Statistics anxiety, self-efficacy, and computational self-concept

Which are the most productive targets for potential improvements in student engagement, transitioning, and success?

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@HEASTEM  #HEASTEM17 #SIHEP
Session: 8.8

Become what you want to be
About me

• Lecturer in Psychology at London South Bank University (LSBU)
  – Modern University with a strong focus on widening participation in HE
• Third year in post
• PhD is in the area of visual cognition
• Teaching quantitative research methods and statistics (QRMS)
• Senior Fellow of the HEA
  – But no ‘real’ experience of pedagogic research

Become what you want to be
Why conduct this research study?

• Quantitative Research Methods and Statistics (QRMS) are a significant part of most psychology degrees in the UK
  – E.g. a third of Level 4 and Level 5 modules at LSBU are QRMS

• Transitioning to HE
  – Many students know or are made aware of the QRMS component (85% - Field, 2014)
  – But students do not have a realistic expectations about **HOW MUCH QRMS** there is in a Psychology degree (Field, 2014)
Why conduct this research study?

• Anecdotes from 10+ years of teaching QRMS, every year many students say:
  • ‘I’m not very confident with numbers’
  • ‘I’m not a numbers person’
  • ‘I just get lost when there are loads of numbers’
  • ‘Even the idea of equations frightens me’
  • ‘I hated maths at school’
  • ‘It’s been ages since I studied maths at school’
  • ‘I think I have dyscalculia’
Why conduct this research study?

- What did I want to find?
  - Is there any empirical evidence to back up this anecdotal evidence?
    - Both in UK universities in general and in a cohort at London South Bank University (LSBU)?
  - Do these anxieties affect academic performance?
  - What can we do about it?
    - What factors are potentially susceptible to intervention?

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Why conduct this research study?

• What we would like to be able to do is:
  – Improve academic performance and success
    • Progression
    • Retention
  – Improve student engagement
  – Lower student anxiety levels
  – Improve student satisfaction
  – … and ultimately NSS scores
What do students think affects their success in QRMS?

- A Higher Education Academy (HEA - Field, 2014) survey of 470 psychology undergraduates across different UK higher education institutions (responses to separate questions):
  - 82% of student respondents said they found quantitative research methods and statistics (QRMS) **challenging**
  - 38% of students would consider themselves as **struggling** with QRMS
  - 21% say they **perform worse** in QRMS modules than in other aspects of their degree
HEA survey (Field, 2014)

• Top **three factors** that inhibit the learning of QRMS from **students** that self-identify as struggling with QRMS (N = 179)
  1. Lack of confidence (70%)
  2. Maths and/or statistics anxiety (54%)
  3. Time elapsed since Maths was last studied (53%)

• Top **three factors** that **staff** believe inhibit their students learning QRMS (N = 78)
  1. Maths and/or statistics anxiety (96%)
  2. Lack of confidence (88%)
  3. Time elapsed since Maths was last studied (31%)

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What do we take from this?

- QRMS seems to be problematic to a sizable proportion of psychology students.

- Students and staff agree that maths/statistics anxiety and lack of confidence (self-efficacy) are the major inhibiting factors to student engagement and success in QRMS.

- Some disagreement with the extent that the time since last studying mathematics has an inhibitory effect.
  - but over half of students believe it to be important.
Where did I start?

• I wanted to:
  – Find empirical evidence to support the anecdotes
  – Investigate the three factors that students self-report as contributing to their difficulties
    • do they actually affect academic achievement?
  – Track these factors longitudinally across the first year of the BSc Psychology course at LSBU
    • Do these factors change ‘naturally’ during the first year of a psychology degree?

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What did I measure?

- Statistics Anxiety Rating Scale (STARS - Cruise & Bolton, 1980)
  - 51 items
  - Six sub-scales

- Asked:
  - How much anxiety would you experience in each of the following situations?
    - 1-No anxiety - - - - 5-strong anxiety
  - Or
    - How much do you agree with the following statements?
      - 1-Strongly agree - - - - 5-strongly disagree
What did I measure?

