Marshalling Technology for Learning

Curt Hill
Department of Computer Systems and Software Engineering
Valley City State University
Valley City, North Dakota 58072
Curt.Hill@vcsu.edu

Abstract

This paper describes an experiment in flipping an introductory programming class. This class was an unusual candidate for an inverted classroom for several reasons. It had a small number of students and it was broadcast to remote sites using interactive video. The instructor used an unusual collection of technology to overcome these issues. Test results and student response suggest that the experiment was successful.

1 Introduction

There has been considerable stir about the inverted or flipped classroom in recent years. [1] The intent was to force the student to learn the easy things prior to class, so that more difficult issues could be considered in class. The approach also emphasizes the instructor speaking less and the students collaborating more within the classroom. This approach started within the physics community but has received considerable attention at several recent SIGCSE conferences, among others.

Presentations at such conferences usually focused on large and local classrooms [2]. The class that was intended for flipping did not share very many characteristics with those normally considered. The course in question was a CS 1 class using C++. It typically has a rather modest enrollment, typically a dozen or less. Moreover, it was broadcast to other sites using the North Dakota Interactive Video Network (IVN). Although it was possible for several such sites to exist, in this instance only one had any students and that one just six. This class was also offered at 8:00 AM, not usually the time of highest creativity or interaction for college students.

The institution also has had a push for improving instruction using the inverted classroom. The book *Teaching Naked* by Jose Bowen [3] has been widely read and promoted by the instructional design team at VCSU. The subtitle of this book is *How Moving Technology out of your College Classroom will Improve Student Learning*. The basic premise of the book is the flipped classroom, but for the author the subtitle was something of a problem. The class is a technology class (programming) and without technology (interactive video) there is no communication with the remote site. This paper was tentatively titled Never Teach Naked for a time, but that title did not enhance the paper. The rest of the paper considers the resolution of this problem.

2 The Class

2.1 Before the Flip

The course had existed for several years as a face to face class taught in a mostly conventional way. The class room was equipped with a projector, so most lectures were delivered with the help of a PowerPoint presentation. These presentations were posted on a web site prior to the class. Each student has a laptop computer equivalent to what the instructor used. They had Microsoft Office as well as the Interactive Development System (IDE) used in the class. Thus they could follow the presentations on their laptops, only taking notes on comments offered by the instructor that were not part of the presentation. Moreover, any demonstrations of the IDE or other software could be reproduced on their laptops as well.

There was no textbook, instead out of class instruction was obtained through the VCSU MEP [4]. Students were given assignments through this online system, which functions somewhat like a textbook, but kept much better track of student progress. The VCSU students were required to buy a professional grade IDE, usually Embarcadero's CBuilder[5]. This IDE could then be used for several subsequent classes without

additional purchase. Most other items, such as the syllabus and test announcements were posted on the class web site.

The class format was very conventional. There was an opportunity for questions at the beginning of the class. This was followed by a presentation or demonstration. About once a week a quiz or worksheet was given and students typically worked in groups of two or three for about the last fifteen minutes.

Things became more complicated two years ago. VCSU entered into agreement with the Northern Information Technology Consortium (NITC) [6]. In the NITC there were three two year public colleges and one tribal college. Each institution agreed to provide one or two classes per semester on North Dakota's Interactive Video Network [7]. Each campus retained the tuition of their students who took the provided classes on their own campus.

This forced the class into classrooms that were specially designed and equipped for IVN. Two large monitors in the front of the room displayed what the instructor was doing and the remote site that had activity least recently. This also restricts what can be easily done. Quizzes or worksheets on paper need to be distributed three days in advance and will not return in less than three days. This is a problem for tests, but forced discontinuation of all quizzes and worksheets and the group work around them. The NITC has at least four different Learning Management Systems and sometimes it is not possible to get a remote student onto the local LMS. Most of the capabilities of an LMS were carried by the class web site and VCSU MEP. The IDE also required change. It was not fair or practical to require remote site students to buy an IDE that they could not install on college laboratory computers. For two years a dual IDE system was used. VCSU students still purchased CBuilder, while remote students use Microsoft's free Visual Studio on college desktops.

