Milestones that evidence student progression from novice to an expert understanding of the nature of scientific knowledge

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Science graduates must have the skills and habits of mind to tackle the complex, novel problems they will face in 21st Century workplaces (Bybee & Fuchs, 2006). In Australia, these skills have been formalised as a set of national academic standards for science graduates that highlight essential skills in inquiry and problem solving (Jones *et al.*, 2011). One of the most difficult scientific thinking skills to foster, and measure, is a deep understanding of the contestable nature of scientific knowledge. Our past research has used in-depth, longitudinal interviews and assessment submissions to understand how students begin to develop their understanding of the construction of scientific knowledge (Zimbardi *et al.*, 2015). In this study, we triangulated students': 1) responses to a validated concept inventory of scientific thinking skills in biomedical science (Gormally *et al.*, 2012); 2) assessment performance on specific criteria relating to the use of experimental evidence to support claims and critical integration of findings with cutting edge literature; and 3) responses to open-ended questions about how they critically evaluate literature, deal with unexpected findings and propose experiments to address novel physiological research questions. Our results indicate that students do improve on the concept inventory as they progress from 1st to 3rd year, and these scores track consistently with assessment performance on criteria focussing on the use of literature and integration with experimental findings. Furthermore, linguistic inquiry and word count (LIWC; Pennebaker *et al.*, 2015) analysis of the open-ended responses on how students critically evaluate literature, deal with unexpected finances, and propose novel experiments revealed that students with higher scores on the concept inventory and assessment criteria also demonstrated higher levels of analytical insight in their open-ended answers. This study has begun to tease out the specific, measurable milestones that indicate progress as students develop their scientific reasoning skills. This approach also provides valuable insights into how to evidence the progressive learning gains physiology students achieve as they come to understand the contestable nature of experimental scientific knowledge.

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