- Sub-scales of STARS (Cruise & Bolton, 1980)
  - Test Anxiety
    - ‘Doing an examination in a statistics course’
  - Interpretation Anxiety
    - ‘Interpreting the meaning of a table in a journal article’
  - Fear of asking for help
    - ‘Asking one of your lecturers for help in understanding a printout’
  - Fear of statistics teachers
    - ‘Most statistics teachers are not human’
  - Worth of statistics
    - ‘I wish the statistics requirement would be removed from my academic program’
  - Computational self-concept
    - ‘I do not have enough brains to get through statistics’
What did I measure?

• Confidence (conceptualised as ‘self-efficacy’)
  – General self-efficacy scale (GSES - Schwarzer, & Jerusalem, 1995)
    • 10 items
    • ‘No matter what comes my way, I’m usually able to handle it.’
  – Self-efficacy in research methods and statistics Scale (SERMS – a novel scale for this study)

• Time since last studied maths

• Other variables
  – E.g.
    • Age
    • Gender
    • General Anxiety (HADS - Zigmond & Snaith, 1983)
Development of the Self-efficacy in Research Methods and Statistics (SERMS) scale

- Existing measures very specific to that module/course/University

- Asked questions that were not appropriate to LSBU content and skills taught on QRMS modules

- I developed a set of 15 questions (with feedback from other experienced staff and existing students)
  - E.g. ‘I can find the appropriate information in the SPSS output’
  - Responses were on a 5-point scale from ‘not at all confident’ to ‘extremely confident’

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Development of the Self-efficacy in Research Methods and Statistics (SERMS) scale

- **Face-validity**
  - confirmed with feedback from 180 LSBU students and 15 LSBU staff
  - Students feedback actually lead to additional questions

- **Concurrent-validity**
  - Used the Generalized Self-Efficacy Scale (GSES - Schwarzer, & Jerusalem, 1995).
When did I measure?

- Longitudinal study
  - Time 1 (T1)
    - First week of teaching in year one
      - Week 1 Semester 1 (end of September)
  - Time 2 (T2)
    - Last week of teaching in year one
      - Week 11 Semester 2 (beginning of May)
  - Therefore there was approximately a 7 month follow-up

- N = 39
  - Participants who completed questionnaires at T1 and T2
Sample

- N = 39
- 21 female, 3 male, and 15 choose not to disclose
- Mean age = 23 (SD = 7)

- Mean Semester 1 RM grade = 63.51 (SD = 10.50)
- Mean Semester 2 RM grade = 64.73 (SD = 12.13)

<table>
<thead>
<tr>
<th>Class</th>
<th>Frequency Semester 1 RM grade</th>
<th>Frequency Semester 2 RM grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>70+</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>60s</td>
<td>15</td>
<td>13</td>
</tr>
<tr>
<td>50s</td>
<td>8</td>
<td>7</td>
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<tr>
<td>40s</td>
<td>5</td>
<td>2</td>
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<tr>
<td>&lt;40</td>
<td>0</td>
<td>2</td>
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</table>
What did I find? Statistics anxiety at T1

- Statistics anxiety is evident in the cohort of LSBU first year psychology students at T1
What did I find? Self-efficacy at T1

- Students start their degrees with some self-efficacy related to QRMS
Statistics anxiety and academic grades

- Statistics anxiety is **NOT** significantly correlated with academic achievement T1 (similar results at T2)

