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Research Article

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Using Integrative Activities to Reinforce Stoichiometry, Solutions, and Aqueous Reactions Concepts as a Review Technique for Exams

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Abstract

The COVID-19 pandemic has had an impact on children's schooling throughout the world, according to a UNICEF assessment. There are several reasons why students struggle to study for their classes, but one of them is a lack of study habits or pertinence. Instructors can employ active learning to help students improve a variety of skills. Incorporating several teaching strategies that allow students to engage with the content either individually or in groups, is known as active learning. Students can overcome the challenges they face because of the epidemic by developing active learning activities to utilize as a review activity to integrate their information, apply it, and collaborate. In this work, active learning activities were devised, assigned to students over a period, and then assessed. These activities covered classifying aqueous solution reactions, determining empirical formulas, stoichiometry, calculations to prepare solutions, and other topics. When asked whether they thought the activity was relevant to the class on a Linkert scale from 4 to 0, all students responded with a 4 or a 3, and 92.3% said they would use it again to study for the test. In conclusion, incorporating integrative review for an exam with active learning activities is an innovative way to engage students while offering them a chance to employ higher-order thinking abilities.

Keywords: Chemistry, Active learning.

Introduction

The COVID-19 pandemic has had an impact on children's educational experiences across the world, according to a UNICEF assessment. [1,2] There may be several reasons why students struggle to study for their classes, but one of them is a lack of efficient learning methods. Instructors can employ active learning to help students enhance a variety of skills. [3] It is known as active learning by employing various teaching methods that enable students to interact with the material individually or in groups to better grasp it.

Students become engaged in the learning process through an assortment of interactive and practical activities while using active learning methodologies in chemistry. These approaches seek to advance analytical thinking, problem-solving abilities, and a deeper comprehension of chemical ideas. [4, 5, 6, 7] The following are a few possible advantages of active learning in chemistry:

- **Improved conceptual understanding:** Students that actively participate in discussions, experiments, and problem-solving activities have a greater comprehension of chemical principles and concepts, which is facilitated by active learning methodologies.
- **Enhanced problem-solving skills:** Students' analytical and problem-solving skills can be developed by active participation in the solution of chemical challenges, which will help them better handle challenging chemical situations.
- **Increased retention of knowledge:** Repeated exposure to concepts through various activities, such as group discussions, experiments, and simulations, is a common component of active learning methodologies. The multimodal method can help students retain their understanding of chemistry over time.
- **Enhanced critical thinking:** Higher-order thinking skills are promoted through active learning practices, which engage students to analyze and evaluate chemical information, draw connections between ideas, and think critically about experimental findings.
- **Improved communication skills:** Active learning often involves group work, presentations, and discussions, which can help students develop effective communication skills in conveying their ideas and scientific findings.

Active inquiry, cooperative learning, and peer teaching are three active learning practices that have been utilized for many years in chemistry to motivate students in the classroom [8]. Students can overcome the challenges they face because of the epidemic by developing active learning activities to utilize as a review activity to integrate their information, apply it, and collaborate. The truth is that general chemistry students benefit considerably from and adapt to the efforts that can be introduced into the classroom, even though they may not always be very actively engaged in the learning process. [9,10].

Stoichiometry and mole are two of the topics that the students have the most trouble understanding, as Ralph et al. [11] noted in their studies. This suggests that new methods should be created to help students who are enrolled in the General Chemistry course and are having issues with understanding these and other subjects. According to Rhoads and Healy [12], students' test performance is significantly impacted by their pre-test activities.

Matošková et al. [13] investigated what may be responsible for a student's success in his or her academic career. Among the factors they investigated were skills, behavior, circumstances, traits of character, and results. Behavior is the one that stood out and a successful student must have basic behavior characteristics. These characteristics are continuous preparation for school, attendance at lectures, active searching for information, participation in voluntary activities, and getting practical experience.

Concerned about our students, we asked ourselves: Will we be able to design an activity that can integrate several concepts from the test? Will this activity be interesting enough for the students? Will it help students review for the test (exam)? Would students be interested in having more activities like this for other topics?

We hypothesize that the development of this integrative activity designed to cover several topics for the exam will be beneficial to the students. They will be able to apply their knowledge to a situation that is interesting to them and will result in better performance on the exam. We also believe that students will find the activity useful enough to want more of these activities and that the one used could be considered for review on another occasion when the topics covered are asked.

Methodology

An integrative prior-to-exam activity was designed (see supporting information). With this activity, students had the opportunity to practice many of the topics that would be included in the course exam. The topics covered were: A. Determine the empirical formula of a compound B. Classify electrolyte and non-electrolyte C. Classify salt, base, or acid D. Preparation of solutions from a solid E. Preparing solutions from a concentrated solution F. Calculate the molarity of a solution using the density and percent by mass of a solution G. Write a double displacement reaction and write the molecular, total ionic, and net ionic equations H. Review and classify the type of aqueous reactions I. Stoichiometry of reactions in solution J. Percent yield. The integrative activity had a narrative of a situation in a laboratory and the topics were developed around that situation having themselves as the main characters.

