NoteBlogging: Taking Note Taking Public

Beth Simon, Krista Davis, William G. Griswold, Michael Kelly, Roshni Malani
Computer Science and Engineering Dept.
University of California, San Diego
La Jolla, CA 92093-0404
+1 858 534 5419
{bsimon, kmd, wgg, rmalani@cs.ucsd.edu, m1kelly@ucsd.edu}

ABSTRACT

Classroom note taking tends to be a private activity, hiding a wealth of knowledge in both content and method. With the advent of the web, whose technology and culture seemingly invites everyone to share everything, we are prompted to ask how making note taking a public activity – *noteblogging* – might advance learning. What does a blog about a computer science classroom look like? What supports are needed to enable noteblogging as a form of auxiliary instruction? In this paper we overview the design and use of noteblogging as part of the Ubiquitous Presenter digital classroom system. With NoteBlogger, students with Tablet PCs take handwritten notes digitally on top of the instructor's slides, and their notes are instantly reviewable by other students in class using a web browser. We examine the impact of noteblogging on a CS1 course through interviews with bloggers (to reveal their motivation and understand their choice of content) and blog watchers (to learn when and why they watch). We also analyze the blogs in this CS1 course to identify their educational contribution. We find that noteblogging enables a unique classroom participation model that specifically engages more advanced students. Blog content spans many levels of intellectual engagement, which can support a range of learners in CS1 as well as perhaps model for them various levels of reflection.

Categories and Subject Descriptors

K.3.1 [**Computers and Education**]: Computer Uses in Education – *collaborative learning.*

General Terms: Human Factors.

Keywords

Blog, Note taking, Tablet PC, Ubiquitous Presenter, CS1.

1. INTRODUCTION

CS1 courses have special challenges in that they often must support students with varying backgrounds in programming – the rate and depth of instruction may need to support rank novices, but hopefully won't completely bore those with some programming background. Additionally, instructors often feel there is much material to cover and students may be reluctant to pose or answer questions where there are definite "right" and "wrong" answers. In this context we seek to explore the potential for "blogging" in the classroom. A blog is a personal reflection on a shared experience – according to wikipedia it provides "commentary or news on a particular subject". It is one way to digitally support a community.

We report on the design and use of *NoteBlogger* (NB), a Tablet PC application for blogging in the classroom in the context of the Ubiquitous Presenter digital classroom system (UP). Students in UP classrooms already bring laptops to class in order to control their viewing of classroom materials or to participate in active learning exercises [6][11]. These capabilities allow for little direct student-to-student communication. In complement to reviewing the instructor's annotated materials (spontaneously inked slides) and responding to instructor-posed problems, we support the review of student contributed "blogs" – additional inked notes as submitted during class by selected "bloggers" in the classroom.

We explored the impact of NoteBlogger on a CS1 classroom in several ways. First we performed a post-hoc analysis of blog content to determine what kinds of materials are blogged and the educational sophistication of blog content. We found that blog entries span a variety of educational sophistication across all levels, for example, of Bloom's Taxonomy [3]. This range of sophistication in blogs has the potential to support the learning of students who are at varying levels of sophistication.

We also sought to better understand the motivations, desires, and potential negative side-effects of blogging in the classroom. We surveyed students in the class on their blog-watching habits, and then interviewed the classroom bloggers and selected blog watchers. The results show that blog watchers watch in order to get a different viewpoint on classroom materials or to divert themselves when, for whatever reason, the classroom material is not engaging them thoroughly. Students feel it has a positive impact on their learning experience.

Of significant note is that the more advanced students who served as bloggers found a new and engaging role in the classroom. Bloggers enjoyed the ambient communication medium of blogging – described as being able to "say things that I want to without having to say it to anyone in particular [and without] interrupt[ing] the class to say it" (B1). They sought to provide clarity, emphasis on important concepts, a student perspective, alternate explanations, and provide peer instruction.