<table>
<thead>
<tr>
<th></th>
<th>RM module grade Semester 1</th>
<th>RM module grade Semester 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test Anxiety</td>
<td>-.02</td>
<td>-.18</td>
</tr>
<tr>
<td>Interpretation Anxiety</td>
<td>-.24</td>
<td>-.27</td>
</tr>
<tr>
<td>Fear of asking for help</td>
<td>-.12</td>
<td>-.28*</td>
</tr>
<tr>
<td>Fear of statistics teachers</td>
<td>.10</td>
<td>.14</td>
</tr>
<tr>
<td>Worth of statistics</td>
<td>.28</td>
<td>.18</td>
</tr>
<tr>
<td>Computational self-concept</td>
<td>.06</td>
<td>.13</td>
</tr>
</tbody>
</table>

* Indicates significance at uncorrected level of .05
Self-efficacy, time since studying maths and academic grades

- Confidence and time since last studying maths are **NOT** significantly correlated with academic achievement T1 (similar results at T2)

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<th>RM module grade Semester 1</th>
<th>RM module grade Semester 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>General SE</td>
<td>-.10</td>
<td>-.15</td>
</tr>
<tr>
<td>SE for QRMS</td>
<td>.05</td>
<td>.15</td>
</tr>
<tr>
<td>Time since last studied maths</td>
<td>-.02</td>
<td>.08</td>
</tr>
</tbody>
</table>

* Indicates significance at a bonferroni-corrected level of .05
Conclusions so far

• Statistics anxiety is present to varying degrees within the cohort of LSBU psychology students
• Students start their degrees with some self-efficacy related to QRMS
• The three factors self-reported by students as contributing to their struggles with QRMS are NOT significantly related to their level of academic achievement
  – statistics anxiety
  – confidence
  – the amount of time that had elapsed since students studied maths
Changes over time – statistics anxiety

- Statistics anxiety is (mostly) stable across time
- **BUT computational self-concept** INCREASES with exposure to and learning of QRMS

\[ \rho = .001; \]  
**Cohen’s d = 0.577**

* Significance at a bonferroni-corrected level of .05 (\( p \leq .00625 \))
Changes over time – Self-efficacy

- General self-efficacy **DOES NOT** significantly increase over time
- **BUT** self-efficacy for QRMS **INCREASES** with exposure to and learning of QRMS

\[ p = .000004; \text{Cohen’s } d = 0.910 \]

* Indicates significance at a bonferroni-corrected level of .05 (\( p \leq .00625 \))
Conclusions from longitudinal data

• Statistics anxiety remains stable with exposure to, and the learning of QRMS across the first year

• Student’s **computational self-concept** (i.e. seeing themselves as a numbers person) does **SIGNIFICANTLY INCREASE** across the first year

• Students’ **self-efficacy in relation to QRMS** (i.e. their confidence) does **SIGNIFICANTLY INCREASE** across the first year

Become what you want to be
What does it all mean?

• Important to acknowledge and manage student’s beliefs in relation to what affects their performance in QRMS
  – statistics anxiety, confidence, the amount of time that has elapsed since students studied maths (Field, 2014)

• Statistics anxiety may be trait-like in nature and therefore not likely to change
  – Bold conjecture at this stage as there was no direct intervention targeted at this or any other specific factor

• Students’ belief and confidence in their own abilities (self-efficacy) and their concept of themselves can change with engagement with the course content.

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Attempt at an intervention

- I embedded a simple and ‘passive’ intervention in this study
  - The lowest performing students in the semester 1 exam were ‘streamed’ into one seminar group for semester 2 and a second staff member joined that seminar group to offer additional support
  - Not enough students in this seminar group completed the questionnaires to analyse the data

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Streaming: good or bad?

• Hesitant to use streaming
• More focused help from staff vs other students helping and ‘bringing’ the others along with them

• Some good feedback from some students
  – ‘I felt bad at first for being in the class, but I appreciated the extra help, and I think it helped me’
  – ‘Yes definitely’ run it again next year
  – Generally they were happy for the extra help
So what do we do next?

