Take Ownership of Learning Outside Classroom:

Dr. Wenli Guo, Queensborough Community College

Dr. Wenli Guo is a professor of physics and her experiences include spectroscopy, pedagogy, etc.
Take Ownership of Learning Outside Classroom:
Reflection through Journal Writing in a Conceptual Physics Course

Wenli Guo

City University of New York/Queensborough Community College, 222-05 56th Avenue, Bayside, NY 11364

ABSTRACT

Conceptual Physics course is a general education introductory physics course focusing on concepts with minimum math requirements for non-science majors. The overwhelming majority of students in this course intend to become licensed teachers. Schoolteachers play a critical role in inspiring and training the next generation of students to join the STEM disciplines: science, technology, engineering, and mathematics. Improving the scientific knowledge, attitude toward science and scientific communication skills of prospective teachers must be critical goals for this course. On the other hand, for many students, Conceptual Physics will be the final science course they take for the rest of their lives. The quality of their physics education may therefore have a lasting impact on their scientific literacy and their attitudes toward science. “Learners are aware of and control their learning by actively participating in reflective thinking – assessing what they know, what they need to know, and how they bridge that gap – during learning situations”. (MacDonald, 2009) In this grant-funded research project, students were asked to perform reflections through journal writing after each class. They needed to include date, list of activities done in class, what they have learned from today’s activities and questions/comments they still have. Journals were collected randomly once a week. The following data were collected for analysis: two rounds of a perception survey related to the learning of physics and a survey for feedback about journal writing; a pre- and a post-force concept inventory test at the beginning and the end of the semester plus final exams. Reflection through journal writing is a wonderful way for students to set their own goals, to guide their own learning. In other words, to think about what they are learning. It provides an additional method of assessment beyond standardized exams. This ongoing activity provides immediate feedback to both teachers and students; it gives teachers opportunities to gain insight into what their students are thinking and learning about science content, therefore, to make changes in instructions. It also helps students
to improve their conceptual understanding of physics and their basic communication skills in written format.

I. Introduction

You are lecturing to your conceptual physics class about Newton’s 3rd law. You’ve carefully explained the content of the law and the relationship between the action and reaction forces. You’ve shown a few examples or perhaps videos and animations to help your students to connect the law to their real life experience. You may have tried some interactive teaching strategies in class, encouraged your students to ask questions if they don’t understand, either in class or during office hours. You may assign thoughtful homework problems, grade them and return back to students with your comments. You talk about the common mistakes you have found when grading the homework and post solutions on the Blackboard. However, when you give your exam, you still find a big percentage of students who can’t answer straightforward questions of the type you have covered in class and assigned as homework. We are teaching. Are they learning? How many times have you wished that you could read your students minds to know what they were really thinking? How much students have actually learned? What do students do after class besides finishing homework? What can we do to help them to become active learners not only inside the classroom but also outside?

The Conceptual Physics in Queensborough Community College is a general education introductory physics course focusing on concepts with minimum math requirements for non-science majors. The overwhelming majority of students in this course intend to become licensed teachers. Schoolteachers play a critical role in inspiring and training the next generation of students to join the STEM disciplines: science, technology, engineering, and mathematics. Improving the scientific knowledge, attitude toward science and teaching skills of prospective teachers must be critical goals for Conceptual Physics course. On the other hand, for many students, Conceptual Physics will be the final science course they take for the rest of their lives. The quality of their physics education may therefore have a lasting impact on their scientific literacy and their attitudes toward science.
Researchers in the field of physics education (PER) have done a lot of work on addressing the improvement of student learning. Educational literature in various disciplines such as physics and mathematics has shown the importance of self-reflective activities in science courses (May & Etkina 2002; Zimmerman & Kitsantas 2005). One way of engaging in reflective activities is through self-corrections of homework and exams (Guo & Vazgen 2012, Henderson & Harper 2009; Ramdass & Zimmerman 2008). It is worthy to mention that reflective homework self-correction activities as part of a conceptual physics course were successfully incorporated in a community college setting. (Guo & Vazgen 2012) The reflection activity showed positive impact on student conceptual understanding of physics and was very welcomed by the students. However, reflection was only limited to homework and students most of the time were still passive learners especially when they were outside classrooms. Journaling after physics class concept was first introduced at the AAPT New Faculty Experience conference (Desbien, 2011). The benefits of students integrating journal writing for physics were very encouraging. Actually, there are few activities that can trump journal writing for understanding and supporting the development of student thinking. The legendary Toby Fulwiler, author of The Journal Book, wrote, "Without an understanding of who we are, we are not likely to understand fully why we study biology rather than forestry, literature rather than philosophy. In the end, all knowledge is related; the journal helps clarify the relationship." As MacDonald and Dominguez pointed out in their article titled “Developing Patterns for Learning in Science through Reflection”, reflective products are not like objective tests, they tend to be subjective when students having an emotional and very personal connection to the learning outcome. “Reflection creates meaning”. (Macdonald & Dominguez, 2009) In this article, reflection through journal writing was implemented in a Conceptual Physics class in a community college setting, which is rarely seen in literatures. The description of the study, preliminary data and results are presented.

