Helping students decode primary literature with a collaborative CREATE approach

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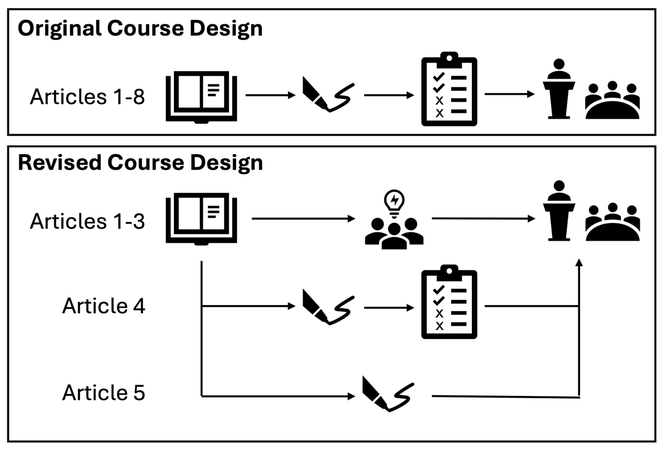
Study Context

Engaging effectively with primary scientific literature is a critical learning outcome in undergraduate education, however, students often face challenges in developing the confidence and skills necessary to interpret and analyze such literature.[1] One way to address these challenges is the CREATE method. CREATE is a scaffolded approach that includes **C**oncept mapping the introduction, **R**eading and annotating the methods and results section, **E**lucidating the hypothesis for each experiment, **A**nalyzing and interpreting the data, and **T**hinking of the next **E**xperiment.[2,3] While previous studies have demonstrated the ability of CREATE to improve data interpretation, reading confidence, and critical thinking, the approach has primarily been used as an individual activity. In this study, we adapted the CREATE method for group-based learning in a third-year bachelor-level chemistry course.

Course Details

The course concept is that students read primary literature in the form of scientific articles with the end goal of having a productive group discussion with one of the authors of the paper. The means in which students prepared themselves for this discussion differed between the 2023 and 2024 cohorts.



Group-Based CREATE Method

Individual Preparation	Group Activities in Class
• Read assigned article • List keywords • Highlight and look up unfamiliar terms • Identify the research question(s) • List all experiments performed • Complete Figure Analysis chart • Summarize introduction and conclusions	• Make a concept map of the introduction • Diagram the experimental design, including identification of experimental hypothesis • Brainstorm future experiments

Figure 1: *Original Couse Design*: Students wrote critical essays on 8 assigned articles and received feedback from the instructor. *Revised Course Design:* Students used the group-based CREATE method for articles 1-3, then wrote a critical essay for articles 4 (with peer feedback) and 5.

Student Confidence Survey

Students were administered a modified version of the survey designed by Lie, R., et. al as a pre- and post-survey.[2] The survey measured the following five factors:

Decoding Literature	
D1	The scientific literature is difficult to understand
D2	When I see scientific journal articles, they look hard to read
D3	I am not intimidated by the scientific language in journal articles
D4	I am confident in my ability to critically review scientific literature
D5	I am comfortable defending my ideas about experiments
Interpreting Data	
I1	It is easy for me to transform data, like converting numbers from a table to percentages
I2	If I see data in a table, it is easy for me to understand what it means
I3	If I am shown data, I am confident that I can figure out what it means
I4	It is easy for me to relate the results of a single experiment to the big picture
Active Reading	
A1	I could make a simple diagram that provides an overview of an entire experiment
A2	If I am assigned to read a scientific paper, I typically look at the methods section to understand how the data were collected
A3	I do not know how to design a good experiment
A4	The way that you display your data can affect whether or not people believe it
Visualization	
V1	When I read scientific literature, I usually look carefully at the associated figures and tables
V2	When I read scientific materials, it is easy for me to visualize the experiments being done
V3	If I look at data presented in a paper, I can visualize the method that produced the data
V4	When I read a paper, I have a clear sense of what physically went on in a lab to produce the results and information I am reading
Science Thinking	
S1	After I read a scientific paper, I don't think I could explain it to somebody else
S2	I am confident I could read a scientific paper and explain it to another person
S3	I enjoy thinking of additional experiments when I read scientific papers
S4	I accept the information about science presented in newspaper articles without challenging it