The assignment was initially carried out in the classroom. Students assembled in groups of two to three in the classroom to discuss the questions that needed to be solved. Students had three to four days after the face-to-face session to submit the assignment via Moodle. The document had to be manually edited and submitted as a pdf document.

The students were then given a survey to fill out to gather their thoughts and feelings regarding the review activity. The methodology of this study is summarized in Figure 1

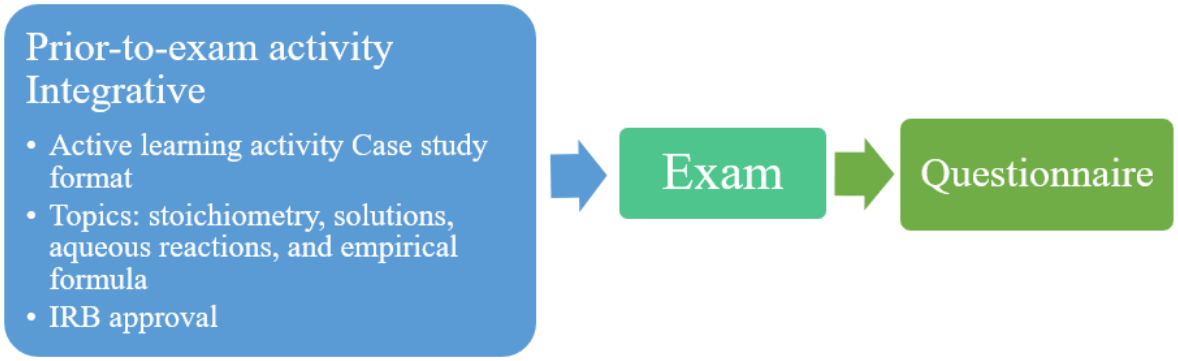

Figure 1: Summary of the process followed in this study

Results

After evaluating the data collected from the students and their grades, we observed that, as shown in Figure 2, those who submitted the activity obtained, on average, higher grades than those who did not. The average and standard deviation for those who engaged in the activity was 61 ± 20% (blue) and 38 ± 21% (red), respectively. We can assert that individuals who turn in assignments typically perform better on the tests, however, we cannot state for sure that the activity was what enabled them to do better.

After analyzing the data obtained from the students and their grades, we found that on average, those that turned in the activity obtained better grades than those that did not turn it in as seen in Figure 2. A 61 ± 20% (blue) was the average and standard deviation for those who turned the activity and 38 ± 21% (red) for those who did not. Although we cannot say with certainty that the activity was what allowed them to do better, we can infer those individuals who submitted their assignments typically performed higher on the exams. This is consistent with other authors' arguments that behavior is important for a student to succeed. Completing all the exercises required to understand the information covered in the exam is a crucial component of the behavior to succeed.

Figure 2: Comparison of the grades obtained by those who turn in the activity and those who did not.

Most of the students expressed interest in including additional similar experiences when asked whether they wanted more integrative activities to review for tests. Figure 3 illustrates that 15% of respondents agreed that they would be receptive to receiving these activities as exam preparation, while 81% of respondents said they completely agreed. This can be because it enables individuals to actively engage through the practice of exam-relevant concepts.

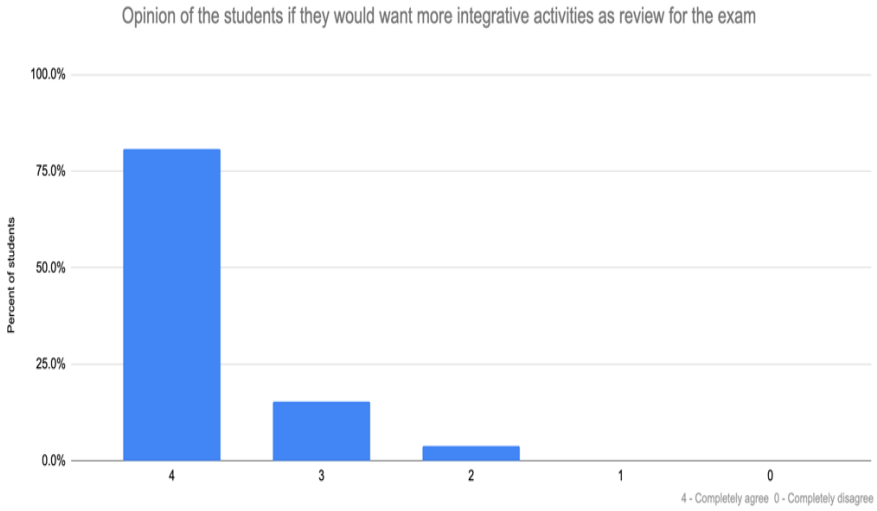

Figure 3: Graph of the opinion of the students regarding if they want more integrative activities as a review for the exam. 4-Completely agree, 0-Completely disagree

