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Using Reflective Learning in an Introductory Programming Course

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ABSTRACT

This paper describes an exploratory study on the use of reflective learning to enhance student learning in an introductory programming course. Students were required to submit a weekly journal detailing their learning challenges and triumphs as they tackled the in-class as well as take home assignments. Initially, some students were resistant to the idea of journal writing for a programming course. As they wrote their reflective pieces, many were surprised that it actually benefited them in the learning process.

INTRODUCTION

Program development involves the use of a programming language to build software applications. The person performing this undertaking uses programming syntax to describe the tasks of the application. The program has to be checked for both syntactic and logic correctness. While this may sound simple for experienced programmers, this process has been shown to be difficult for novices. Studies in didactics for programming in several introductory programming courses indicate high failure rates of 25% to 85% (Kaasboll, 2002). One reason cited for the failure is that inexperienced programmers found the process of describing algorithms for a task to be abstract.

The challenge is to help students make the abstract more concrete for their understanding. As students articulate connections between what is new and what they already know, they learn. Students can be encouraged to write about their learning and to demonstrate what they learn through reflective writing (Moon, 1999; Carroll, 1994). Elbow (1994) highlighted that "low stakes writing-to-learn is not always good as writing, it is particularly effective at promoting learning and involvement in course material."

The journaling tool is often used in the humanities as a learning tool. More recently, it has also been used in scientific disciplines, for example communicating learning in science (MacCallum and Hickey, 1997) and mathematics (Noblitt and Pochis, 1997). Fairholme, Dougiamas and Dreher (2000) illustrated the use of online reflective journal for a group process for information systems majors. George (2001) reported relative success of journaling for a computer science course.

As the students write and reflect on what they learn, they are reconstructing knowledge. This process of constructing and reconstructing knowledge was found to be effective in encouraging learning (Carroll, 1994). In this paper, I describe an exploratory study on the use of self-reflection to help students learn a programming language like VB.NET.

METHODOLOGY

In the first class session, a multiple-choice quiz was designed to test the students' level of VB.NET programming knowledge. This quiz served as the baseline for the class. All students took the test. The quiz was not available for review during the course. To compare the learning acquired by the students, they took a similar quiz at the end of the semester.

The students were informed of the rationale for doing a reflective piece for each week of class work. They were given an example of a reflective piece. The class met once a week. For each class meeting, there were

in-class and take home assignments. The students were given guiding questions for their reflective pieces. The reflective journal was submitted online. The journal submission accounted for 15% of their course grade to motivate students to take the task seriously. As the purpose of the journal was to reward reflection and learning, students were given points for highlighting problems encountered, problems resolved and effort taken to work with their partner on the learning process. Students were not assessed on their writing skills in the journal.

FINDINGS

Analysis of the Students' Journals

When the idea of writing the journals was first introduced to the students, most of them thought that it was just an additional burden. As the journals were assessed, students did them for the grade. However, after spending time and reflecting on their learning experience, they were surprised to see the benefit of writing out what they learned. By writing, they were making their learning concrete and were better able to grasp the concepts. Further, the journal also served as an avenue where doubts were resolved as I answered their queries through the journal piece. Students also started to see their mistakes and found ways of correcting them. For example, one student found that he had to start reading and understanding concepts before attempting to do his assignments. Below, I highlight comments extracted from the journals on the students' comments about their learning experience through their reflective writing.

Reflective Learning: A Worthwhile Experience:

This week's homework assignments gave me all sorts of problems. I didn't read the chapter before I started on the work and then they frustrated me. I am having problems with the dim functions. I remember doing them in high school, but I don't remember anything about them. My trouble right now is that I assumed I understood them and jumped into the assignment and in reality I didn't understand them at all.

Actually at first I didn't think we needed the reflections, and it was just extra stuff to do that was a waste of time. But once I started doing them I found that when I typed it out I would remember a lot more of the concepts, especially the ones that I thought I forgot. This brief refresher was a reminder of what we had done during the week, which helped me going into the next class because it was fresh in my mind and I was ready to build on it with the new material I learned the next week.

