

# Facilitating Bloom's Level One through Active Learning and Collaboration

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## ABSTRACT

*Bloom's 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. However, in Bloom's taxonomy, Level 1 (factual) 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 Level 1 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 Level 1 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 technology 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 current and future directions. A sub-discipline has emerged in recent years to capture this historical information. Likewise numerous WEB sites exist which are devoted to historical issues of computing, a noteworthy example is that of JAN Lee at Virginia Tech. (<http://lei.cs.vt.edu/~history/index.html>)

The emergence of the WEB has created a vast source of information. 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 fundamental glimpse of our past. ACM, IEEE, NSF; universities and numerous individuals have established sites which capture these past adventures of computing and the founders of our discipline. The importance 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 participate in planning for future innovation, and to realize the societal 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-identity. This is followed by a "great flood" that results in recognition by the community. Finally, there is a "steady stream" with occasional "small floods" that nurtures the subject. 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; they are 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 (theory 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 nurturing in successive courses, is a means of creating the distinctions.

However, the greatest problems associated with teaching history 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 measurable 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; Langan 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 importance 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 application is not content dependent. In the context of computing. fact: Babbage designed the Analytic Engine in the 1820's; 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 part 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 major course objectives. In the initial CIS courses the primary objective is the development of effective problem solving and 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 Level 1 items in a curriculum to the individual student through reading assignments. However, unless student study groups are self-formed, the reading assignment 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 assignment approach in dealing with high volume Bloom Level 1 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 50's, 60's and 70's, 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 participant entitles the participant'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 supplying resources to develop competitive teams and attract outstanding students. Year-long team activities encourage extensive

preparation and provide opportunities for the experience of competition. The experiences and insights of one of the authors as a participant 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 programming language [Pardue 1991, 1994], [Doran 1993]. As previously 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 presentation 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.

#### 2. Collaboration

- a. Each student team assembles an electronic list of questions and answers for their area of investigation.
- b. The student lists are combined to form an initial database.
- 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.

#### 3. The College Bowl Contest

- a. New teams are formed so that each area of investigation is represented on a team.
- b. The participants 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 question associated with it.
- d. Enough rounds are conducted so that each team member 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 database 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 control 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.





Depending 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 previous 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 part of the expected learning behaviors for the courses. Most the basic general facts found by all groups will be used on quiz or test.

**RESULTS** In addition to the course objectives being met in a fun and exciting 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. Certainly; 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, reflective problem solving and program development. With minimal lecture time and one day of competition, a broader coverage of historical topics can be accomplished and lecture can proceed quickly and directly to the problem solving aspects of the course.

As part of the game format questions must be developed on the various historical topics. The faculty started 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 opportunity to obtain the skill of WEB development not usually associated with the introductory problem solving/programming course. However, it encouraged and provided an avenue for these students to undertake 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 discovered facts. This foundation could be built upon by later students. The WEB development also provided an opportunity for a collaborative effort at this early stage of the curriculum. The authors have explored and discussed how collaboration could and should be integrated throughout the curriculum [Pardue 1991], [Daigle 1996], [Landry 1997]. This project provides yet another vehicle to accomplish this collaboration goal and reinforce the overall curricular goals.

## OBSERVATIONS

The following are general observations of the authors of the benefits and students perceptions when this College Bowl tournament and all the supporting 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 societal implications of technology (Bloom Level 2) instead of the basic facts.
- 4) More of the pure Bloom Level facts can be learned in a shorter time frame outside of the traditional classroom lecture. Not only is lecture time saved but more historical 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 unimportant distraction 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 scarce resource.
- 10) The approach is learning level independent. Although we primarily used it to cover the vast amount of factual Level knowledge, it can be adapted for topics targeted at any of the Bloom levels.

In summary, the authors have found the College Bowl tournament 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 efforts 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 students. 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.

## REFERENCES

- [ACM 1991] ACM/IEEE-CS Joint Task Force, Computing Curriculum 1991.
- [Bloom 1956] B. Bloom et al, *The Taxonomy of Educational Objectives: The Classification of Educational Goals*,



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*Handbook I: The Cognitive Domain*, McKay Press, New York, 1956.

[Daigle 1995] R. J. Daigle, M. V. Doran and J. H. Pardue, "A Group Problem-Solving Model for the CIS Curriculum", Association for Information Systems Inaugural Conference, August 25-27, 1995, Pittsburgh, PA.

[Daigle 1996] R. J. Daigle, M. V. Doran, and J. H. Pardue, "Integrating Collaborative Problem Solving Throughout the Curriculum", SIGCSE'96 Technical Symposium, February 1996, Philadelphia, PA.

[Daigle 1998] R. J. Daigle, M. V. Doran, J. H. Pardue, "Group Zig Zag: An Extension of McCaulley's Model", Journal of Psychological Types (forthcoming).

[Denton 1996] L. Denton, K. Cannon, J. Toomey and A. Lee, "Use of Participatory Development as a transition to Higher Bloom Levels", 34th Annual ACM Southeast Conference, Tuskegee, AL, April 1996, pp198-210.

[Doran 1993] M. V. Doran, J. H. Pardue and H. E. Longenecker, "Strategies for Success in CS1 and CS2: Implications of Polya in Implementing Software Engineering Principles", The Association of Management 11 th Annual Conference -Information and Technology Management Group, August 5-9, 1993, Atlanta GA, invited paper.

[Doran 1994] M. V. Doran, J. H. Pardue and H. E. Longenecker, "A Systems Approach to a Data Structures Course for Information Systems Students Consistent With DPMA IS'90, ISECON'94, October 28-30, 1994, Louisville, KY.

[Doran 1995] M. V. Doran, D. D. