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Developing and Implementing Learning-Centered Assessments for Measuring Linked Concept in Chemistry

Project Narrative

a. Introductory chemistry is generally taught in a linear manner, in which information builds upon itself. Instructors often expect students to make connections among topics spontaneously in the course. However, students may not understand how individual topics within chemistry are interrelated. As such, students may rely heavily on rote memorization for learning chemistry. Ausubel's Assumptive Learning Theory[1] describes meaningful learning as when the learner actively incorporates new knowledge to prior knowledge and lead to long-term retention. This is in contrast to rote learning, where new knowledge is memorized in isolation and is easily forgotten. Assessments play an essential role in measuring students' understandings in a course and they also send signal to students about what are deemed as important for instructors. The nature of the assessments might change how students approach learning and subsequently impact their achievement in the course. In this project, we would like to develop and implement novel learner-centered assessments that can promote students making connections among concepts and meaningful learning in in CHEM 100 course.

   CHEM 100 course was selected because it has the second highest failure rate among all the courses at CSUN. Also, the report generated by the data champion in the College

of Science and Math has indicated the pass rates in CHEM 100 were highly associated with graduation rates of students at CSUN.

b. The project director of this proposal taught CHEM 100 in Fall 2017, at the end of the semester, she conducted an exit survey and asked students "What is the biggest challenge for you in CHEM 100 class?" Many students indicated that memorizing information is the biggest challenge for them. This data shows that students rely on memorization for learning chemistry instead of understanding and making connections among concepts. Also, students tend to forget the topics they have learned early in the semester if they are not part of the future instruction or exams. Thus, students don't perform well on the cumulative final exam, which contributes to a large proportion of their grades, and lead to high failure rates in the course.

c. I have tried to add a few questions from previous chapters in the later mid-term exams, but I didn't see a sizable impact for student learning. Students don't perform well on those questions from earlier topics because they tend to not review and forget how to do them when they learn new topics.

d. If students are able to make connections among topics in chemistry instead of relying on memorization, they would understand all the topics are interconnected. This would help students to construct coherent and robust structures of the content they learned in the course, and lead to better understanding of the concepts and longer retention. This might also impact students' learning approaches, for example, transfer students from surface learning to deep learning. Beyond students' academic achievement, an instrument measures students' learning approaches (i.e. Study Process Questionnaire)

can be used to collect data on how the assessments impact students' learning approaches.

e. In this project, we are planning to develop and implement two learner-centered assessments **(**Creative Exercises, **CEs &** Measures of Linked Concepts, **MLCs)** in CHEM 100 course at CSUN. In CEs, students are given a simple prompt in chemistry like "3.5 g of HCl reacts with 5.6 g of $AgNO_3$" and asked to write as many statements as they can that are *distinct, correct, and relevant* to the prompt. We termed CEs as a learner-centered assessment because students take an active role in determining what knowledge to be assessed. For example, students can convert grams to moles, identify the types of elements in compounds, and write the chemical reactions between compounds for the above prompt. Most importantly, CEs require students actively make connections between prior knowledge and new knowledge they currently learn in the course. CEs will be used multiple times throughout the semester so that students can build on continuing interconnectivity among concepts. MLCs will be developed based on student responses to CEs, in MLCs, a similar prompt as CEs students along with a series of statements related to the prompt and cover a wide range of prior and current topics in the course will be given to students and ask them to judge the legitimacy of the statements. The assessments proposed seek to provide a method for revisiting prior concepts in different contexts that can allow instructors insight into these perspectives. Also, by placing concepts in different contexts, students can begin to demonstrate a more sophisticated understanding of concepts beyond application in the scenario as presented by instruction and begin to consider application throughout the diverse range of concepts in chemistry.

The implement of the Creative Exercises and Measures of Linked Concepts can be scaled up to more sections of CHEM 100 course if the results of implementing them in my sections are positive for student learning and achievement. The development of assessments in the same fashion can be applied to other disciplines with the aid of content expects in the fields.