Design and development of online learning modules for self-directed study

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Background

- Student behaviors are found to be different in the online settings [Louwrens & Hartnett, 2015]
- While studying at a distance without teacher presence or peer support it remains a challenge

    -To engage student effectively with the learning activity

    -To ensure student to complete the task

The Learning Modules

Topics

Abstract Science concepts

- Modules for inquiry learning on Phase change and Heat
- 50-60 minutes length
- Delivered as web content

Pedagogical Strategy

Technology mediated scaffolding

- Predict Observe Explain and Evaluate (POEE) strategy
- Conceptual, metacognitive and procedural scaffolding

Study Environment

Online mode

- Self-directed
- No teacher support
- No peer support

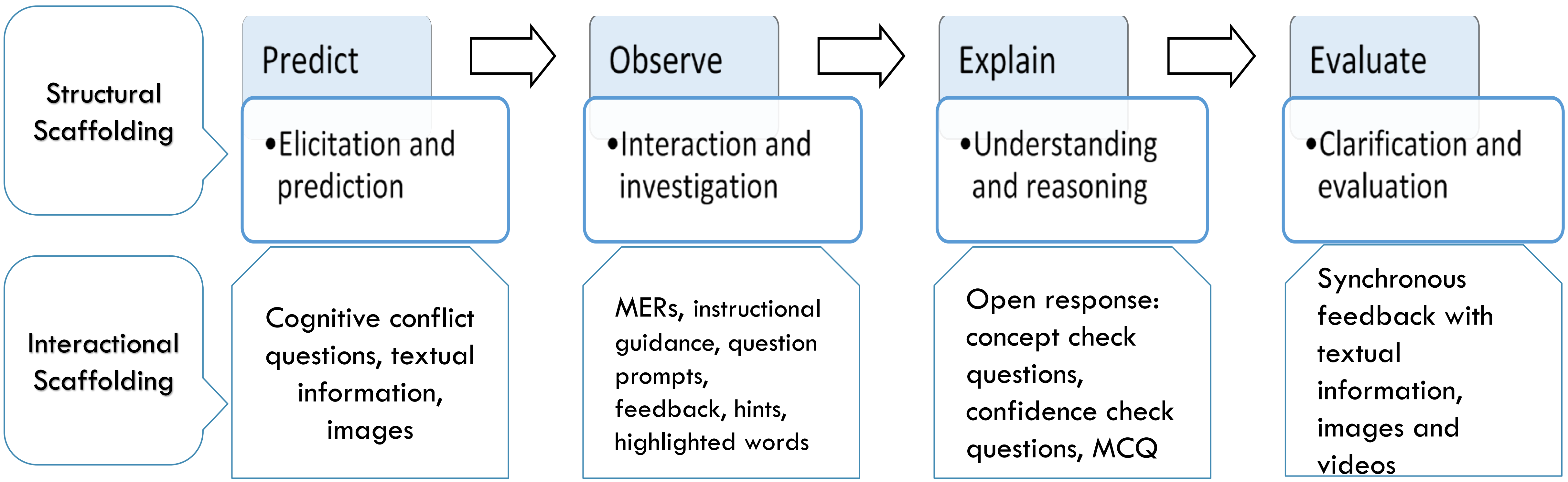
POEE scaffolding strategy

- Original Predict Observe and Explain (POE) strategy for use in traditional teacher supported environment (Gunstone et al., 1981; R. White et al., 1992)
- This study introduced Evaluate (E) Phase to the original POE to provide synchronous FEEDBACK in the self-directed online environment

Predict Observe Explain and Evaluate (POEE) strategy

Scaffolding Strategy

Scaffolding level	Scaffolding tools	Scaffolding support
Level 1 scaffolding	***Predict Observe Explain Evaluate (POEE) strategy:*** Create constructivist environment by providing elicitation, cognitive conflict, opportunity to explain, reflect and evaluate	**Structural scaffolding**: POEE provides sequences of work
Level 2 scaffolding	***Instructional guidance:*** strong or moderately guided activity support students' inquiry	**Interactional scaffolding**: Provide conceptual, metacognitive and procedural scaffolding support
	Multiple External Representations (MERs): macro, sub-micro and symbolic level representations support the construction of mental model	
	Inquiry questions: These provide reflective, elaborative and procedural guidance to students in their inquiry	