Reflecting and writing out what I learned surprised me. I didn't think it would really help at all, but again I was wrong. By writing out what you learned it helps to jog the memory and help reinforce what was learned. It got me to think about what I did, and learned in class as well from the text.

This class is the first class I've had here at _____ where weekly reflections were part of the homework assignments. I think it's very beneficial to think over how the week has been and how the assignments have been. Looking back each week and writing about my experiences has really helped me solidify what I have been learning.

While debugging the Athas Construction program I was able to get a good sense of the mistakes that I could when making a program myself. There

are many places where someone can the wrong character and not know it. In terms of both Athas Construction and Maria's Limo, I was also reminded that you have to pay attention to logic errors as well as syntax. Logic errors are usually the more difficult to notice because the IDE will not tell you that your logic is wrong as it does with syntax errors. You have to test your program and test the output to make sure that your calculations in the program perform as expected.

The example we did in class was a perfect example when we had to distinguish certain points like (1, 2), (2, 4), (3, 6)) using a for each next loop. The loop however can be difficult to use but it is a very useful function when you know how to use it correctly. This is why I've been reading the chapter over and trying examples to use the loop on my own time. However, I am excited to keep learning more VB functions because it truly is a challenge to my knowledge of VB so far.

Writing down what I've learned in the this class and past classes helps keep track and opens up my mind to what I've learned that I may not have thought about in much detail.

I also believe the reflection pieces were beneficial to me. It was a good chance to sit and think about what I had learned, what I understood, and what areas I needed additional work with. It helped to just sit and organize my thoughts.

I like how we work in class to complete assignments and do example, it helps me to learn the projects when you do it along with us, because I get to see it and do it at the same time, so next time I have something to look back on for reference when I am using the code in a project or homework assignment.

I believe the best way for me to improve on my programming skills is to just keep practicing the exercises we are given. Also, to create my own exercise similar to the assignment given and see if I'd be able to create on my own without really the help of anyone but to test myself and see how much I learned.

The reflections that we wrote helped me realize what I was good at and what I needed to look over, I needed some more practice. That is what this whole program is about, practice, this is where the assignments come in, those problems helped me anyway get better at VB.Net because they made me code over and over again.

The weekly reflections are key concepts as well. It lets us write what is on our minds about assignments we have been working on, how things have been going in class.

I do feel the reflections enhanced my understanding of Visual Basic a little. As you write the reflections you think about what you did wrong and how you fixed it, this helps when you get to the next assignment. You know where you went wrong last time and can prepare to deal with problems much better when you think about previous assignment problems.

Writing out what I've learned helped me realize more about what important things were covered and how to use them when I was doing my assignments and the final project. Reflecting made me uncover things I didn't think about as much when I was hearing them in class. Writing it out helped express how much I have learned in the course about many areas of VB.NET.

Writing the reflections gave me a chance to reach out to the professor and let her know what I did and didn't understand from the material she covered. The professor responded to the reflections which also I found was a good connection to the students because it showed a good one-to-one relationship between the professor and the student.

Overall, I learned how to summarize what I have learned each week by writing reflections. Most importantly, these reflections enable me to find out what conceptions I need to work on. Also, they help me retain the concepts I have learned each week. After many weeks of doing this, I can feel my skills improving. This is because with reflections, I am able to put what I have learned into my own words.

As far as the reflections have gone, they have mostly been a way to enforce what I have learned throughout the semester, and it has helped

me out quite a bit going over exactly what we have done, or even what I have had trouble with to try to improve upon it.

While most of the students found the journal reflection piece to be useful, one person thought that it was not as effective.

Doubts on Reflective Learning:

I can't say reflecting helped a great deal. While it did make me remember things we talked about in class the homework did the same so it wasn't all that effective.