2. RELATED WORK

Ubiquitous Presenter is a derivative of the University of Washington's Classroom Presenter (UWCP) [1] system and shares many features including instructor inking over slides and support for active learning through student submissions. UWCP supports a student interface designed around the Tablet PC – which provides natural support for private note-taking. DyKnow is a similar system, available commercially, which supports a great range of instructor and student activity and support [2]. UP differs in that students are supported in engagement in the classroom with the

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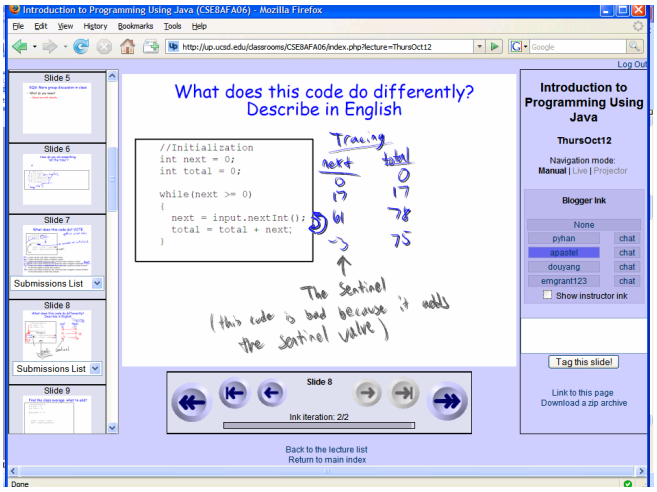

Figure 1. Blog watching interface, ink shown is blogger ink.

most minimal of overhead – a login-based web portal. No software must be installed and no support beyond standard networking is required in the classroom or on campus. Classrooms are hosted for free on a server at UCSD.

Large-scale, but highly constrained classroom interaction is supported through a variety of commercially available "clicker" or personal response systems [7]. Group Scribbles supports in-class group collaboration in an electronic post-it note format [4], Message Grid supports both in and out of class active learning and peer evaluation electronically [9], and Livenotes is a system for cooperative note-taking where preformed groups of students can take and manage collective notes [8].

In 2004, Nardi, et. al. performed an ethnographic study of blogging reporting on motivations, quality of social interactivity and relationship to audience [10]. They report that a clear and personal audience relationship is critical in a blog – and that readers seek out blogs because of the non-intrusive, lower impact nature of a blog – it doesn't require an "intense conversion". Blogging has a natural community building or finding component. This seems a match for the university classroom.

3. SYSTEM DESIGN

NoteBlogger (NB) is a Tablet PC application designed to work in conjunction with the UP system. The fundamental idea behind this application is to allow a select number of students to create public noteblogs for a UP classroom. A key aspect is that noteblogs are set in the context of instructor-prepared slides and that they are available real-time (no explicit posting is required). Furthermore, the content of the blogs are available to other students on the same website as the instructor's annotated slides, thus supporting increased communication in a forum already engaged by the students. Both the instructor and the notebloggers use Tablet PCs as a convenient way to place their thoughts, sketches, and annotations on top of prepared slides. However, the output is universally available in any web browser on any platform.

Different blogs can be quickly reviewed by students through the AJAX-based implementation of blog note viewing. Figure 1 shows the student browser-view of a lecture slide with review of blog content. By mousing over blogger names (on the right), the student view is updated with blogger ink. The student can click on a blogger name to permanently synchronize with that blogger and can, additionally, choose to have the instructor ink visible or not. Blogs are available for view both synchronously in class, and asynchronously for review outside of class.

4. BLOG CONTENT ANALYSIS

As part of our multi-pronged analysis of the impact of noteblogging, we perform a content-analysis examination of the blog content from a 10-week CS1 course introducing programming in Java. Since we are interested in the educational impact and import of blogging, we analyze the content in the framework of Bloom's Taxonomy of Educational Objectives [3]. We sought to find out if blogs simply made low-level comments on content (e.g. knowledge level) or if blog content reached into higher levels such as application, analysis, synthesis, or evaluation.