Level 1 Scaffolding: Schematic representation POEE strategy

Instructional guidance	MERs used	Functions
Strongly guided	Simulations, animations, videos, textual Instructions, question and prompts, highlighted words	Exploratory learning with detail guidance Students received detailed instruction of what to do to understand the concepts as well as freedom to inquire and explore independently
Moderately guided	Simulations, animations, videos, 'check concept', hints, question and prompts	Exploratory learning with moderate guidance With moderate instruction, students are placed in inquiry learning contexts and asked to explore and understand the concepts.
Open ended (or, minimally guided)	Simulation and videos	Pure Exploratory learning This will create exploratory learning environments, based on the foundation of constructivist and inquiry-based premises. Students might obtain support and guidance from the built-in affordances in the environment

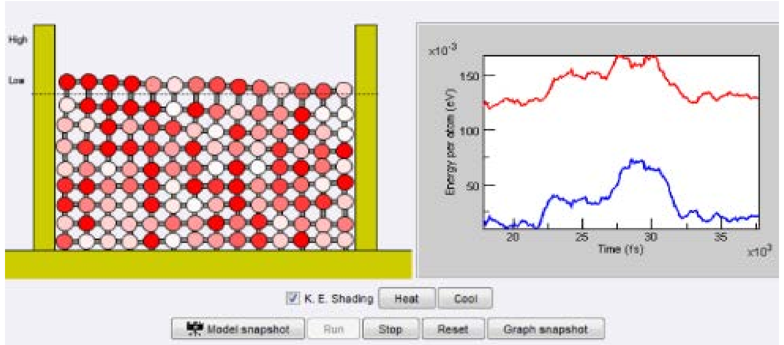
Level 2 Scaffolding: Instructional guidance

MERs	Visual nature	Examples
Symbolic representations	Symbolic	Texts (questions, textual instructions and information, hints, highlighted words)
Macro and sub-micro level representations	Static	images, photos, diagrams
	Dynamic	animations, videos
	Interactive	simulations

Level 2 Scaffolding: Multiple External Representations (MERs)

Macroscopic representation

Sub-microscopic representation



Symbolic representation

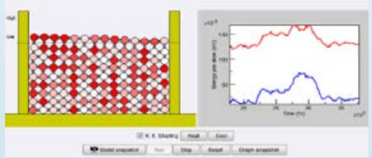
The simulation model shows that a solid responds to heat input by increasing its volume due to increased atomic vibrations. This is thermal expansion. The buckled rail lines are the example.

MERs: Example (extracted from ***Heat*** module)

Inquiry Questions	Functions
Cognitive conflict Questions	Elicit what students know, encourage them to elaborate on their thinking, and help them to resolve the problems
Question Prompts	Encourage students to explore the concepts, look for evidence in the learning modules, guide them to inquire into meaningful and productive exploration
Concept Check Questions	Facilitate students to explain what they have understood, help them to evaluate and reconstruct their knowledge
Confidence Check Questions	Reflect on what they have understood and explain, help them to refine and modify their understanding and scientific reasoning
Multiple Choice Questions	Served the same purpose of concept check questions, e.g., facilitate students to explain what they have understood, help them to evaluate and reconstruct their knowledge by encouraging them to revisit the simulation models

