This is the third 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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Students in physics classes must learn to express simple ideas with equations, and interpret equations as appropriate. Teachers may assume students are competent in math skills necessary to manipulate these mathematical expressions while students actually struggle with concepts learned in previous math courses. In this study, the authors attempt to develop an understanding of how students use calculus by interviewing students of varied abilities from two calculus-based physics classes.

Students participated in three interviews using a think-aloud protocol. Two of the interviews focused on general problem solving while the third interview which is the focus of this paper, dealt with solving for physical quantities using calculus. Sherin’s work on symbolic forms in physics served as the basis for analysis of the transcripts. The term symbolic form refers to the relationship between the arrangement of symbols in an equation and students mental construct of physics concepts. Symbolic forms allow students to translate between conceptual understandings in physics and mathematical expressions. While Sherin’s work dealt with algebraic problems only, Meredith and Marrongelle’s study expands the use of symbolic forms to calculus contexts.

From the interviews, the authors determine that students use various symbolic forms, described by Sherin, to determine when to integrate in a physics problem. The results also confirm that an understanding of a physical situation is necessary but is not sufficient for students to successfully apply math skills to physics problems. The authors conclude by suggesting ways to improve instruction and develop students' use of symbolic forms, including the use of guided discovery problems, where students are prompted to reinvent equations from physical situation.

This study focuses on the usage of online quiz taking in large lecture courses (biology courses in this particular study). Having students take quizzes online is a growing trend in some large lecture courses. Using an online quiz is attractive to teachers because it eliminates grading, passing back papers, and doesn't take up class time. One of the main concerns of online quiz taking is academic dishonesty. The author of this paper hypothesized that students who take the quiz early would share information and answers with the other students. Thus, the students who took the quiz early would score below those who took the quiz later.

There were two courses participating in this study: cell biology (an upper division course) and introductory biology (a lower division course). Both of the courses were set up to give a weekly online quiz that was graded. The quiz material would cover topics discussed in lecture during the previous week. The quiz access period was 72 hours for introductory biology and 24 hours for cell biology. Once the quiz was started, the students had 20 minutes to complete the quiz, and they could only take the quiz one time. The quizzes accounted for 10% of the students overall course grade.

There were several interesting outcomes from this study. First, the author found a negative correlation between quiz scores and access time. This means that the students taking the quiz later in the access period scored worse than the students who took the quiz earlier in the period. This finding held true for both courses and went against the author's original hypothesis (she felt the
scores would increase due to information sharing among students). This finding supports the author's opinion that cheating and information sharing are not happening as much as would be expected. Second, the time of day that the quiz was accessed was looked at to see if it made a difference on student performance. Not surprisingly, many of the students took the quiz later at night (around 8pm), and the largest block of students took the quiz during the hour before it was due, whether it was 8am or 3pm. The author found the scores of students taking the quiz between midnight and 8am to be 0.6 points lower than the students taking the quiz at any other time of day.

Students in both courses were asked to fill out feedback surveys about the online quiz taking experience. The introductory biology thought the quizzes were stressful and unfair. They felt that they needed more time to complete the quiz than was given, and also felt that clarification about certain questions was need to answer some parts of the quiz. The upper division cell biology students thought the quizzes were helpful and fair even if the quiz was difficult. Overall, this study shows that online quiz taking doesn't lead to excessive cheating, and that upper division courses might benefit more from online quizzes than lower division courses.

**BIOCHEMISTRY AND MOLECULAR BIOLOGY EDUCATION**


This study, the authors present a novel molecular visualization program that has the ability to include textual, tonal, and visual cues when studying proteins. The program was started by one of the authors, T.J.C., who developed the program in order to meet his own needs as a blind structural biologist.

