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Journal of Information Systems Education ***WINTER 1998***

Facilitating Bloom's Level One through Active Learning and Collaboration

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ABSTRACT
Blooms taxonomy provides a means of structuring learning activities according to levels of comprehension ranging from factual knowledge to the creation of new knowledge. There are problems with presenting factual knowledge in *the traditional lecture mode: student motivation, time-to- present, and course priorities. Howevel;* in *Blooms taxonomy, Levell (jactual) knowledge is the basis for knowledge comprehension at higher levels. Therefore, it is essential that the 'fact base" comprehension be attained so that higher levels of knowledge can be addressed. Active learning and collaborative approaches have been shown to be effective in promoting learning. How can active learning and collaboration be used to overcome the problems associated with promoting Levell comprehension? In our introductory Computer Information Science (CIS) course, we attempt to answer this question for the topic "history of computing":* We *have combined a student research and collaborative assignment to acquire Levell comprehension with a culminating College Bowl activity to reach the goal of Level* 2 *comprehension. In this paper we discuss course organization, course goals, the College Bowl format of quizzing, contest results, and overall observation of the process.*

INTRODUCTION "The past is prolog to the future", a quotation engraved on the front of the National Archives in Washington D.C., is a reminder that the study of history is essential to shaping the future: this is no less true in the field of computing. The current state of tech- nology builds upon the successes and failures of innovators and visionaries from the past. The field of computer science is so young that many of these pioneers are still actively shaping cur- rent and future directions. A sub-discipline has emerged in recent years to capture this historical information. Likewise numerous WEB site exists which are devoted to historical issues of comput- ing, a notewonhy example is that of JAN Lee at Virginia Tech. (hup:llei.cs. vt.edu/ -history/index.html)

The emergence of the WEB has created a vast source of infor- mation. As could be expected, computing's history and pioneers are highlighted in many locations. Textbooks and "war stories" provide only a brief and limited view of this interesting and fun- damental glimpse of our past. ACM, IEEE, NSf; universities and numerous individuals have established sites which capture these past adventures of computing arid the founders of our discipline. The imponance that is placed on a "historical perspective" is evident in curricula documents [ACM 1991], [IS 1997]. These documents prescribe an awareness of the significance of historical events so that students are able to understand the current state of technology, to panicipate in planning for future innovation, and to realize the sociaVethical implications of the role of technology. Several problems exist in the accomplishment of this goal. Sheer volume and pace of new innovation pose problems for educators. The set of historical events for a subject might be char-

acterized by an initial "trickle" in the struggle for self-identit~ This is followed by a "great flood" that results in recognition by the com- munity. Finally, there is a "steady stream" with occasional "small floods" that nunures the sub.iect. Computing has been in the "great flood" phase almost since its inception fifty years ago. The volume and rate of change is so great and continuous that the recording, reflection, and understanding of these innovations is overwhelming. Therefore, the true benefit of placing technological innovation in perspective and its social impact might be completely ignored.

Another problem is that a major attraction to the computing discipline is the use of technology. Students are often moderately interested in the stories of the development of technology; theyare more often consumed with immediate use of current tools. Computing and technology are so tightly associated by the general public that they are indistinguishable. Separating computing (the- ory and practices) from technology and revealing the relationship between the two is a curriculum objective. Planting the seeds of an historical perspective early in the curriculum, with continual nur- turing in successive courses, is a means of creating the distinctions.

However, the greatest problems associated with teaching his- tory of computing are not a consequence of content: They are a consequence of the type of comprehension that is needed in Level 1, factual knowledge.

BLOOM'S TAXONOMY OF COMPREHENSION Bloom [1956] has established levels of learning with clear mea- surable outcomes for each level. Bloom's taxonomy has been used successfully to associate levels of learning with topics in computing courses [Doran 1994, 1995, 1996, 1997; l.angan 1996]. At the lowest Bloom level, Level 1, is the recitation of facts. Historical facts as well as computing facts defining control and data structures are included in Level 1 issues. According to Bloom's taxonomy, Level 1 factual knowledge is prerequisite to higher levels of comprehension, and, therefore special attention must be given to insure that the Level 1 foundation is laid. The imponance placed on the "fact base" is fundamental to problem-solving methodologies (Polya. Zig Zag. Group Zig Zag [Daigle 1995. 1996,1998]). From this base of facts, it is possible to move to Level 2, (use) to understand the impact of facts on individuals and society and Level 3. (application) to apply the facts in the appropriate manner. The general principle of Bloom's taxonomy; that fact precedes both the use and the applica- tion is not content dependent. In the context of computing. fact: Babbage designed the Analytic Engine in the 1820'5; understanding: stimulated by societal need to provide accurate calculations of math tables for navigation; application: general model of computing INPUT-PROCESS-OUTPUT and concept of memory.