The dual IDEs was particularly frustrating. Most demonstrations had to be done in parallel. The class has for some time[8] used GUI builder features, which are different on both IDEs. Microsoft C++ uses managed memory instead of the standard C++ features, so even the basic languages are not the same. This problem was resolved by the adoption of DevC++ IDE at the same time as the introduction of the flipped classroom. Of course, it was not without issues.

2.2 After the Flip

Many of the pieces of the course stayed the same. The web site still contained announcements, PowerPoint presentations and the like. VCSU MEP is fully under the control of the instructor, so giving accounts to students at other colleges is no different than local students. As mentioned the IDE changed, but that was coincidental with the implementation of the flip and had little impact other than complicating the instructor's life.

What did change were two big pieces. The introduction of an online quiz system and the complete overhaul of the normal classroom format.

The online quiz system was a serendipitous discovery. VCSU had a new hire, David deMuth, to direct the STEM center. He had previously developed this system and so installing it at VCSU was not a substantial task. However, it was not available until the second full week of the Fall of 2013 semester.

This system allows the instructor to create sets of questions of various types, set the timing of their availability and show in real-time how many have answered and what answers have been given. Each student is given a login and uses a web browser as the client. Since IVN rooms are universally equipped with internet access for all students, this was a very convenient solution.

The class format was what was actually inverted. The students typically started with an online quiz. These were usually multiple choice, although short answer was sometimes used. They were given about ten minutes to complete this. During this time the instructor is monitoring how many students have answered each question and how many are right. This led to the quiz discussion, which often occupied the bulk of the class. The quiz is graded, although the students receive points for the attempt as well as right answers.

The instructor now has to determine the problem with the student answers. The online system shows the correct answer. If a question was largely answered correctly no further comment was needed. It is when there are many wrong answers that the instructor needs to give an impromptu talk on what is right and why the incorrect answers are wrong. This is a special time, for the students are in a particularly teachable moment. They know that they have missed it, but do not usually know why. Unlike a conventional lecture, there can be no preparation. The instructor needs to diagnose the problem and deal with it on the fly. This may not be the best approach for novice teachers, but it pays off well for the experienced ones.

This period may last anywhere from a few minutes to the rest of the hour. It is usually followed by a presentation or demonstration. The closing minutes include announcing what needs to be covered for next time. In this course, it is what lessons in VCSU MEP need to be covered, but it could as well be textbook pages.

The out of class time is also important. This instructor has taught this class many times. Historically, preparation for class is very minimal, but this was not the case in this semester. Quiz preparation becomes very important. The goal of a question is **not** to distinguish the good students from the poor, tests and assignments do that. Rather, it is to uncover the student's misconceptions. One of the precepts of this type of teaching is to let students learn the easy material outside of class and the hard material inside class. A student may read the material, but the true significance does not sink in. This is only exposed by the quiz question and then corrected by the explanation that follows.

Therefore, crafting questions becomes an important skill. Each question should drive at a concept or fact and each answer at a possible misconception or be the right answer. Alas, experienced practitioners of any skill have developed a proper way of thinking. Observing all the improper ones requires a different set of educational experiences.

The change between 2012 and 2013 is reflected in the data of Table 1. This records the differences between a flipped and unflipped IVN class in regards to PowerPoint slides given and quiz questions given.

	2012	2013
Slides before test 1	384	201
Slides before test 2	337	159
Slides before test 3	343	21
MC quiz questions (work alone)	0	79
MC quiz questions (work together)	0	24

Table 1: Significant presentation differences in classes.

The table also shows that the instructor modified his approach as the course proceeded.

3 Results

Taking an educational research methodology point of view, there can be no definitive results. The class size was too small, there experiment has not been done multiple times, etc. However, there are some indications that this did provide an increase in student performance. These fall into two categories: test results and student testimonies.