• Increase the sample size and/or replicate results at other universities
  – Ideally from several institutions, where the type and location of university could be measured
  • Urban vs campus/rural university
  • Russell Group vs ‘Red Brick’ vs ‘Modern’ Universities
  – Type of course?
    • Most/all STEM subjects teach statistics to some extent

Become what you want to be
What I set out to do

• What we would like to be able to do is:
  – Improve academic performance and success
    • Progression
    • Retention
  – Improve student engagement
  – Lower student anxiety levels
  – Improve student satisfaction (and NSS scores)?
Gateways to engagement and success

- If self-efficacy and identity are malleable
- Then they can use these as gateways towards improving student engagement and academic success

- Self-efficacy
  - If a student believes they have the skills and resources to overcome the problems set, they will be more likely to engage with the course (and less likely to drop away)

- Self-identity
  - If a student starts to endorse an identity of someone who CAN do statistics, rather than someone who ‘is not a numbers person’ then they will be more likely to engage with the course (and less likely to drop away)
Gateways to engagement and success

• This improved engagement will hopefully lead to greater academic success rates
• As students’ self-concept changes it will begin to be more aligned with the academic goals and strategies of the academics
• Which in turn should promote greater satisfaction with the course

• Can we construct interventions to boost these changes?

• Any questions?

Become what you want to be
Become what you want to be
What did I find? At the start of their degree

- Statistics anxiety is evident in the cohort of LSBU first year psychology students at T1
- Students start their degrees with some self-efficacy related to

<table>
<thead>
<tr>
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<th>Mean</th>
<th>Std Deviation</th>
<th>Min (possible)</th>
<th>Max (possible)</th>
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<tbody>
<tr>
<td>Test Anxiety</td>
<td>23.73</td>
<td>6.41</td>
<td>8</td>
<td>40</td>
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<tr>
<td>Interpretation Anxiety</td>
<td>29.23</td>
<td>10.42</td>
<td>11</td>
<td>55</td>
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<td>Fear of asking for help</td>
<td>9.23</td>
<td>4.18</td>
<td>4</td>
<td>20</td>
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<tr>
<td>Fear of statistics teachers</td>
<td>19.82</td>
<td>4.20</td>
<td>6</td>
<td>30</td>
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<tr>
<td>Worth of statistics</td>
<td>61.34</td>
<td>12.96</td>
<td>15</td>
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<td>Computational self-concept</td>
<td>23.29</td>
<td>6.71</td>
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<td>General SE</td>
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<td>5.52</td>
<td>10</td>
<td>40</td>
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<tr>
<td>SE for QRMS</td>
<td>43.10</td>
<td>9.96</td>
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Changes over time – statistics anxiety

- Statistics anxiety is (mostly) stable across time
- **BUT computational self-concept** INCREASES with exposure to and learning of QRMS

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<th>T2 Mean</th>
<th>Sig (bonferroni-corrected level of .05)</th>
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<tr>
<td></td>
<td>(SD)</td>
<td>(SD)</td>
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<tr>
<td>Test Anxiety</td>
<td>23.73(6.41)</td>
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<td>29.23(10.42)</td>
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<td>Fear of statistics teachers</td>
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<tr>
<td>Worth of statistics</td>
<td>61.34(12.96)</td>
<td>65.76(10.98)</td>
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<td><strong>Computational self-concept</strong></td>
<td>23.29(6.71)</td>
<td>26.74(6.37)</td>
<td>Yes, p = .001</td>
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* Indicates significance at a bonferroni-corrected level of .05 (p ≤ .00625)
Changes over time – self-efficacy

- General self-efficacy **DOES NOT** significantly increase over time
- **BUT self-efficacy for QRMS** **INCREASES** with exposure to and learning of QRMS

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<th>T2 Mean (SD)</th>
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<th>Max (possible)</th>
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<tbody>
<tr>
<td>General SE</td>
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<td>30.69 (6.07)</td>
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<td>10</td>
<td>40</td>
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<tr>
<td>SE for QRMS</td>
<td>43.10 (9.96)</td>
<td>53.27 (11.87)</td>
<td>Yes, p = .000004</td>
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<td>75</td>
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