PROBLEMS WITH ADDRESSING BLOOM'S LEVEL 1

The traditional lecture delivery mode encourages a passive and self absorbed behavior on the pan of the students. If the volume of factual knowledge is large and the relationships among the facts are complex, in-class delivery consumes much time and competes with tnajor course objectives. In the initial CIS courses the pritnary objec- tive is the development of effective problem solving arid algorithm design/coding skills. The consequence of insufficient examination of complex relationships and issues is an inferior "big picture~.

A typical solution to the dilemma described in the preceding paragraph is to "out-source~ the Levell items in a curriculum to the individual student through reading assignments. However, unless student study groups are self-formed, the reading assign- ment denies the student collaborative and judgment-forming experiences. In our approach, we describe an alternative to the traditional lecture delivery and to the individual reading assign- ment approach in dealing with high volume Bloom Levell items. This approach incorporates active learning, collaboration, and individual accountability developed and used in the introductory Computing I course at our university. In addition to addressing historical topics, this approach provides a model for cooperation with peers in succeeding computing courses in the curriculum.

COLLEGE BOWL College Bowl is an academic competition between two teams from different universities. Each team is made up of 4 players. The game, which appeared on TV in the SO's, 60'5 and 70'5, uses a question and answer format. A toss-up question is used initially to obtain a response from any member of either team who is the first to "buzz" in. A correct response from a panicipant entitles the panicipant's team to collaborate to answer a multi-part bonus question. In its purest format, questions cover a wide range of academic disciplines of varying degrees of difficulty and include current events as well as popular entertainment news. The game continues today without the TV exposure, with universities sup- plying resources to develop competitive teams and attract out- standing students. Year-long team activities encourage extensive

preparation and provide opponunities for the experience of com- petition. The experiences and insights of one of the authors as a panicipant and as a faculty advisor to our university team were instrumental to the adaptation to the classroom implementation.

APPROACH Our implementation of the introductory CIS course sequence has reflective problem solving and algorithmic design issues as the primary goals. This course sequence accomplishes these goals by the establishment of problem solving strategies, adherence to the algorithmic process, and development of code in a high level pro- gramming language [Pardue 1991, 1994], [Doran 1993]. As previ- ously mentioned, a brief discussion of the historical perspective is called for by curricula models. The initial version of the course as developed under an NSF grant, included this historical discussion within the first couple of weeks of the first course. An extensive pre- sentation has been removed and replaced by a brief overview and the directions necessary to search for this historical information in other sources. The approach consists of four stages:

1. Investigation
a. Student teams are formed; each team is given a specific area in which to focus.
b. Several acceptable general web sites are distributed.
c. A deadline for sharing and integration is established. 2. Collaboration
a. Each student team assembles an electronic list of ques- tions and answers for their area of investigation.
b. The student lists are combined to form an initial data- base.
c. The initial database is reviewed by the instructor(s)
and supplemented with items to achieve completeness of coverage.
d. The final list is distributed as a database of study items to each member of the class.
e. A class period is set aside for the contest 3. The College Bowl Contest
a. New teams are formed so that each area of investiga- tion is represented on a team.
b. The panicipants of each round are representatives of each team.
c. A fixed number of toss-up questions is determined for each round; each toss-up question has a bonus ques- tion associated with it.
d. Enough rounds are conducted so that each team mem- ber represents their team at least twice.
e. A class victor team is declared; if multiple sections are involved, a final contest (outside of class) can be scheduled to identify a final victor team.

4. Questions for the examination are taken from the data- base of study items.

An active discovery is needed by the students to be successful in this project. They soon realize that they are in complete con- trol of their learning, only guidance will be provided by the instructor. The actual details and amount of material to satisfy the requirements are the responsibility of the students. Students are cautioned to choose reliable sites such as those associated with the ACM, AITp, IEEE organizations or with a College or University.

Dependmg on student constraints much of the work can be done individually but eventUally there must be a sharing of results. The use of groups at this point in the curriculum can provide a valuable experience in collaborative learning which can be utilized later in the curriculum. Prior work has shown the benefit of this early collaboration [Daigle 1996] . Another resource for the student learning in the use of previ- ous questions from past contests. These questions can come from faculty or former students. .

