Electronic Supplementary Information

for the manuscript:

Problem solving in chemistry supported by metacognitive scaffolding: Teaching associates' perspectives and practices

Kimberly Vo[a], Mahbub Sarkar[b], Paul J. White[a], Elizabeth Yuriev[a,*]

[a]Faculty of Pharmacy and Pharmaceutical Sciences, Monash University, Parkville VIC 3052, Australia
[b]Faculty of Medicine, Nursing and Health Sciences, Monash University, Clayton VIC 3800, Australia

* Correspondence: Tel: Int +61 3 9903 9611, E-mail: elizabeth.yuriev@monash.edu

Contents:

Appendix 1: Round 1 interview protocol

1. **Problem-solving workflow Understand-Analyse-Plan-Implement-Evaluate (i.e. Goldilocks)**
   - 1.1. What did you think about using the problem-solving workflow to help teach problem solving?
   - 1.2. Did your students find any of the steps too difficult to perform?
   - 1.3. Do you think students gained confidence as the result of using the workflow?
   - 1.4. Any other comments about the workflow?
2. **Evaluation**
   - 2.1. How did your students feel about having their problem-solving skills evaluated?
   - 2.2. Do you think the evaluation changes how students prepare for/perform in classes?
   - 2.3. Any other comments about evaluation?
3. **Expectations**
   - 3.1. Did you feel clear about what was expected of you in these classes?
   - 3.2. Did your students understand what was expected of them in these classes?
   - 3.3. If you or your students felt confused with respect to expectations, how do you think this lack should be addressed?
   - 3.4. Any other comments about expectations?
4. **Problem sets (Applieds and Workshops)**
   - 4.1. Did you use the problem-solving workflow when preparing for these classes?
   - 4.2. Did your students use the problem-solving workflow when doing in-class problems?
   - 4.3. Any other comments about problems?
5. **Instruction**
   - 5.1. Do you feel you received insufficient, appropriate, or excessive guidance during these classes around the problem-solving process?
   - 5.2. Do you feel you gave insufficient, appropriate, or excessive guidance on problem solving during these classes?
   - 5.3. On average, did your students find prompting questions from TAs useful or confusing?

Appendix 2: Round 2 interview protocol

1. **TA academic background**
   1.1. As an undergraduate student, were you exposed to structured problem solving such as Goldilocks Help?
   a. If yes, how has that impacted your problem-solving abilities?
   b. If no, have you used structured problem solving to solve chemical problems?
2. **Comparison between semester 1 vs. semester 2**
   2.1. Did student engagement with the scaffold differ between semester 1 and 2? If so, how and why?
   2.2. How did the use of Google docs change student problem solving/use Goldilocks Help?
   2.3. In general, how was semester 2 different to semester 1 in terms of teaching/instructing?
3. **TA's perception of students' scaffold use**
   3.1. Can you describe various approaches students use in their problem solving? Give us a couple of 'student types', when it comes to problem solving.
   3.2. Do students engage with the scaffold? (incl. rough percentage that do and don't use the scaffold)
   3.3. Why do students engage with the scaffold? What observable behaviours led to these perceptions?
   3.4. Why don't students engage with the scaffold? What observable behaviours led to these perceptions?
   3.5. Have you experienced students who were overly confident in their perceived problem-solving abilities? If so, did their perceptions align with their actual abilities?
   3.6. Does the level of engagement with the scaffold differ when learning online vs. face-to-face?
   3.7. Fading process
   a. Will students use structured problem solving once the scaffold is not constantly reinforced?
   b. When should we fade the scaffold from students?
   c. How should we fade the scaffold from students?
4. **TA use of scaffold**
   4.1. Do you use structured problem solving or an approach such as Goldilocks Help?
5. **TA teaching with the scaffold**
   5.1. How would you increase student engagement with structure problem solving/Goldilocks helps?
   5.2. Does teaching with the scaffold differ when teaching online vs. face-to-face?
   5.3. Do you think the scaffold causes students to create a 'tick box' attitude? If so, how would you address this to ensure meaningful learning?