3.1 Testing

Like many, the instructor maintains a pool of multiple choice and other more elaborate questions. These may serve as a way to compare sections from different years, but there is substantial uncertainty. The multiple choice questions have a larger pool on a topic than is ever used on a test. This allows some variance between one test and another that cannot be ascribed to the student's performance. The other set of questions is typically along the lines of "find what is wrong with this code" or "code a program/function/piece of code that will …" and these are much harder to grade subjectively. It is possible to believe that one section may be graded consistently, but folly to believe that two different sections graded in two different years will be consistent with each other. Therefore only the results of multiple choice questions will be considered.

As mentioned, the class has evolved in recent years from a purely classroom course, to an IVN course and now to a flipped IVN course. This introduces another variability into the situation. Yet it is still possible to compare multiple choice percentage correct among tests given and this is what was done. The results are shown in Table 1.

	Test 1	Test 2	Test 3
2013	62.07%	48.83%	60.00%
2012	38.46%	16.67%	30.00%
2011	54.84%	35.00%	58.80%
2010	65.52%	56.21%	65.56%

Table 2: Test Results by Year and Test Number

The 2013 class is the one most discussed in this paper, using a flipped classroom in an IVN environment. The 2011 and 2012 classes were not flipped and used IVN, while the 2010 class was the last of the non-IVN classes.

The prima facie conclusion is that IVN courses damage student performance, since the non-IVN class towers over the IVN classes. There may be some truth to this, but the conclusion is not justified from this data. The 2010 class was simply exceptional. It was small but very talented. From a class of 7, four graduated with the CS minor and all four were employed in IT shortly before or after their graduation. The 2009 class was also in a classroom setting. Where the test score data exists, the class of 2009 did not perform as well as the 2010 class.

3.2 Testimonies

The course in question has two follow up courses, the first of which is being taught currently, that is, in the spring semester of 2014. Since there were some issues that need to be resolved with the online testing system and the addition of students and courses as well as instructor workload, the subsequent class was **not** flipped. A small number of students have expressed some dismay at this. Therefore, they must have perceived it as a good thing.

4 Summary

The inversion of the course was a challenging, but rewarding proposition. It was much more labor intensive than the normal offering of the course. However, this is similar to any large scale overhaul of the class. There is an expectation that offering this class in the way again would be easier.

It is too soon to tell the results. Was 2013 an exemplary class or did this technique enhance their learning? The author’s current opinion is that both of these are true, the latter perhaps more than the former.

Despite not flipping the subsequent course this year, the inverted classroom seems to merit the acclaim that has surrounded it. The author intends a similar approach in the fall of 2014.

References

[1] Lockwood, Kate and Rachel Esselstein. The Inverted Classroom and the CS Curriculum. In ACM *Meeting A 2004 Proceedings of ACM SIGCSE,* pages 41–46, March 2013.

[2] Porter, Leo, Cynthia Bailey-Lee and Beth Simon. Halving Fail Rtes using Peer Instruction: A Study of Four Computer Science Courses. In ACM *Meeting A 2004 Proceedings of ACM SIGCSE,* pages 177–182, March 2013.

[3] José Antonio Bowen. *Teaching Naked.* Jossey-Bass (John Wiley & Sons) 2012.

[4] Hill, Curt and Brian Slator. Visualization Enhanced Hypertextbook for Computer Science Education. *Proceedings of Computers and Advanced Technical Education (CATE '09).* November 2009.

[5] Embarcadero. http://www.embarcadero.com/products/cbuilder Date accessed 29 March 2014.

[6] Hill, Curt, Susan Pfeifer, Diane Keller, Colette Schimetz, Marlin Allery, Heidi M. Schneider, Jason P. Brandvold and Ken Quamme. *Proceedings of the World Conference on E-Learning in Corporate, Government, Healthcare & Higher Education (E-Learn 2012).* October 2012.

[7] NDUS Advance Learning Technologies. http://alt.ndus.edu. Date accessed 29 March 2014.

[8] Hill, Curt. Experience with GUI Programming in Lower Level Classes. *Proceeding of the Midwest Instructional and Computing Symposium.* April 2002.