Level 2 Scaffolding: Inquiry Questions

POOE task: Example

POEE Task	Representations	Scaffolding Elements
Predict (P) When you heat a substance, the rise in temperature is not the only thing that occurs on the atomic scale. There are other important changes that can arise from the transfer of heat energy. Think about the following question and explain your understanding in the text box. *Railway lines can buckle in very hot weather. Explain how this might occur in molecular terms.*	 Figure 4.12: Buckled rail lines, Representations of an actual object	-Cognitive conflict question -MERs: image and text
Observe (O) The following simulation shows that a solid responds to heat input by increasing its volume due to increased atomic vibrations. This is thermal expansion. *Click here* to go to the Molecular Workbench simulation entitled: Heat and Temperature: An energy view of heating (extract from page 8). Once you finish the activity, return to this page and do the following concept check activity.	 Figure 4.13: Molecules vibration in solid, representation at the molecular level (simulation model hSim3)	-MERs: simulations -textual instructions -Instructional guidance is minimal
Explain (E) *The iron plate pictured here has a hole cut in its centre. What will happen to the hole when the plate is heated? Explain in molecular terms with reasoning.*	 Figure 4.14: Hole in iron plate, representation of an actual object	-Concept check questions -MERs: image and text
Evaluate (E) Students received synchronous feedback ***Feedback 1:*** First of all, we need to recognise what is occurring on a molecular/atomic level, when the iron is heated. -the iron atoms vibrate more due to the increase in heat energy -each atom takes up more space Consequently, on average each atom is further apart from it's neighbours. This results in "thermal expansion" in the material being heated. Here, the iron plate will expand. It is relatively simple to rationalise that the circumference of the outside of the plate has expanded, but this is not as simple when we consider the inner hole. Imagine the atoms that line the edge of the inner hole (effectively a circle of atoms – see the diagram below). If the distance between them increases, then the circle becomes bigger. In effect, the hole increases in size. ***Feedback 2:*** Watch the video below to see a classic demonstration of this concept using a brass ball and ring.	Feedback 1  Figure 4.15: Thermal expansion, representation at the molecular level Feedback 2  Figure 4.16: Video demonstration, hVid2 (Source: YouTube, https://www.youtube.com/watch?v=V0ETKRz2UCA)	-Synchronous feedbacl -MERs: Images with textual explanation an video demonstration

Results: Key findings from the study

Scaffolding	Engagement	Learning approaches
Multimodal scaffolding strategy showed potential benefits to support self-directed inquiry learning in online settings	-Students required intrinsic motivation from constructivist environment and motivational regulation which is coming from POEE scaffolding strategy	Experienced learners adapted better in the self-directed online context and outperformed novice leaners by demonstrating deep learning approaches
POEE strategy, instructional guidance, MERs, question prompts and feedback	Autonomy, cognitive conflict, prior experience, self-efficacy, comfort and preferences	Prior experience, representational competence, instructional guidance

Results: Factors affect the engagement

Videos	Simulations	Open responses	Feedback
-Videos are simple -Focus only one specific concept -It took less time	-Simulations are complex -Present volume of information -Require interaction and input -Demand both manipulative and cognitive effort	-Create a cognitive workload (and perhaps overload), -Demand physical effort to provide written input -Demand cognitive effort to explain their understanding	-Clarify concepts -Enhance understanding -Stimulate persistence on the task

Results: Student effort level in simulation activity

Instructional Settings	Persistence	Systematic investigation
Open exploration	Low Persistence = 86% High Persistence =14%	0 concept = 43% 1 concept= 29% 2 concepts= 29% More than 2 concepts =0%
Moderately guided	Low Persistence = 33% High Persistence = 67%	0 concept = 0% 1 concept= 50% 2 concepts= 17% More than 2 concepts =33%
Strongly guided	Low Persistence = 25% High Persistence = 75%	0 concept = 0% 1 concept= 0% 2 concepts= 25% More than 2 concepts =75%

Limitation of this study

- Learning modules were designed and develop solely by the researcher. The researcher does not have any professional or certified multimedia designing experience.
- This study does not speak about the questions arise in students mind during their interaction with the learning modules.
- This study assumes that the use of simulations enhances student understanding of the complex scientific phenomena regardless of their experience with the technology.
- Some students may lack even basic computer skills necessary for learning in a computer-mediated, online environment which is not tested for this study.

Further research implications

- Future research in this field should provide further insights into the innovative use of the POEE strategy in online environment. Therefore, further exploration and justification of POEE strategy for learning science concepts in online environment is essential.
- Further research can investigate the factors that influence novice learners' understanding in online environment and can endeavour this issue for a viable solution for a proximal learning environment for novice learners.
- The general understanding originated from this study is that the open or minimal guided activity was not as effective as the guided activity. However, there is a need of doing further research whether these attempts and exploration are really an apparent failure or it has some future effect on students learning.

References

- Gunstone, R., & White, R. (1981). Understanding of gravity. *Science Education*, 65(3), 291-299. doi:10.1002/sce.3730650308
- Louwrens, N., & Hartnett, M. (2015). Student and teacher perceptions of online student engagement in an online middle school. *Journal of Open, Flexible and Distance Learning, 19*(1), *27*
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Thank You

QUESTIONS ?