4.1 Methodology

We study the artifacts from author Simon's CS1 in Fall 2006. The final enrollment was 119 students. The students slightly varied programming backgrounds, though the majority had no prior experience. Students with significant prior experience (e.g., a passing AP grade) were placed in a different class. Most students were Computer Science majors. The instructor made a determined effort to foster active learning in her classroom: she encouraged students to read the textbook before lecture and carried out at least three active learning exercises in each 80-minute lecture (supported by UP). About half the students brought web-enabled personal computing devices (mostly laptops) to class to participate in the exercises. Four notebloggers were selected by application and instructor review. Half way through the course, a re-election process occurred: students voted to keep a blogger or elect a new one. As a result, two of the bloggers remained while the other two were replaced by new bloggers. Blog entries were categorized using a grounded-theory based analysis and then placed into Bloom's Taxonomy categories using a card sort process performed by three authors, with disagreements resolved via discussion.

4.2 Blogging by Bloom's Taxonomy

Reviewing the content of students' noteblogs revealed 31 different blog event types. Due to lack of space, we cannot provide examples of all event types, but samples of interesting events will be discussed. We apply Bloom's Taxonomy of Educational Objectives [3] to analyze the perceived understanding expressed by various noteblog events (Table 1).

Knowledge. At this level, we placed Defining Terms, Shell Commands, and Comparing to Outside Resources. While Comparing to Outside Resources sounds more advanced, the examples in the blogs did not make inferences. Rather they recalled and noted difference between lecture material and the material in the text.

Comprehension. Since bloggers could make any kind of annotations in their blogs, we expanded this level to include acknowledgment of a lack of understanding or questioning – that is events which signal seeking to comprehend. Blog events that introduced terminology showed a level of comprehension beyond simple knowledge recall (like Defining Terms). The instructor began the section on overloading by showing sample overloaded methods and without using the term until later in the lecture. On the first

Taxonomic Level	Descriptive Verbs	Blog Events
Knowledge: recognition or recall, of ideas, material, or phenomena	defines, describes, identifies, matches, recalls, states	Defining Terms, Shell Commands, Comparing to Outside Resources
Comprehension: understanding of the literal message contained in a communication	comprehends, converts, distinguishes, explains, extends, interprets, translates	Code Tracing, Highlighting New Concepts, Connecting Output to Code, Asking Questions, Introducing Terms, Drawing Memory, Mental State
Application: use of abstractions in particular and concrete situations	applies, changes, constructs, demonstrates, modifies, produces, relates, shows, solves	Providing Solutions, IDE Hints, Additional Practice, New Concepts, Correcting Code, English to Code
Analysis: breakdown of the material into its constituent parts and detection of the relationships of the parts	analyzes, breaks down, compares, contrasts, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects	Teaching with Questions, Highlighting Peers' Errors, Hints (other), Comparing Conventions, Explanation, Explanation of Peer's Work
Synthesis: putting together of elements and parts so as to form a whole	categorizes, combines, compiles, composes, creates, generates, organizes, reorganizes, rewrites, summarizes	Multiple Solutions, Pictorial Annotations, Code to English, Analogies
Evaluation: making of judgments about the value of ideas, works, solutions, methods, material, etc.	appraises, contrasts, criticizes, critiques, discriminates, evaluates, justifies, relates	Advice, Admonishments, Hints to Start, Empathy, Style Comments

Table 1. Bloom's Taxonomy Categorization of Blog Events

slide where overloaded methods are shown side-by-side, blogger B1 wrote "overloading?". In this case, the blogger did more than note the term and its definition: he understood the context enough to recognize the concept. Similarly, Connecting Output to Code (see Figure 2, blogger B2) and Code Tracing are placed in comprehension because they demonstrate knowledge of what the code is doing, but not a higher level because they are not applying the coding concepts themselves.

Application. A good example of application occurs when a blogger translates a problem from English to code -- they are not told which concepts to use (e.g. if or for-loop). Correcting Code is another example of Application because the bloggers first identify a misused concept and replace it with the correct one. A particularly valuable application blog event is suggesting Additional Practice. This includes blog content like "can you write code to print the even numbers" (on an example which required printing odds). Sometimes bloggers expand upon and apply a New Concept. For example, in class, sentinel values were introduced only with numbers. B3 noted that "sentinel values don't have to be NUMBERS ONLY".