This program is easily accessible from www.bact.wisc.edu/timmol and can be downloaded to either MAC or WINDOWS systems. Once downloaded the program prompt uses two windows to communicate with the user. In one window, you get visual information about the protein and in the other window; you get textual information about the protein. Uploading your protein into the program is simple. You will want to save the protein's pdb file in the same folder as the program, and then enter that name followed by ".pdb" into the program. After you've uploaded your protein, you are able to perform a variety of tasks on it. I tried the program out, and was impressed at how easy it was to use. Most of the commands used to manipulate the protein are one-letter codes that make its use easy. The part of the program that was most interesting to me was the use of tonal cues. A musical note is played to help the user "feel" their way around the protein. Tonal variation in the musical note indicates you're moving in the +x/-x direction, a change in pitch indicates a change in the +y/-y direction, and volume changes signify changes in the +z/-z direction.

A pilot study was conducted on this program and there were two major findings. Participants that have used other visualization programs frequently in the past had a hard time using this program and didn't find it helpful, but those who have had little experience with such tools found the program helpful and easy to use. The authors suggest that their findings are analogous to another study's in which they report about "the impact of prior content knowledge and visuospatial ability on success in learning from graphical displays."

I have used many different visualization programs before and still found this one interesting. Like any program, it takes a while to get accustomed to but is relatively easy to use. Having the different cues, textual, tonal, and visual, gives the user a more complete picture of the protein.
In this paper, the authors briefly describe and overview a survey conducted in their general chemistry courses. They introduce the project by stating that in their general chemistry courses, they experience high DFW (drop-fail-withdrawal) rates in both General Chemistry I (38%) and General Chemistry II (39%). Due to this high drop-out rate, the professors of that course designed a survey to obtain information about the students and their previous academic backgrounds, including what high school courses the students took and what their major is. The authors then matched the information the students gave with the grades the students received at the end of the semester in chemistry. Statistical analyses were conducted to see if any significant differences existed among the data groups.

What the authors found was not entirely shocking. In general, they found that taking advanced courses in high school led to a higher average grade in their General Chemistry I and II courses. The course effect, however, lessened as the level of high school course increased (a grade boost of 0.5 GPA points was experienced for students who had trigonometry while a boost of 0.8 GPA points was experienced for students who had both trigonometry and calculus). A surprising result came from the fact that while a background in mathematics had a seemingly large effect on student performance; a background in high school chemistry did not have as large of an effect on grade averages. Students who had taken chemistry for one year had a 0.2 GPA point boost over those with no chemistry background. Those with a second year of high school chemistry saw a boost in their average grade of 0.27 GPA units. Similar results were seen with the General Chemistry II students where those with one year of chemistry background performed 0.15 GPA units better than students with no background. Again, students with two years of high school chemistry experience performed only slightly better with an improvement of 0.23 GPA units over those with no experience. While these results are promising, it is still quite interesting that students with strong backgrounds in mathematics could potentially perform significantly better in the classroom than students with strong backgrounds in chemistry.

In this study, the authors were the instructors of a science course for pre-service K-8 teachers. The students were given two activities: one on the vaporization of a liquid, another on the fusion of a liquid. In one of the activities, the material was presented in an inquiry format, where the students had to create their own procedures; the other activity was a fill-in-the-blank activity sheet with spaces for students to fill in their data and analysis. The students of the course were split evenly with some getting the inquiry activity for the fusion lab and direct instruction for the vaporization lab. The other half of the course received the opposite instruction with a direct instruction fusion activity and an inquiry-based vaporization lab. Students were then given surveys to gauge how much they liked or disliked inquiry versus direct instruction.

Results showed that most of the students would have preferred a mixture of the two methods, using inquiry to create their own procedures and discover concepts. The role of direct instruction to many of them would have been a confirming resource to check if they were correct in their ideas.
general, the authors found different things that were effective for both methods. For direct instruction, they found that students felt the most positive feature knew the right answer at the end of the activity. For the instructors, they found that uniformity of timing was a key advantage to direct instruction. The work of the students was more standardized because they had a set of instructions and knew what to do from the start with direct instruction. With inquiry, on the other hand, students felt a benefit of being able to design their own procedure. They also gained the important benefit of learning to develop and reject procedures that ended in failure. Students also felt that inquiry was a much less boring activity than direct instruction. Overall, the authors felt that there was merit to both procedures, though through their activities they were able to impress the value of inquiry on to the group of pre-service teachers, making them more ready to deal with inquiry-based science as described by the National Science Education Standards.