The Reflective Learning Experience

In reviewing the journals, I gained some useful insights on student learning:

Reinforcing Concepts Learned:

Students found that hearing a lecture or doing some examples alone is not sufficient to really understand the concepts. Engaging students is an important part of learning (Davis, Sumara, Luce-Kaplar, 2000). Gagne (1985) suggests that learning intellectual skills require a series of tasks that increases in complexity. To facilitate learning, each of the tasks has to be recognized by the learner. In writing the journal, the students had to find time to think through what they had learned (stimulating recall of prior learning). In the process, they were actively reviewing class materials over the week. This was found to be helpful for many of the students as a way of reinforcing concepts covered in the class (providing feedback and enhancing retention and transfer). As a result of this, I would suggest that instructors who want to implement journal writing in a class ask their students to be as specific as possible in writing what they have learned. Students should not simply write down in point form the topics covered in the class. They should instead write on two or three key concepts and how they are applied in the class. Focusing on the concepts helps students to reconstruct what they know or do not know. In fact, in comparing students who reviewed concepts in at least 2 or more journals and those who reviewed them in one or fewer journals, the former was found to perform better in a objective test score than the latter. This is discussed in a later section.

Persisting on the Learning Experience:

In the initial period, some students found the reflective journal to be a "waste of time". However, as they progressed through the semester, they began to see the usefulness of the journal piece in their learning process. Many of them were "pleasantly surprised" by the effect of the reflective journal on their learning. Of the 20 students in the class, only one student mentioned that the journal piece was not as effective in helping him to learn. He preferred working on the home work assignments as a means to learn. It took time for students to get into the habit of writing the journal pieces. But once they became more familiar with the concept, they started to use the writing to reflect on the work done. So, it is important to "go the distance." There were some initial disappointments on my part, but with time, students did get into the project and were really learning as they wrote their reflective pieces.

Assessing the Journals:

The journal writing made up 15% of the course assessment. Because of the weight given to the journal piece, students had to make sure that they spend an appropriate amount of time working on their journals. George (2001) commented similarly on the importance of assessing journals to encourage *all* students to work on the task. Further, with an appropriate level of motivation (through the weight given), students were more likely to work on the reflective piece. Anecdotally, some students who missed one or two journal pieces were upset that they missed working on the journals. This was partly because of the weight given to the journal piece. In implementing journal writing to encourage learning, instructors should choose a weight that will significantly motivate the students to take the task seriously.

Table 1. Comparing the objective scores (before and after the course)

Group	Average Score		t-value	p-value
	Before	After		
Concepts included in 2 or more journals (n=11)	47.3	72.7	2.23	0.0009
Concepts included in 1 or less journals (n=9)	47.8	58.9	2.31	0.0027

Table 2. Comparing the objective scores after the course among the two groups

Group	Average Scores (After)	t-value	p-value
Concepts included in 2 or more journals (n=11)	72.7	2.10	0.0177
Concepts included in 1 or less journals (n=9)	58.9		

Objective Test Scores

The objective test score as obtained from the multiple choice quizzes was not intended to measure the effectiveness of the journaling process. However, it could provide some indications on whether students were better able to retain some of the concepts as a result of the journal writing. Croxton and Berger (1996) found that students who wrote their journal entries on concepts learned in class were more likely to answer those objective test questions better than those that did not. In this study, I also noted students who wrote in their journals on concepts covered in the class appeared to do better than those who did not. There were eleven students who wrote in at least two of their journals on programming concepts in the journal. Nine students wrote about concepts in one or less of their journals. In reviewing the scores of these two groups, I found that the increase in scores for both groups were found to be significant (p-value = 0.0009 and p-value = 0.0027 respectively). When I compare the average scores for the quiz taken at the end of the semester (after), the group of students who wrote on concepts in at least two journals had an average of 72.7 and those who did not had an average of 58.9. The difference in the two scores was found to be significant (p-value = 0.0177). The results are summarized in Table 1 and Table 2.

The results suggest that the process of including the discussion of concepts in a journal piece can help students to retain knowledge of the concepts. In future implementations of the journal piece, I would suggest asking students to include concepts and any matters related to the concepts in their journals.

CONCLUSION

This exploratory study looked at journaling to enhance learning among students enrolled in an introductory programming class. Based on the feedback obtained from the journal entries, I conclude that the effort to introduce the concept was effective in this class. Through weekly reflective journal entries, many students were surprised at the degree of reinforcement the reflective writing brought to their learning process in this course. It was a lot of work to grade the weekly journals. However, students learned a lot through the reflective writing and this made the effort worthwhile. Given the success of this initial effort, I would continue to use this strategy for other programming courses.

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