

Investigating the Impact of Creative Exercises as a Competency-Based Assessment on Concept Integration Across Chemistry Modules and Students' Self-Efficacy

Creative Exercises (CEs) require students to produce relevant and accurate statements and make connections among concepts within a module and between related modules from open-ended prompts. CEs can be used for formative and summative assessment because they enable instructors to assess students' learning, they also reveal students' misconceptions. Due to the interconnected nature of organic chemistry concepts, CE is a suitable assessment tool for this area but CEs in organic chemistry are understudied. This study investigates the impact of a competency-based assessment on polytechnic learners' concept integration across two first year organic chemistry modules and their perception of CEs. It further examines CEs influence on learners' self-efficacy.

A mixed-methods approach analyzed polytechnic students' CE scores and responses to assess conceptual links and common misconceptions. The impact of CEs on self-efficacy was measured using the Motivation Strategies for Learning Questionnaire (MSLQ), and qualitative survey items captured students' perceptions of CEs.

Results from three creative exercises (CE1, CE2 and CE3) administered across two first year organic chemistry modules demonstrated a general improvement in students' performance. In the *Organic Methodologies* module, mean scores increased progressively across the three exercises ($M=8.74$ to $M=9.05$ out of 10). Similarly, in the *Chemical Structures and Reactivities* module, a general trend of increased mean scores ($M= 7.69$ to $M= 8.07$ out of 10) was demonstrated. Content analysis of CE statements revealed common misconceptions about the properties and functional groups of organic molecules.

MSLQ results show students found CEs helpful for foundational concepts ($M = 5.45$, $SD = 1.32$) but less so for challenging ones ($M = 4.10$, $SD = 1.25$). Their expectations for success, in terms of obtaining an excellent module grade, were moderate ($M = 4.37$, $SD = 1.64$). CEs enable instructors to track learning and misconceptions and offer students a means for self-assessment, especially in modules requiring concept connections.

Keywords: Self-efficacy; competency-based assessment; organic chemistry; creative exercises