Survey Results

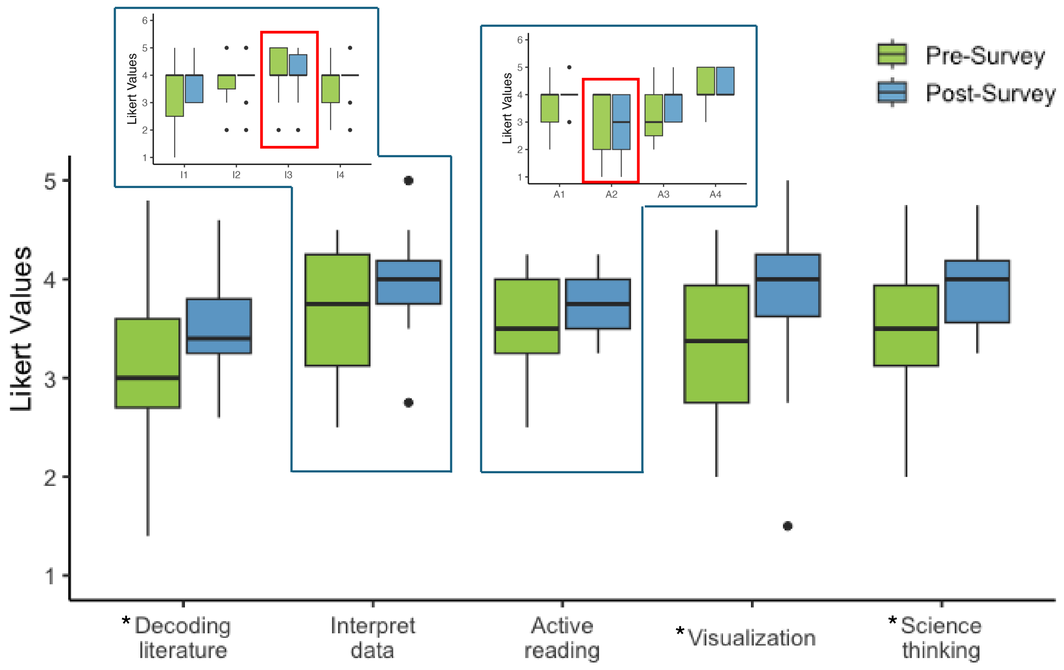


Figure 2: Averages of the survey items associated with the five factors. Pre-survey scores are green; post-survey scores are blue. Responses were given on a five-point Likert scale: 1 – strongly disagree, 2 – disagree, 3 – not sure, 4 – agree, 5 – strongly agree. There was an increase from pre- to post-survey scores across all factors, with significant increases indicated by an * ($p < 0.05$). Inserts show the only two survey questions where there was a decrease in score from pre to post.