Analysis. Both Explanation and Explanation of Peers' Work fall into Analysis because bloggers are able to analyze a concept or proposed solution and provide additional information. In some cases, blog events in the Explanation category may only show comprehension; however, in many cases bloggers are extending another explanation in a way that shows a higher level of understanding than just comprehension. For example, one slide asked students how much memory is required to store Class types to emphasize that the size varies. B1 expanded by clarifying that "it stores ADDRESS" instead of the data -- like primitives. The Hints (other) category shows a level of distinction that is a hallmark of the Analysis level. As shown in Figure 2's blogger B1, we see circled curly braces, distinguishing the scope of the inner loop as key to solving the problem. In this same slide we also see an example of B1 Teaching with Questions when he asks "where does the println (or enter) happen?". This is a critical element of analysis we hope students can perform with this example.

Synthesis. Analogizing new concepts to those familiar is an exemplar for Synthesis. When students notice parallels between preexisting concepts and one newly introduced, they construct an understanding of the new concept based on similarities to familiar ideas. An example of an analogy provided by B1 shows his deep grasp of a new concept. When instances of classes were introduced, B1 analogized them to "instances" in massively multiplayer online games (MMOs). In MMOs such as World of Warcraft, instances are areas that can have multiple concurrent copies which do not interfere with one another. Pictorial Annotations show synthesis since bloggers are quite literally putting together parts (e.g. lines of code) to form a whole (e.g. the concepts of inner and outer loops) – as shown in B3's blog in Figure 2. Blog content based on describing Code to English was specifically taught in the class – students were told that one should always seek to find English-definable meaning in a code segment – and bloggers took this to heart even when not prompted.

Evaluation. Among others, the events Hints to Start and Style Comments belong in Evaluation. When bloggers give hints about how to start an in-class problem, they are assessing the value of different potential approaches and picking the one they think will be best. Blog events about different coding styles (Style Comments) show evaluation since the bloggers identify what they believe to be good and bad styles (even though their comments may be based on limited experience). Admonishments included notes like "Watch out for OBOs!" (off by one errors). Statements of empathy include comments like "Genius! I didn't think of that : (" when commenting on another students' work.

While there is some degree of flexibility regarding to which taxonomic level each blog event description belongs, including that some could arguably span multiple levels, it is interesting to notice that the techniques employed by CS1 students span the entire range of Bloom's Taxonomy. Moreover, anecdotally, we see usage spanning the levels throughout the chronological delivery of the course. While these students' familiarity with CS1 concepts may be limited, they still think about these concepts at the Analysis, Synthesis, and Evaluation levels.

