Z) = \text{Var}(X) + \text{Var}(Y)$$

or equivalently

$$\text{Var}(Z) = \text{Var}(X) + \text{Var}(Y) - 2\text{Cov}(X, Y)$$

(0.5p)
ii) Correct answer: Var(Z) = 10 + 5 = 15 (0.5p)

b

i) Give the correct expression for the variance:

$$\text{Var}(U) = \text{Var}(X) + \text{Var}(Y) + 2\text{Cov}(X, Y)$$

(0.5p)
ii) Correct answer: Var(U) = 10 + 5 + 2 * 1= 17 (0.5p)

Task 12

$$
\begin{aligned}
E[(X - E(X))^2] &= E[X^2 + E(X) * E(X) - 2 * X * E(X)] &&(+0.5p)\\
&= E(X^2) + E[E(X) * E(X)] - E[2 * X * E(X)] &&(+0.5p)\\
&= E(X^2) + [E(X)]^2 - 2 * E[X * E(X)] &&(+0.5p)\\
&= E(X^2) + [E(X)]^2 - 2 * E(X) * E(X) &&\\
&= E(X^2) - [E(X)]^2 &&(+0.5p)
\end{aligned}
$$

Task 13

i) Calculate the variances correctly. (+0.5p)
ii) Calculate coefficient alpha correctly. (+0.5p)
iii) Interpret coefficient alpha correctly. (+1p)

Each part:

i)

$$\sigma^2_{X_1} = 0.7 \times 0.3 = 0.21$$
$$\sigma^2_{X_2} = 0.5 \times 0.5 = 0.25$$
$$\sigma^2_{X_2} = 0.6 \times 0.4 = 0.24$$

ii)

$$\alpha = \frac{3}{2}\left[1 - \frac{0.21 + 0.25 + 0.24}{1.5}\right] = 1.5 * (1 - 0.7/1.5) = 1.5 - 0.7 = 0.8$$

If answer is built on wrong input from i), but internally correct still get 0.5p.

iii)

Different types of answers and scoring:
Correct answer (example): Under the assumption that a single factor model holds, the reliability is equal to or higher than 0.8, assuming no sampling variance. The reliability can under those circumstances be considered acceptable. (1p)
Partial credit: Mentions a lower bound but not under which conditions. (0.5p)
Partial credit: Mentions internal consistency and correctly states it is acceptable. (0.5p)
Partial credit: Other response which makes sense but is not entirely correct. (0.5p)

Task 14

$$\rho_{X,Y} = \frac{3}{3 \times 4} = 0.25$$

i) Identify correct components to use to calculate the correlation. (+0.5p)
ii) Calculate it correctly. (+0.5p)
ii) Answer the question correctly based on the result, i.e. the relationship is fairly weak. (+0.5p)
iv) Either of the following adds another 0.5p:
- Comment on the reliability of the two tests influencing the result.
- Comment that the correlation measures a linear relationship.

- Comment on the sampling variance being a potential factor.
- Other things that make sense.

Task 15

i) Calculate the SEM correctly. (+0.5p)

$$\text{SEM}(X) = \sqrt{16 \times (1 - 0.75)} = \sqrt{4} = 2$$

ii) Construct a CI consistent with the answer in i): (11-4, 11+4) = (7, 15) If wrong answer from i), still get full marks if correctly defined. (+0.5p)
iii) Interpret the confidence interval correctly (+0.5p)
iv) States either of the following things: (+0.5p)
- Assumes a classical test theory model with homogeneous error terms.
- Assumes a large amount of items on the test.
- Other aspects that make sense.

Task 17

a

All latent variables correctly identified (Calculus, Statistics, Math). (1p)
Only some of them correctly identified or including more than the correct three variables. (0p)

b

Correct answer is 0. (1p)
Any other answer. (0p)

c

Either

$$X1 = \mu_1 + \lambda_{M,1}M + \lambda_{C,1}C + E_1$$

or

$$X1 = \lambda_{M,1}M + \lambda_{C,1}C + E_1$$

gives +0.5p.
Explaning M as the general factor, C as the subfactor and E the variance, and explaining the factor loading interpretation. (+0.5p)

d

Correct answer is the product of the factor loadings for the general factor Math for items X1 and X4, i.e. 0.4 * 0.5 = 0.2. (1p)
Any other answer. (0p)

Task 18

General comment on the predictive validity as showing some prediction performance but lower than the HSGPA. (+1p)
Comment on the criterion used not being a perfect proxy for university performance. (+1p)
Comment on that we are only considering predictive validity and not other aspects of the exam score use validity. (+1p)
Comment that the validity evidence is generally weak for the intended use of the exam scores. (+1p)
Other, similar response which are relevant can get up to +1p, depending on the type of response. Maximum points are 4.

Task 19

a

Justifies an acceptable but not good model fit based on the criteria we have used. (Acceptable fit: GFI > 0.90, RMSEA < 0.10, mean residuals = 0) (1p)

b

Calculate the coefficient omega correctly. (+0.5p) Calculation:

$$(1+1.5+1.5+2+3)^2/[(1+1.5+1.5+2+3)^2+(4+4+3+3+5)] = 81/(81+19) = 0.81$$

Interpret the observed omega as the estimated reliability of the sum score. (+1p)
Qualify the comment with either of the following: (+0.5p)
- Sampling variability.
- Factor model not fitting perfectly means the reliability estimate is not necessarily reflective of the true reliability.
- Other reasonable comment.

c

i) Identify that the information (factor loading squared divided by the unique variance) is the appropriate way of assessing this. (+1p)
If instead using the factor loadings. (+0.5p)
ii) Calculate the information for each item and select the items with the lowest and highest information. Even if calculating the information wrong, still choose consistently from that you obtain full marks. (+1p)

4

Item 1: 1/4
Item 2: 2.25/4
Item 3: 2.25/3
Item 4: 4/3
Item 5: 9/5

So Item 5 adds the most and Item 1 adds the least.
Use factor loadings instead. (+0.5p)
Other reasonable but not entirely correct response. (+0.5p)

Task 20

a

For example:
- Sum scores are not perfectly correlated with sum scores on a depression scale.
- Sum scores have different means for men and women.

Other things can also make sense. One point per correct implication. If listing more than two implications, reduce to one point if the implications are not all correct.

b

0.5p for each of the following aspects being mentioned.
i) Unidimensionality check. (Using a factor model or another statistical model specified that makes sense.)
ii) Comment on establishing reliability for the scale. (Coefficient alpha or coefficient omega.)
iii) Comment on mean differences between men and women. (T-test or multiple group factor model.)
iv) Comment on correlation not being perfect with depression scale scores. (Estimate correlation and associated standard error - possibly adjusting for attenuation.)
v) If mentioning other things that are correct and relevant this can also add 0.5p up to a maximum of 2p in total.

1p for mentioning limitations pertaining to either of the following aspects:
- We can not identify how well we are actually identifying the students who have panic disorder.
- We can not directly extrapolate the results to other populations.
- Other things that make sense, which may give full or partial credit.