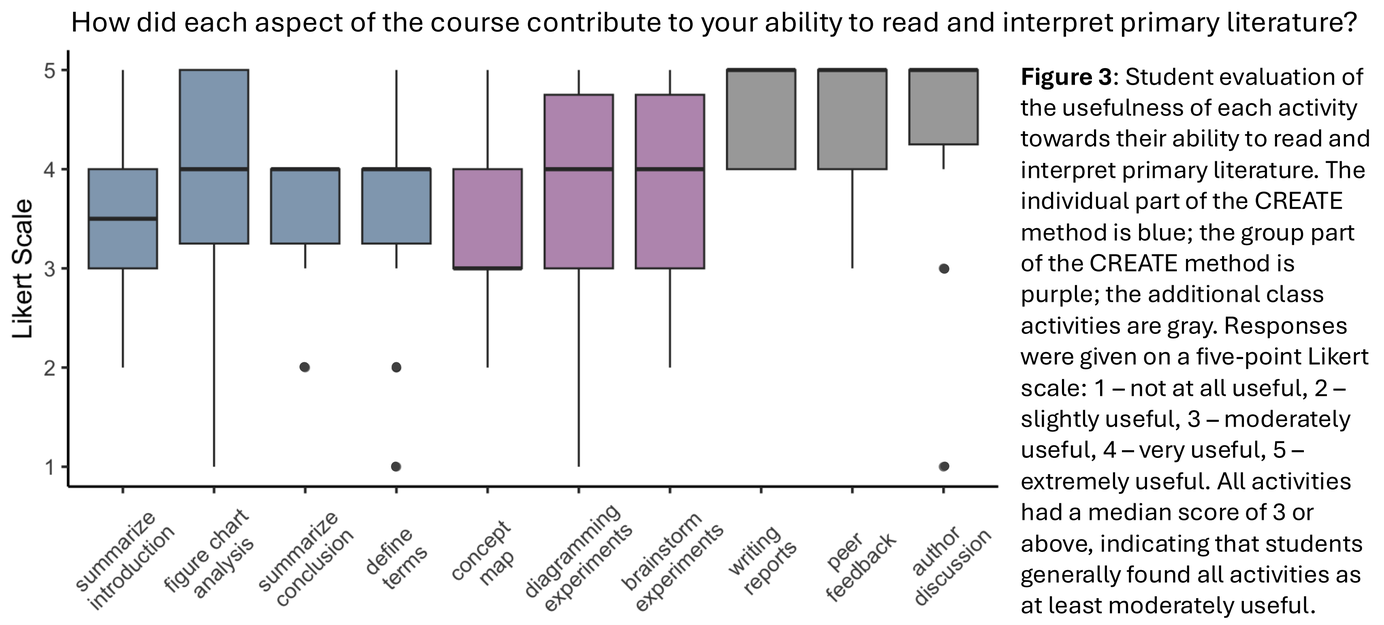


Figure 3: Student evaluation of the usefulness of each activity towards their ability to read and interpret primary literature. The individual part of the CREATE method is blue; the group part of the CREATE method is purple; the additional class activities are gray. Responses were given on a five-point Likert scale: 1 – not at all useful, 2 – slightly useful, 3 – moderately useful, 4 – very useful, 5 – extremely useful. All activities had a median score of 3 or above, indicating that students generally found all activities as at least moderately useful.

Text Analysis

We analyzed student texts using the Critical Thinking VALUE Rubric[4] to determine if students exposed to CREATE were able to write a sufficient critical essay on a research article despite spending less time on writing. Scores are out of 4 points.

Rubric Items	Original Course			Revised Course	
	Article #3	Article #6	Article #8	Article #4	Article #5
Explanation of Issues	2.2	2.7	2.0	3.5	3.1
Evidence	2.4	2.3	1.5	3.0	2.6
Context & Assumptions	2.3	2.4	1.5	2.8	2.7
Student's Position	2.6	2.4	1.8	3.2	2.9
Conclusions & Outcomes	1.8	2.1	1.9	3.2	3.1

Student Interviews

We conducted 10-minute interviews with 4 students via Teams. Quotes have been edited for clarity.

CREATE made reading articles easier

"I think you really get the tools to find a way which works for you to really understand it and fully get all the things and all the graphs and stuff like that." (Student A)

"Being led was really useful, which is really not happening if you're just writing." (Student B)

"I think I did start to analyze articles in a little bit of a different way and that makes it feel a little less scary, but I think it still remains if you see that it is a very long paper, it's still like, oh, I have to get through all that." (Student D)

Students preferred different aspects of CREATE

"When you write down the keywords and write down a little summary of everything, then you really have to conceptualize it in your head and not only have the vague idea that you know what it's about." (Student A)

"I also quite liked the diagram for the figures. Sometimes it's quite hard to get from the article the hypothesis that the authors had, or maybe the specific methods, and really having to fill out that complete figure table really lets you dig deep into the article" (Student D)

The group portion of CREATE was viewed positively

"Because you have different opinions then you can better understand the actual idea behind the paper, instead of what I thought the idea was." (Student A)

"The talking about it with other people was also really nice because I feel you don't understand something until you have to explain it." (Student B)

"Sometimes you either interpret something wrong or other people have interesting insights, and then you get to learn from their experiences." (Student D)

Some parts of CREATE were seen as transferable

"if I would imagine myself being in a research group, I would try to implement something similar. Sometimes we collaborate for presentations but for a scientific literature reading there aren't that many group activities. I would try to spark ideas with other colleagues and friends in the future." (Student C)

"I do think that now I go through the figures in a similar approach. I would previously just look at the figure entirely. I now go through every panel." (Student D)

Conclusions

It appears that the CREATE method was a success:

- Students showed an increase in confidence when reading primary literature.
- The figure analysis and group discussions were found to be beneficial, and students felt they could use these techniques in the future.
- Despite not spending much time writing, students exposed to CREATE did just as well if not better when writing critical reviews of the articles they read.

References

[1]Lie, R., et al. **2017** *CBE-LSE*, 15(4), 1-12.
[2]Hoskins, S.G., et al. **2011** *CBE-LSE*, 10(4), 368-378.
[3]Goodwin, E.C., et al. **2023** JMBE., 24(2), 1-14.
[4] Association of American Colleges and Universities. *VALUE Rubric: Critical Thinking*. AAC&U. Accessed June 3, 2025. https://www.aacu.org

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