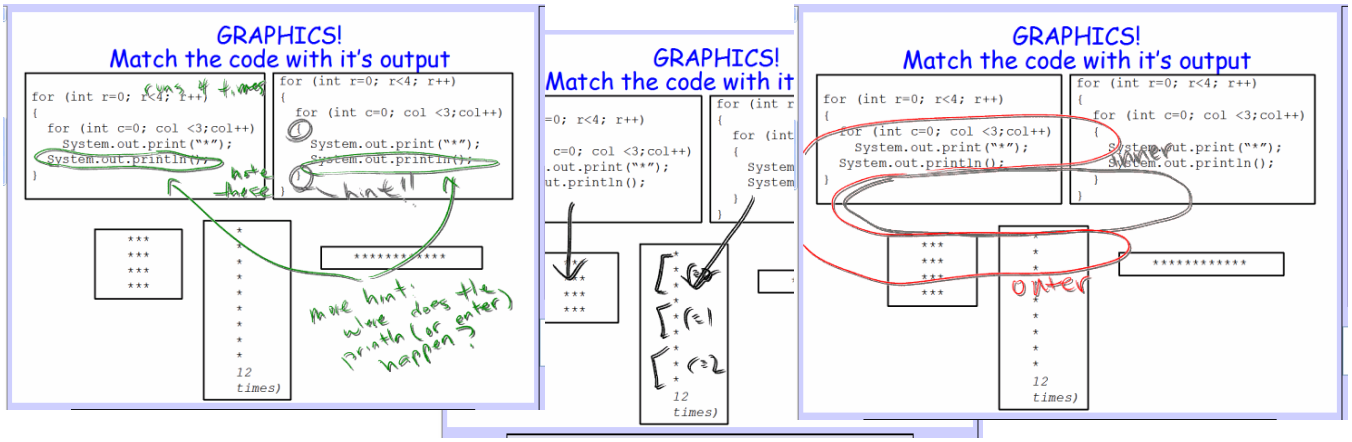

Figure 2. Sample blog entries from left to right: B1's Hints (other) and Teaching with Questions events; B2's Connecting Output to Code (the writing on the right-hand side of the output refers to the loop variable in the outer loop); B3's Pictorial Annotations.

5. BLOGGER AND BLOG WATCHER INTERVIEWS

5.1 Methodology

Authors Davis and Malani conducted and recorded interviews of three bloggers and two watchers, using a semi-structured protocol. The interviews were transcribed, broken into quotes, and analyzed to find emerging patterns. Also, a survey about NB was given midterm in the course. We discuss the behavioral and perceptual changes, evident from the data, of the bloggers and then of the watchers in the sections below. This data is reported in more detail in an earlier publication [5].

5.2 Changes in the Bloggers

Overall, bloggers actively thought about their note taking behavior as "bloggers". They focused on the clarity and organization of material as well as providing alternative explanations and problem solving hints. As they took on a more active role in the classroom, the blogs became a medium for self-expression and individuation. We elaborate on these changes below.

Blogger B1, "signed up to noteblog because [he] could kind of give tips or ideas that [he] thought would help the learning process" for his peers. He explained that NB "kind of forced [him] to take […] good notes, because other people are relying on them in some way or another." Later, he emphasized that he "tr[ied] to make things clearer for other people." B3 claimed that her noteblogs were "more like a student's point of view of what the content is rather than the instructor's point of view," in that they might "stress a point" that the professor might not because she didn't have sufficient background knowledge. Thus, with her noteblogs, "the content becomes more detailed and easier to understand for the other students." B2 described the content of his blogs: "if [the professor] said something out loud important that she didn't write down, [he] would write that down, […] or just like if [he] had a question about like a program, [he]'d write that, and maybe like someone would ask it or something like that, and [he]'d like underline, circle important stuff." Thus, bloggers clearly had their audience in mind and tried to please them by taking clear, complete notes with an emphasis on important concepts.

Providing alternative explanations and different perspectives was a goal for some of the bloggers. For example, B2 explained that "people don't want to look at the same exact thing for each blogger, they want to read different stuff." So, he "tried to write as much helpful stuff as [he] could, and keep it interesting." He actually "looked at, like, the other people [blogging] and tried to, you know, write different kinds of stuff, [he] didn't want to write the same stuff everyone else's writing." B3 also agreed that "if more people [blog], then yeah there is more variety of like watching some point that [she] might not think is important but some other people think that part is important."

In addition, bloggers also tried to give hints or suggestions for solving the problems. B1 explained that for "some of the in-class problems, like, if you're completely new to computer science, like it would take you way longer than the professor gave you time for in order to solve the problem, and then by then the professor would have told you the answer, so then, [he] think[s] if, just the few hints of from, like, where to start, like, what to focus on, could help them write the program a little faster, if they choose to read it." This blogger concluded that NB was "most efficient if the person that's blogging has […] his own ideas of tips and ways to learn the material," describing his blogs as "more like during class, just like an extra self-tutor kind of deal" for the watchers."