Appendix 3: Personal details questionnaire

1. What is your age? _____

2. Are you?

☐ Female ☐ Male

☐ Other ☐ Prefer not to say

3. Is English your first language?

☐ Yes

☐ No

If no, please specify your first language _____

4. Please state your academic qualifications and specify the institution?

☐ PhD _____

☐ Masters _____

☐ Undergraduate degree _____

☐ Other [please specify] _____

5. Do you have any formal postgraduate qualifications in Education (e.g. Graduate Certificate in Education)?

☐ No

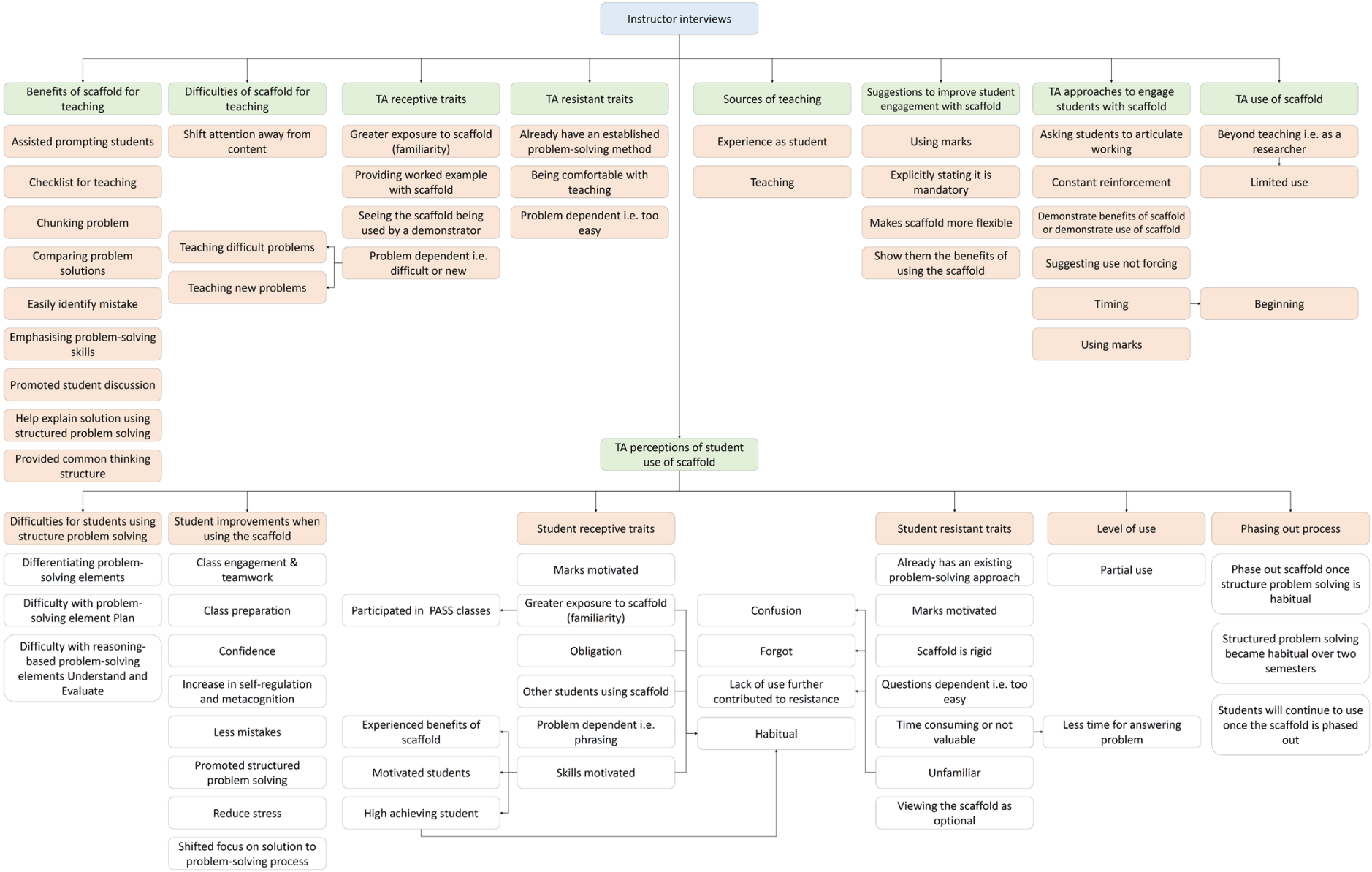
☐ Yes

If yes, please specify _____

6. How many years have you been teaching undergraduate students at the university?

_____

Appendix 4: Codebook tree for instructor interviews (Blue: data analysed, green: theme, orange and white: sub-theme).


Instructor interviews
Benefits of scaffold for teaching
Assisted prompting students
Checklist for teaching
Chunking problem
Comparing problem solutions
Easily identify mistake
Emphasising problem-solving skills
Promoted student discussion
Help explain solution using structured problem solving
Provided common thinking structure
Difficulties of scaffold for teaching
Shift attention away from content
Teaching difficult problems
Teaching new problems
TA receptive traits
Greater exposure to scaffold (familiarity)
Providing worked example with scaffold
Seeing the scaffold being used by a demonstrator
Problem dependent i.e. difficult or new
TA resistant traits
Already have an established problem-solving method
Being comfortable with teaching
Problem dependent i.e. too easy
Sources of teaching
Experience as student
Teaching
Suggestions to improve student engagement with scaffold
Using marks
Explicitly stating it is mandatory
Makes scaffold more flexible
Show them the benefits of using the scaffold
TA approaches to engage students with scaffold
Asking students to articulate working
Constant reinforcement
Demonstrate benefits of scaffold or demonstrate use of scaffold
Suggesting use not forcing
Timing
Using marks
TA use of scaffold
Beyond teaching i.e. as a researcher
Limited use
Beginning
TA perceptions of student use of scaffold
Difficulties for students using structure problem solving
Differentiating problem-solving elements
Difficulty with problem-solving element Plan
Difficulty with reasoning-based problem-solving elements Understand and Evaluate
Student improvements when using the scaffold
Class engagement & teamwork
Class preparation
Confidence
Increase in self-regulation and metacognition
Less mistakes
Promoted structured problem solving
Reduce stress
Shifted focus on solution to problem-solving process
Student receptive traits
Marks motivated
Participated in PASS classes
Greater exposure to scaffold (familiarity)
Obligation
Other students using scaffold
Experienced benefits of scaffold
Problem dependent i.e. phrasing
Motivated students
Skills motivated
High achieving student
Confusion
Forgot
Lack of use further contributed to resistance
Habitual
Student resistant traits
Already has an existing problem-solving approach
Marks motivated
Scaffold is rigid
Questions dependent i.e. too easy
Time consuming or not valuable
Unfamiliar
Viewing the scaffold as optional
Level of use
Partial use
Less time for answering problem
Phasing out process
Phase out scaffold once structure problem solving is habitual
Structured problem solving became habitual over two semesters
Students will continue to use once the scaffold is phased out