Creating a Blended Cooperative-Learning Classroom

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Abstract

This report describes the implementation of a blended chemistry classroom for non-science honors majors, a face-to-face Process-Oriented Guided-Inquiry (POGIL) classroom coupled with on-line lecture instruction. The objectives of the project are to reduce the confusion and negative attitudes with which many students greet discovery learning and to promote student engagement with the course. The on-line instruction presents useful background material in a mini- lecture format that is designed to help orient students to the POGIL lessons. Face-to-face classroom time is reserved for concept building and concept testing in a social setting. Assessment results show that student attitudes toward discovery learning are improved in a blended classroom. Student engagement is extremely good. There appears to be an improvement in the performance of students in the bottom quartile of the class. Also, the blended course proves to be more economical of instruction time than a traditional POGIL course.

Keywords

Blended/Web-based learning, student-centered learning, inquiry-based/discovery learning, process-oriented guided-inquiry learning, STEM.

Introduction

This report describes the implementation of a blended process-oriented guided-inquiry learning ("POGIL") teaching strategy. Interest in blended guided-inquiry instruction, particularly in science, technology, engineering, and mathematics ("STEM") education, results from the interplay of two important trends in contemporary teaching practice. First, active learning methods produce superior learning outcomes in education in general and in the teaching of STEM subjects in particular (Bransford, Brown, & Cocking, 2000; McKeachie, Pintrich, Yi-Guang, & Smith,1986). The most effective teaching practices now emphasize strategies in which students are given responsibility for actively constructing their own knowledge base, usually in a social setting (Bodner, 1986; Spencer, 1999; Bodner, Klobuchar, & Geelan, 2001). Second, much ongoing effort to enhance the quality of teaching by STEM educators, technophiles by and large, involves integration of modern technology into the classroom.

There is no specific definition of a blended classroom. Blended learning implies any use of internet technology coupled with face-to-face instruction in a physical classroom. Our blended

POGIL classroom couples face-to-face guided-inquiry learning in a physical classroom with an on-line instructional component that is intended to enhance student engagement and reduce the confusion with which students often initially greet guided-inquiry learning. On-line instruction is used to present useful information that should help orient students to the group work. Classroom time is reserved for the concept building and concept testing phases of learning.

Course Design

The course described here is a one-semester laboratory science course that is part of the general education sequence for non-science Honors majors in a medium-sized, mid-Western state university. The course is team-taught and consists of physics, chemistry, and physiology necessary to understand how the human body distributes and uses chemical energy. Only the chemistry section of the course, comprising approximately one third of a semester in length, was evaluated in this study.

Twenty four students, primarily sophomores and juniors, were enrolled, a typical number of students taking the course. All were non-science majors. At the beginning of the course, the students were surveyed concerning their engagement with science, their engagement with technology, and their involvement with education in general. Most participants reported a negative attitude towards science. Some participants reported negative experiences with their prior science education. Few students exhibited interest in technology. However, the students did assert a strong involvement with education in general.

The POGIL method consists of a carefully structured programme in which students build on their prior knowledge and experience as they engage in a cognitively challenging situation (Lewis & Lewis, 2005; Spencer, 1999; Farrell, Moog, & Spencer, 1999). Group work takes the place of the lecture in POGIL. Students are given much of the responsibility for learning the material as they complete course activities working in small groups. The structure of most classroom activities is based on the learning cycle concept (Kolb, 1984; Spencer, 1999). The process begins by guiding the students through data processing and concept formation with a series of simple and direct questions. The students are then led through concept testing and application with ever more difficult and open-ended exercises. POGIL lessons are designed to be completed within one or two class periods.

The instructor's role in a POGIL classroom is to serve primarily as a facilitator of group learning, to monitor progress and to intervene when guidance is needed. Usually, the instructor does not answer questions directly, but instead helps students resolve uncertainties for themselves. The students, for their part, are assigned specific team roles to perform such as manager, recorder, assessor, and presenter. This promotes positive interdependence and accountability (Johnson, Johnson, & Smith, 1991) and provides opportunity to develop process skills.

The presentations, made available to the students on the internet, are assigned as homework prior to in-class group work. Class time is reserved for concept formation, testing, and application. The web portion of the class does not include concept formation and validation because group study is most effective and tutoring is most needed during such activities. The POGIL method places strict requirements on the structure of a lesson and, in particular, on any activity which precedes concept formation. In our blended classroom, we introduced videotaped mini-presentations of 10 - to 20-minute duration designed to orient and engage the students in the class work as well as to present some useful information. For instance, preliminary on-line presentations might introduce basic definitions or describe important models such as the periodic table of the elements. Also, the students may be reminded of fundamental concepts developed previously which would be applicable in the group work to follow.

