This is the second edition of a publication of the Towns Research Group, Division of Chemical Education, Department of Chemistry, Purdue University. The purpose of the literature review is to review and share relevant chemical education research literature with fellow group members, university colleagues, and the chemical education research community at large. Please feel free to direct questions about this publication to Dr. Marcy H. Towns (mtowns@purdue.edu).

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This article from the American Journal of Physics is part of a special issue on the use of computational methods in introductory college-level physics courses. The potential benefits of are numerous. According to Buffler, Pillay, Lubben, and Fearick (2008) computational modeling can help students develop mathematical problem-solving skills while developing a better understanding of physical systems through modeling and visualization. Additionally, since modern physics relies heavily on computational models, a teaching approach focused on computational problems brings undergraduate physics courses closer to authentic practice and highlight the nature of science.

With these benefits in mind, the authors presented a model of physics that they suggest may be used as a framework for designing computational exercises for students. The model focused on describing how physicists translate between physical theories, real-world phenomena, and conceptual models. Buffler et al. described how this model works in a classroom setting, reporting on a recent case study in which freshman physics students completed a computational exercise based on the model. Students were guided through a process similar to that of physicists modeling real-world scenarios in which they were to describe the path of a thruster-propelled spaceship. Students were then asked to sketch the path of a spaceship and describe the physical forces acting on the spaceship. Students then were to describe the system mathematically and convert the mathematical model to a computational model using VPython software.

Analysis of students’ written responses to the worksheet suggested that for the computational project to be effective the objectives related to the project should be made more explicit. One way to address this problem might be to include more information about the physics-model and give a rationale for the activities in the worksheet. The authors noted that teaching assistants, who mostly assisted with programming during the activity, could assist in instruction if they would check for correctness of the student’s mathematical models before helping with programming syntax. Teaching assistants could be more effective if they were asked to be part of the instructional team and made aware of the educational objectives of the activity (i.e. the model framework) before the activity. The author’s future work will address these concerns and build upon the current study.


This study compared two pedagogical approaches, traditional lecture with cooperative learning and limited numbers of lecture in biochemistry. The goal of the study was to determine if students understood biochemistry topics better when they used cooperative learning versus traditional lecture. Cooperative learning involves students working together to solve a problem. With this teaching style, students are able to learn the material in addition to improving their communication skills by working as a team.

The cooperative learning teaching style was use in two years of a biochemistry course for optics and optometry methods: 24 students in 2004-2005 and 20 students in 2005-2006. Topics taught ranged from proteins to metabolism and lasted between one to four hours depending on the difficulty of the topic. Each day, students were responsible for reading course material individually, and then work problems within small groups (2 or 3 students). At the end of each lesson, students were asked to provide written or verbal materials to the group and teacher. The instructor used this information to guide any needed lectures on difficult topics and
explain misconceptions. An example lesson plan can be found in the article (p. 36).

The results of this study revealed that 81% of students from 2004-2005 and 70% of students from 2005-2006 passed the course, as compared to 22% and 40% when this course was taught with lecture only in 2002-2003 and 2003-2004 respectively.

The students reported positive and negative feedback about cooperative learning with short periods of lecturing. Positive comments included: studying at home was easier, left class with the lesson learned, difficult items were easier to learn, and students helped one another when something was difficult. Some negative comments dealt with faster students having to wait for slower students, the difficulty to get use to this new type of learning method, and feeling lost if they didn't attend class. Overall, this study outlined a different approach to learning biochemistry that could be used in other courses.

CHEMICAL EDUCATOR


Brammer, Nelson, and Hallman (2007) conducted a survey of organic chemistry professors from the Big 12 universities (Oklahoma, Oklahoma State, Texas, Texas A&M, Texas Tech, Baylor, Kansas, Kansas State, Nebraska, Colorado, Iowa State, and Missouri) to determine the role of teaching assistants in undergraduate organic courses. The survey came about largely because of students at the Oklahoma University voicing concerns about the level of individual attention received and the perception of needing to do well in organic chemistry. The authors decided to investigate how other competing institutions fared to make a comparison because Oklahoma University does not have teaching assistants available for lectures.

Data were collected using survey information from professors who were the primary instructors of organic chemistry at their institutions. Questions included average enrollment, number of staff, TAs, etc. that were being paid to help with the lecture, and roles that such staff had in running the course. Results showed that most institutions (ten of the twelve) hire TAs for their courses, but only six institutions used TAs to provide discussion sessions for lectures. TAs were hired to assist in grading papers, exams, and quizzes. Oklahoma University has thus begun to hire TAs to conduct discussion sessions for their organic lecture classes.

INTERNATIONAL JOURNAL OF SCIENCE EDUCATION


This case study considered a scientific argumentation activity based on Toulmin’s model of argumentation. These activities are a method to increase a learner’s understanding of science concepts and to explore identities in classroom science settings. Argumentation discourse is suggested as a way to get learners involved in a community of practice that mimics the way scientists’ reason and evaluate data, and as a way to get students to evaluate their existing scientific knowledge by constructing new knowledge from the understandings of their peers.

After taking a non-graded quiz, two classrooms of 10th and 11th grade students in a BioBLAST biology course (curricula developed by NASA) reviewed quiz answers by forming small groups, and arguing for their quiz answers by presenting Toulmin-style arguments. Students were instructed on Toulmin-style argumentation before taking part in the activities. Students watched a cartoon video in which the parts of an argument were explained and sample discussions were demonstrated. Pre and post-instruction tests were administered and the
activities of one group (of three students) were recorded and coded for evidence of use of the various parts of
the argument (i.e. claim, data, warrant, backing, rebuttal, and qualifiers).