In general, bloggers valued NB as a means for self-expression and communication. As already noted above, B2 strived to differentiate himself from other bloggers, to form his own persona. He also expressed how "everyone gets to see what I write […] and it's just like a cool way to get your opinion out there for everyone to see." Later, he expanded more about the nature of the communication: "it's a cool way to you know, if you don't understand something or something makes you angry […] you could write like an angry face or something without having to you know shout it in front of the whole class and everyone having to hear it, so it's a cool way to express yourself." B3 explained that she "can like point out and write what [she] thinks is important," "what she found difficult, or which other students should stress more on" as a response to what the instructor thought was important in the lecture. B1 compared noteblogging to traditional weblogging, and found that both allow him to "say things that [he] wanted to say without having to say it to anyone in particular [and without] interrupt[ing] the class to

say it." However, the note blogs were not personal to him in the same way as traditional weblogs or journals were. This blogger described the flow of communication in the classroom as a "downward hierarchy, like, there's a professor, there's the bloggers, and there's the students, and then, you can see everything that the person above you writes, but you can't write back to them." Thus, he concluded that "it's a forum that happens during class as opposed to after class [and that makes a big difference] 'cuz a lot of times, like [he]'ll have like questions during class, um [he] won't bother to ask like or find the answer, and then when [he] goes out of class, [he]'ll forget about it because it's not on [his] mind at that time, […] but it feels like if [he] could write it down, […] then it's as easy as that."

Hence, qualities that notebloggers endeavored to achieve included clarity, emphasis on important concepts, a student perspective, various explanations, and suggestions for starting to solve a problem. These were achieved through attempts at self-expression and individuation in an ambient peer-to-peer communication medium.

5.3 Changes in the Watchers

Two-thirds (n=48) of students who participated in the mid-course survey reported they watched blogs during class (with varying frequencies), while lack of a laptop in class was a common deterrent for non-watchers. Clearly, a change in student behavior in the classroom has occurred – students bring laptops and use them to class-related activity. Our interviews indicate that watchers valued blogs as a source of assistance, encouragement, and reassurance.

Watchers changed their in-class habits by turning to blogs to keep themselves engaged or amused. Watcher W1 commented that "the questions, like the, the input they have is really helpful," and that he "would be a little more lost" if the blogs weren't there. He explains that "since it's [his] major class, [he] should try taking notes, and then, [… he] didn't find [him]self like looking over them, rather like, [he found himself…] going to the blogs." W2 indicated that he used classroom idle time, such as when the professor was "writing something," to "look over to the other blogs to see what they have to say."

What did the watchers want to see in the blogs? According to W1, he "would look at notes if [the bloggers] outlined stuff… or if they like provided like their own like content." What did the watchers actually see? W1 indicated that when an in-class activity was underway, he would "scroll down like through [all the bloggers]" and he found that "they won't like give you like the answer directly, as much as they'll […] give you […] hints or like how to solve it or the logic behind like solving it." This watcher noted that a blogger was "a student too, but just [one who] helps the students learn, and to I guess like complement [the professor's] teaching." W2 also "look[s] for solutions, for how to figure out how to do this" and for "ideas on ways to attack the problem." He explained "when [he tries] to solve a problem, [he's] not sure if [he's] doing it right, not sure if the blogger is […] either, but it gives you a feeling that you're probably going the right way."

6. IMPLICATIONS FOR INSTRUCTION AND CONCLUSIONS

Blogging, as a form of public note taking, has a significant and potentially useful impact on the computing classroom. Our work shows that blogging can support a sense of community in the classroom (perhaps especially in large classes) through an ambient communication channel. But we also suggest important recommendations for instructors to positively engage blogging in their classes. Bloggers should be selected to be more advanced and confident students – so that they can (and are likely to) contribute meaningful content. Additionally, the bloggers engaged based on their perceived social responsibility to the class – in this case supported by the midterm blogger re-elections.

In a study of blogging in CS1, we find that blog content spans a range of educational complexity – as evidenced by an analysis based on Bloom's Taxonomy of Educational Objectives. Student bloggers produce a range of interesting content which spans from the lower Knowledge level to the Synthesis and Evaluation levels. Importantly, classroom blogging has reported positive impact on the student classroom experience. Bloggers report conscious note taking changes to support clarity, multiple explanations, and peer instruction. Blog watchers appreciate the alternate viewpoints and the confidence they gain from seeing the efforts of their peers.

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