It is of concern that the pre-recorded mini-presentations might prove to be counterproductive and inhibit rather than facilitate student progress and engagement. Social interaction is an important component of the POGIL process, after all. Nevertheless, there are some advantages to on-line learning. The schedule is conveniently flexible, and students are free to learn at their own pace. Students do not risk being left behind in fast-paced group work. In any event, on-line learning is well suited to students with a strong bias towards learning, students who are highly motivated, and students who have strong time management, literacy, and technology skills. These are all characteristics of Honors students, in general.

Course Assessment

We compared student performance in the chemistry section of the blended class offered in fall 2011 with that of student performance in the chemistry section of normal POGIL classes offered during the eight year period from 2005 to 2012. Median exam scores and score distributions for all years except 2007 and 2009 are shown in Figure 1. Between 17 and 22 students participated in the course each year. Thick candlestick bars show the range of exam scores in the second and third quartile of the grade distribution. Narrow candlestick bars show the complete range of individual student scores other than the numbered outliers. (The POGIL course was not offered in 2007, and the 2009 grade distribution is unique and proved to be an outlier).

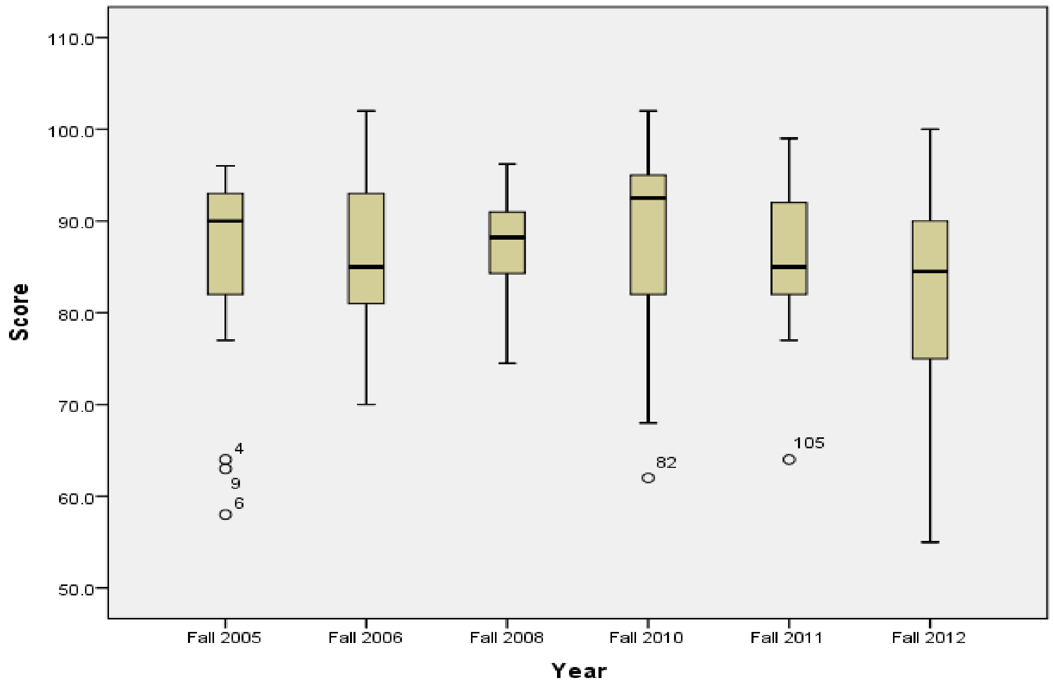

Figure 1. Median exam scores and distributions for the chemistry portion of "Human Body in Motion" (2005 - 2012).

Table 1 summarizes the results. Independent 2-sample t-tests were performed with SPSS to compare score distributions on chemistry exams given in the traditional course with the score distribution of the chemistry exam given in 2011 in the blended POGIL course. Student grade distributions proved to be statistically indistinguishable in both the blended POGIL course and in the traditional version of the course. The distribution for the blended-POGIL class was perceptibly narrower than the others, however. The lower quartile was truncated in comparison with the normal POGIL distributions. This suggests that the on-line presentations may have helped the weakest students to improve their performance, although there is not enough data to support such a conclusion definitively. This issue is the subject of further investigation.