The three student’s level of engagement in the activity varied considerably, and student gain scores from
the pre/post tests increased with level of involvement. The authors noted that just because students are arguing
does not mean they are learning. Cross et al. asserted that learner engagement in the activity, adequate prior
knowledge, and effective teacher facilitation of arguments are critical to ensuring that each student contributes
and has a meaningful experience.

**LIFE SCIENCES EDUCATION**


O’Day (2007) presented a good introduction into how animations compare to still visual representations.
Yet, O’Day points out one key factor that needs to be realized: many animations available on the World Wide
Web do not have narration. This has the implication that students will not have access to this feature when
viewing these visual representations (p. 217). O’Day explored the use of animations versus still images
comparing the retention of the information to Ebbinghaus’s forgetting curve.

O’Day made animations and still images of cholesterol uptake using Power Point. In addition, O’Day
created the apoptosis animation and still images using Corel Draw 7.0. Graduate students administered the test
to compare animations to still images. The students were given ten minutes to study the respective
representations. Following this, the students were given a 10 question survey. The survey was then given 21
days later to check for long-term memory retention. One note of interest is that there is a complexity level
assigned to the topics that are not the same. The cholesterol uptake representations are ranked at a simple
complexity, and the apoptosis representations are ranked at moderately complex as defined by the author.

Students (80.9%) found the visuals useful for the experience that the representations gave. This study
compared the use of Hermann Ebbinghaus’s forgetting curve. At 21 days the amount a person should
remember is about 21%. What the study found that the amount of information remembered is higher than 21%.
The author suggested that the increase in the retention might in part be based on “the relevance and the
nonrandomness nature of information” (p. 222). Yet, I am still concerned about the context that the animation
is given, because I do not know anything about the course structure around this intervention. I wonder if the
course was actively exploring these topics before, during, or after the intervention. The information gathered
lead to these results: “animations provide a better learning experience, leading to great retention” (p. 222),
“animation leads to better memory retention regardless of to the nature of the material being learned” (p. 222),
and uses the results of this work to support that notion that narration is important in biological animations.

The author is quick to point out that the survey needs to be better defined. When I went back over the
questions and reviewed them, the classifications that I gave to some of the questions were different than that of
the authors. While most of the question we agreed on, there were a few that I questioned the validity for. In the
set apoptosis, one question looks at the order, but the answers to the question are very similar and a student
could miss read the line and still know the correct answer. The specificity of this question is rather precise for a
ten minute review of the material. Concerning cholesterol uptake, without narration and the speed that some of
the information is shown, I am not sure if the student would be able to pick out the information needed. With
the design of the representations, I am not convinced that students would know about conformational changes in
a protein depending on the position in the course. Yes, this could be covered in an earlier course, but looking at
the representations themselves it is difficult to note because the simple nature of the representation. Also, in
another question, the students have to infer what will happen, because the information is not given on the
animation. I am not sure what the relevance of this question is to the two representations styles that are being
explored.
I question this paper because it does not show significance the results of the data. I know that the author is comparing the questions back to Ebbinghaus’s forgetting curve, but without significant difference, how can a conclusion be drawn to show that one version of representation is better. While I may agree with the results that the author has presented, I have to question the strength of the results because of the lack support that is given to them without showing a significant difference in the two representation styles.

**SCIENCE EDUCATION**


Russ, Scherr, Hammer, and Mikeska (2008) discussed the need for the addition of another dimension to the definition and description of ‘scientific inquiry.’ The authors began with a commentary concerning inquiry and the difficulties associated with it. Scientific inquiry has been described as a method of student investigation into scientific ideas related to the processes of true science, such as data interpretation, experimental design, etc. (p.500). Russ et al. argued that true science involves a “causal mechanism,” (p.500) involving intense argumentation skills and that scientific revolutions in science are not reflected in current science education practices. “A challenge for science education, however, is that there has not been the same progress with respect to making explicit what constitutes mechanistic reasoning as there has been in making explicit what constitutes controlled experimentation or scientific argumentation” (p.501)

Thus, the authors presented a need for such a component to be added to the working definition of school scientific inquiry. This argument is developed from both a historical/philosophy of science perspective and a psychological/cognition perspective. According to the authors, student mechanistic reasoning has several criteria: it is “nonteleological,” (p.502) meaning that it is not based on simple explanations of an observation, but rather, is derived from actual understanding of a phenomenon. Mechanistic reasoning is also “causal,” “built from experience,” and “describes underlying or relevant structure” (p.503-504). These descriptions (explained in detail in the manuscript) provide a functional definition of mechanistic reasoning as executed by students. The authors then contrasted the student model to the cognitive processes of scientists, and described approaches for finding mechanisms in practicing science (p.507-511). Based on an earlier discussion in the paper, the authors argued that mechanistic reasoning is a sound method of incorporating authentic science into classrooms.

To validate claims on the value of mechanistic reasoning, the authors presented data analyzed using discourse analysis (p.512-517). The goal of data collection was to describe mechanistic reasoning in a science classroom, illustrate what mechanistic reasoning is and can be used to teach about science. Data indicated that even young children are capable of mechanistic reasoning, and that this is an area open for continued investigation.