II. Description of the study

The typical PH101 Conceptual Physics course has three 50-minute lectures and one 1 hr 50 minute long laboratory per week. The official textbook for the course is “Conceptual Physics” by Paul Hewitt. Students are generally required to write lab reports for each lab they do but they do not do any other writing except homework for lectures. Regular student-centered lectures cover
basic concepts and principles. Different activities were carried out inside classroom such as group work, peer-instructions, work-sheet practice and multiple-choice questions practice, etc. Approximately ten to fifteen problems were assigned as homework every week and solutions were posted online one week afterwards. Two tests were administered during the semester plus a final comprehensive exam. They were all composed of certain multiple-choice questions and a few short answer questions. Once-a-week popup quiz was given in class to ask students to work on most recent-covered materials. Quiz then was graded and given back to students as soon as possible.

At the beginning of the semester, students were asked to each purchase a notebook to write journals outside classroom after every lecture. Students needed to write the following in the journal: a. date; b. a list of activities done in class; c. what students have learned from today’s activities (this is the meat part of the journal, they can put examples, details etc, usually should be at least one page); d. questions students still have, leave 2-3 blank lines between each question for answers (this is a very important part of the journal, they can use this part to communicate with professors). Journals were collected randomly once a week. When collected, journals were reviewed and graded in a 10 scale system: 9 means good, 6 is OK and 2 means bad. Students cannot copy notes when they write journals; instead, they have to use their own words and thoughts after reflecting upon what they have learned from classes. Journals are part of the homework grade, which is 30% of the total grade. Students were also told that if everyone in the class did a good job, they would be allowed to use their own journal during the tests.

The following data were collected for analysis: two rounds of a perception survey related to the learning of physics (http://cosmos.colorado.edu/phet/survey/CLASS/) and a survey particularly designed for journal activity; a pre- and a post-force concept inventory (FCI) (Hake, 1984) at the beginning and the end of the semester plus two tests and a final exam (quizzes and exams are the same as what were used in the previous semester without this intervention).

III. Results, discussions and conclusions
About 40 students participated in this project. Compared to the grades from the previous semester without any intervention, all grades from this project have improved, especially the average final, which went from 72.64/120 to 80.29/120. It is worthy to mention that I have been teaching this course for more than 5 years, and the final is always around 70/120. In addition, the final is a comprehensive exam which covers all the materials students have learned throughout the semester. Students need to really understand the concepts in order to correctly answer many of the questions on the final. This gives us confidence that these students have better understanding of physics concepts through journal writing. Class learning gain is also calculated by the following formula through FCI pre-test (4/30) and post-test (16/30):

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\langle g \rangle = \frac{\langle \text{post \%} \rangle - \langle \text{pre \%} \rangle}{100 - \langle \text{pre \%} \rangle} = 0.46
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In the survey we did at the end of the semester, about 50% of students expressed that they liked to do this activity. Among others some students claimed that although they sometimes did not like it, but it was helpful to learn more physics, get more extra credits, make the information stick and have more chance to ask questions. Some mentioned that they did not like to write, or they were not used to writing journals, or it was added stress to the class because they did not have enough time. When asked “what do you think you gained from writing journals?”, majority of the students expressed that they have gained in several different ways, especially a. understand better; b. be able to point out what they did not understand before; c. writing in their own words helps to retain the knowledge; d. good review tool; e. better writing skills; f. have questions answered; g. look for examples related to the concepts learned in class; h. better note takers, etc. Based on our preliminary data, we have found the following benefits from reflection through journal writing in physics. We are planning to conduct a finer-grained analysis of students’ responses to investigate the impact of the intervention on students’ conceptual understanding of physics. The analysis of the intervention impact on students’ scientific attitude is in progress as well.