Additionally, students were questioned about their understanding of the activity's benefits for exam preparation, if they would use it again to review for exams, whether they had enough time, whether the activity was enjoyable or fascinating, and whether it was pertinent to the course. When asked if the activity helped them prepare for the test, the students' responses revealed that 23.1% agreed and claimed that it did, while 69.2% said they absolutely agreed. When asked if the review activity was enjoyable or engaging, 42.3% indicated they completely agreed and 42.3% agreed. When asked if the activity was appropriate for the class, 80.8% and 19.2% respectively responded that they completely agreed and agreed. These findings suggest that the students found the activity to be a fun and engaging approach to learning about and reviewing the material that would be presented on the test.

There were ten subjects in the activity. The topics included were: A. Determine the empirical formula of a compound B. Classify electrolyte and non-electrolyte C. Classify salt, base, or acid D. Preparation of solutions from a solid E. Preparing solutions from a concentrated solution F. Calculate the molarity of a solution using the density and percent by mass of a solution G. Write a double displacement reaction and write the molecular, total ionic, and net ionic equations H. Review and classify the type of aqueous reactions I. Stoichiometry of reactions in solution J. Percent yield. We queried the students on whether they thought the exercise adequately addressed the subjects. Most of the learners thought they were covered in all subjects. Figure 4 shows that, overall, students thought the topics were covered. Some students felt that topics such as classifying electrolyte and non-electrolyte, classifying salt, base, and acid, calculating the molarity of a solution using the density and percent by mass of a solution, writing a double displacement reaction, and writing the molecular, total ionic, and net ionic equations, and reviewing and classifying the types of aqueous reactions were left out even if the task was requested in the inquiry.

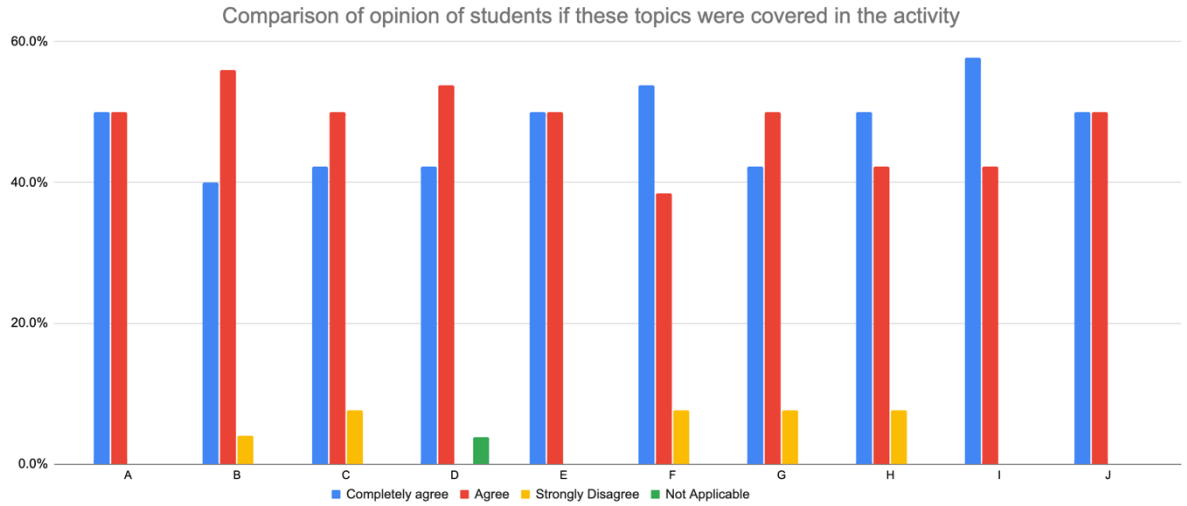

Figure 4: Opinions of students about if they felt that the topics were covered by the activity. A. Determine the empirical formula of a compound B. Classify electrolyte and non-electrolyte C. Classify salt, base, or acid D. Preparation of solutions from a solid E. Preparing solutions from a concentrated solution F. Calculate the molarity of a solution using the density and percent by mass of a solution G. Write a double displacement reaction and write the molecular, total ionic, and net ionic equations H. Review and classify the type of aqueous reactions I. Stoichiometry of reactions in solution J. Percent yield

Conclusions

In conclusion, employing integrative activities as exam review techniques is a fun and effective way to involve students and encourage them to forge deeper connections. Activities that are more formative approaches to reinforce what students have learned are needed. More research should be done on the impact of these activities on exam grades. Even though it may take some time to comprehend and complete these exercises, students prefer the idea of using them as test preparation.

Associated Content

Supporting Information

The Supporting Information is available using the next QR Codes:

English Spanish

Conflict of Interests

The author declares no conflicts of interest.

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