Table 1. Exam scores and distributions (2005 - 2012)

Study Period	Sample Size	Mean Exam Score	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Min	Max
					Lower Bound	Upper Bound		
Fall 2005	17	84.882	12.1803	2.9542	78.620	91.145	58.0	96.0
Fall 2006	17	86.059	9.1274	2.2137	81.366	90.752	70.0	102.0
Fall 2008	22	87.409	6.4638	1.3781	84.543	90.275	74.5	96.2

Fall 2009	17	95.088	6.0058	1.4566	92.000	98.176	75.0	100.0
Fall 2010	22	88.455	10.7248	2.2865	83.699	93.210	62.0	102.0
Fall 2011	21	86.381	8.4230	1.8381	82.547	90.215	64.0	99.0
Fall 2012	24	82.917	10.4670	2.1366	78.497	87.336	55.0	100.0
Total	140	87.111	9.7359	.8228	85.484	88.738	55.0	102.0

Anecdotal evidence shows that the on-line presentations assigned as homework prior to group work in the course did help some students adapt to the POGIL cooperative learning approach. Several students commented that they did not experience the confusion in the blended POGIL course that they had experienced in other guided-inquiry courses they had taken. The students offered little or no resistance to inquiry learning, and they exhibited satisfaction with their achievement in the blended POGIL course. Because of prior experience, many non-science majors have negative impressions of science courses and usually report poorer performance in POGIL courses than is actually the case (Felder & Brent, 1996; Silverthorn, 2006). This perception problem did not occur in the blended POGIL course. Also, several students reported that the blended POGIL experience was more enjoyable than expected.

A survey of student engagement was distributed at the conclusion of the chemistry segment of the course. The questions examine student participation in class and student interest in the material being studied. This is similar to questions about student engagement asked in Part 1 of the National Survey of Student Engagement (NSSE). The survey questions along with the distribution of responses to each question are shown in Table 2 (for both course versions).

The results show that the students were highly engaged in both the blended and traditional version of the POGIL course, more so than is usually reported in engagement studies. Almost all of the students came to class prepared, having completed their homework assignments. Most students reported that they worked hard to meet the instructor's expectations. Almost all students actively participated in class, most of them on a regular basis. Furthermore, students recognized the connection between course material and other aspects of their lives, and they discussed these issues outside of class. Such activities are among those that are performed most poorly by college students (e.g., NSSE, 2008) and the results of this study are exceptionally good. The responses are substantially the same for the blended course, offered in fall 2011, and the traditional course, offered in fall 2012, as indicated by the Fisher test's p-values. A response distribution virtually identical to that of the blended course was obtained in a different traditional Honours course given during the same semester.

Table 2. Engagement survey responses (fall 2011 / fall 2012

Did you engage in the following activity?	Never	Some-time	Often	Very Often	Fisher's Test p-Value
	fall 2011 / fall 2012				
Q1. Asked questions/ contributed to chemistry discussions	1/0	5/11	13/7	3/5	0.1108
Q2. Came to class without completing chemistry readings and assignments	15/10	5/11	1/2	1/0	0.1534
Q3. Discovered some material from the chemistry section to be relevant to other aspects of your life.	1/1	14/12	5/8	2/2	0.8727
Q4. Worked with classmates outside of class to prepare chemistry assignments	7/6	8/9	3/8	3/1	0.3744
Q5. Worked harder than you thought you could to meet instructor's expectations	3/6	9/11	9/4	2/2	0.3707
Q6. Discussed ideas from the chemistry section outside of class.	4/4	12/13	4/4	2/2	1

The chemistry section of the course is offered over a period of four weeks for three hours per day on two days per week. It covers the processes that convert nutrient energy into work and heat in the human body. The level of presentation of topics is similar to that in *Chemistry in Context: Applying Chemistry to Society (*Middlecamp, Keller, Anderson, Bentley, Cain, & Ellis, 2012). The blended POGIL sessions proceeded quickly, and it was possible to add a section on muscle work and energy production to the syllabus of the blended course without expanding the time allotted to the chemistry section Baum (2013). The main anaerobic and aerobic pathways of producing adenosine triphosphate in muscle tissue were examined along with the production and removal of important by-products. The additional material represented an expansion of the course content by about 10%.

Conclusion

The results show that the students performed at least as well in the blended course as in the traditional POGIL course. Based on anecdotal evidence, blended learning did help students to adapt to a cooperative learning strategy. There appeared to be no student resistance to the teaching strategy in the blended course, and the perception problem sometimes observed in POGIL classes did not occur.

The blended POGIL classroom was more efficient and economical of face-to-face time than the traditional POGIL classroom. Time usually taken to address confusion and refocus students in a normal POGIL course was spent covering additional material. Teachers often complain that student-centered instruction is too time consuming and that not enough important material can be included in an active learning syllabus. The blended classroom appears to be, at least, a partial solution to this problem.

Many students become disengaged as they perceive active learning to be difficult and confusing. This is compounded by a common perception that science is dry, boring, and irrelevant to student's lives. The results of this study show that good student engagement can be maintained in a blended POGIL class.

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Disclaimer

Bio

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