Each team takes great pride in winning the class competition. No actual grades are used but possible rewards might include bonus points. Usually just the claim of winning gives the students a sense of bragging rights. A class pride also usually results as competition between sections might occur. The learning is complete with the knowledge covered is now pan of the expected learning behaviors for the courses. Most the basic general facts found byall groups will be used on quiz or test.

RESULTS In addition to the course ob.iectives being met in a fun and excit- ing fashion, other benefits have been derived from use of this approach in our introductory course. The most direct result was a savings in lecture time. Often several lectures were needed to cover a broad historical overview of computing. Cenainly; this time gave the students some historical perspective but did not encourage them to seek more information. Also students felt, although the topics were of interest, it delayed the main objectives of the course, reflec- tive problem solving and program development. With minimallec- ture time and one day of competition, a broader coverage of histor- ical topics can be accomplished and lecture can proceed quickly and directly to the problem solving aspects of the course.

As pan of the game format questions must be developed on the various historical topics. The faculty staned with what was thought to be an ample supply of questions. This supply of questions was supplemented with a cadre of interesting and relevant facts found by students. This question generation is also thought to increase the students learning as they ~apply" the principle of Blooms taxonomy to pose appropriate questions at the necessary levels. This idea of student generated questions to increase Bloom mastery has likewise been applied in other courses [Denton 1996], [Doran 1996].

The most unexpected but useful result of this endeavor has been the creation of our own WEB site based on a historical time-line as supplied by the textbook [Friedman 1997]. Several student groups combined their resources and developed this site. This provided the students an opponunity to obtain the skill of WEB development not usually associated with the introductory problem solving/program- ming course. However, it encouraged and provided an avenue for these students to undenake a project which exposed them to the WEB which we assume our students will implicitly acquire. Additional benefits of this WEB page is a repository of previously dis- covered facts. This foundation could be built upon by later students. The WEB development also provided an opponunity for a collabora- tive effon at this early stage of the curriculum. The authors have explored and discussed how collaboration could and should be inte- grated throughout the curriculum [Pardue 1991], [Daigle 1996], [Landry 1997]. This project provides yet another vehicle to accom- plish this collaboration goal and reenforce the overall curricular goals.

OBSERVATIONS

The following are general observations of the authors of the bene- fits and students perceptions when this College Bowl tournament and all the supponing activities are incorporated into the course setting.

1) Students generally find more information than faculty have in the past. Faculty tend to tell the same standard stories.

2) Students take a more active role in learning. This active learning is called for by the curriculum and has been integrated. in various academic environments. When students are fully engaged in the process they tend to exhibit more interest and a willingness to explore beyond the expectations.

3) Faculty have updated their stories used in the limited lecture time and have a wider repository to draw upon. Also, this limited lecture time can be used to emphasize the sociaVethical implications of technology (Bloom Level 2) instead of the basic facts.

4) More of the pure Bloom Levell facts can be learned in a shoner time frame outside of the traditional classroom lecture. Not only is lecture time saved but more histori- cal facts are encountered.

5) The saved lecture time can now allow for the earlier introduction of problem solving/algorithm development issues which can then be implemented in code.

6) Students view what was considered an unimponant dis- traction in the learning of ~programming" as a chance to explore and discover facts about their discipline

7) Students acquire skills not previously present in the class but useful to their computing career. This includes the WEB skills as well as the collaborative team skills.

8) The interest level of the students is increased as they want to find new unknown facts and win the contest. A sense of pride is developed when they discover something new. Although the contest does not directly affect course grades, students still want to be considered the best. It has even fostered friendly competition between sections of the course.

9) The approach is discipline independent. It can be used in any learning situation where time is always a scare resource.

10) The approach is learning level independent. Although we primarily used it to cover the vast amount of factual Levell knowledge, it can be adapted for topics targeted at any of the Bloom levels.

In summary, the authors have found the College Bowl tourna- ment format with the supporting activities provided numerous benefits when integrated into the course. These benefits greatly exceeded the expectations of the authors when we experimented with the approach. We found that it complemented the previous curriculum effons undertaken at our university in prior NSF grants. The approach provided another vehicle to utilize an active style of learning with early collaboration. These concepts, in other forms appropriate to the later courses, could likewise enhance the learning experience of student$. It is these habits, once instilled in our students, which are hoped to remain a natural behavior in later courses and throughout their professional career.

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ISSN 1055-3096