JOURNAL OF COLLEGE SCIENCE TEACHING


The paper begins with some statistics that have been reported in national assessments and research studies about the confidence that elementary education teachers have towards teaching science and the mastery levels that their students receive. Most surprisingly, the article reports that science is the subject toward which elementary education teachers are least comfortable in their instruction (p.40). In addition, national standards for elementary education are described. The authors use these statistics to inform their development of the college science course for elementary ed. majors to improve preservice teachers’ confidence levels in these crucial areas of science, and also to teach preservice teachers to use inquiry-based approaches, in hopes that the preservice teachers will continue to use these inquiry strategies in their classrooms later in their careers.

In the course, four main areas of science are addressed: the physical world, the chemical world, the biological world, and then a “project-based seminar in the natural sciences” (p.44), which is used as a capstone for the course. Throughout the descriptions of the four sub-segments of the course, the authors provide either instructional materials or student work. The writing is very descriptive and addresses how the instructors coached the students through the inquiry. At the end of the paper, the authors describe students’ feedback as being both positive and negative. Overall, I thought this paper was relevant to our group’s research interests, and believe it is a good reference for instructors and researchers.
JOURNAL OF COLLEGE SCIENCE TEACHING


This article comes from the “Point of View” segment of the Journal, but raises some interesting points that I believe instructors should consider in their teaching. In short, the paper provides some advice for instructors on effectively using Powerpoint in classrooms, and describes how the use of Powerpoint may enhance or hinder learning, depending on how it is used. In the presentation of some types of content, Powerpoint may not be an appropriate instructional media, and the authors do a good job illustrating when this scenario may occur. The authors end the paper by writing that the list of advice they provide is not all-encompassing, and encourage others to contribute their ideas as well. I think any instructor who uses Powerpoint in his/her instruction should consider the points raised in this article.

THE SCIENCE TEACHER


This article was chosen for June 2008 journal club because it relates to all members of the Towns research group; all of us, in some way, are involved in chemistry instruction either in lecture or laboratory. In this paper, the authors discuss how well students are able to collect and draw conclusions from data gathered. An interesting aspect of the paper is that participants are as young as elementary school age. Participants also come from the high school level, which is similar in age and development to first-semester college students.

In the paper, students complete an experiment where they make water quality measurements. The students work in groups and receive a lecture from a scientist on water quality issues, the procedure itself, and safety. Student groups were provided water quality kits that included colorimetric tests and titrations, and were supervised during data collection at the water source and during experimentation. Overall, the authors report that the values obtained by students were not statistically different from the values reported by experts, and I believe many comments can be made about this paper.

As a resource for high school (or even middle to elementary) teachers, I believe the paper is a great reference and provides an activity that can be easily (and fairly accurately) completed by both young and more mature students. The water quality experiment is clearly something younger children can accomplish, but at the same time, can also be made meaningful for older students as well. With regard to my own research interests, I think this experiment’s procedure could also be modified to incorporate more inquiry for older learners.

As a researcher though, I think the findings of this paper may be somewhat misleading because they imply that novices and experts are on the same ability levels, which I do not believe is the case. I think the simplicity of the water quality experiment (e.g. color changes and simple titrations) masked the expertise that comes with being an expert, and promoted the novices such that the novices and experts appear to be comparable. Had a more involved experiment been chosen for this study, I do not think the same results would have been achieved. If this paper is viewed solely as an resource that provides hands-on experiences in experimentation to young learners, though, I think it is an excellent piece.