**Facilitate self-regulated learning**

Reflection helps students take responsibility for their own learning. The addition of reflections in the form of statements about what has been learned, and comments about successes and failures will assist students to form meaning from their learning experiences. (MacDonald, 2009) When students wrote journals, they needed to make sure that they understood the materials in order to
write in their own words. They either looked up the textbook or notes or had some conversation with their classmates to reflect upon what they have learned in class. Sometimes when they got stuck while doing homework, they would use journals to search for answers. They were driven to think physics on their own and became more hard-working. This method also helped them to consolidate their knowledge about physics and retained more information, especially to memorize more equations and formula. Students were also encouraged to ask questions so that they did not leave questions unanswered. In addition, it served as a push for some students so that they could spend more time on those parts they did not get during the class. Some students reported that they became more focused and serious in class to take notes so that they could write better journal at home. Through finding examples of the concept, students realized that physics is everywhere. As one student pointed out: “Writing journals were for things I learned and understood. Not everything in the notes is something I learned.” These are especially important to community college students. By saying that, we have to consider the fact that community college students are different from those from colleges under a selective admission policy. When we consider student learning outcomes, we must factor in the under-preparedness of our students, the low socio-economic structure of the populations we serve, the significant impact on adults with their complicated lives and competing interests. (Marti 2009) Reflection through journal writing just works for this group of students.

*Provide opportunities to close the gap therefore to improve students’ conceptual understanding of physics; professors can use feedback to improve their teaching*

Purposeful, guided ongoing reflection may be an opportunity for teachers to gain insight into what your students are thinking and learning about science content. (MacDonald, 2009) Questions generated by students can then be used to identify concepts that need further explanations. This helps professors to gain insight about what students are thinking and learning so that professor can make corresponding changes in instruction, correct misconceptions, and further explore complex concepts with which students maybe struggling.

Students who are shy in class to ask questions or did not have chance to ask questions in class can do so in journals. If there was not enough time to finish a problem in class, students could use journal to finish it up. After a quiz or a test, students were asked to reflect upon their
mistakes in journals to find out why they made certain mistakes. There are all kinds of questions found in the journals such as questions about grading policy; examples they saw outside class which are related to the concepts covered in class; requests to discuss certain topics again in class, etc. This is like an expanding classroom. As a professor, one could learn about his students better; they could use all these questions as a guidance to adjust their teaching or clarify students’ misconceptions or even learn some new examples and applications related to the concepts they cover in class. This is a win-win situation.

In the article titled “Reinvigorating Science Journals” (Bricker, 2007), it was suggested adding prompts such as the following:

- What is something I discovered for the first time?
- What did I find that surprised me?
- What happened reminds me of
- What else do I want to know
- What am I wondering about now
- I had trouble with
- I was successful when

These could be useful in future journal writing in physics classes.

*Help students improve their basic communication skills in written format*

It is for sure that students needed to spend more time on physics and writing outside class when journal writing are required for a physics course. Students reported that their writing skills have been improved. After writing, they were able to understand some concepts they could not before.

*Different learning styles and how they perform*

People learn differently. It is found that there are seven types of learning styles ([http://www.learning-styles-online.com/overview/](http://www.learning-styles-online.com/overview/)) such as visual (prefer using pictures, images, and spatial understanding), aural (prefer using sound and music; Verbal: prefer using words both in speech and writing), physical (prefer using your body, hands and sense of touch), logical (you prefer using logic, reasoning and systems), social (prefer to learn in groups or with other people), solitary (prefer to work alone and use self-study). Several visual learners claimed that journals
are not so useful, however, majority of students benefited in different ways through journal writing regardless of their learning styles. More data analysis and research will be done on how different learning style students respond to this method.

In conclusion, reflection is most effective as structured, guided, purposeful activity that occurs on regular basis. (MacDonald, 2009) The strategy of using reflection in physics courses allows students the space and time to think about what they are learning. Although probably not the best for every learning style student (needs further studies), reflection through journal writing is a wonderful way to introduce to community college students. It can be utilized to help students to set their own goals and to guide their own learning. This ongoing activity provides immediate feedback to both teachers and students; it gives teachers opportunities to gain insight into what their students are thinking and how much they have learned about physics content, therefore, to make changes in instructions. It also helps students to improve their conceptual understanding of physics and their basic communication skills in written format.

References


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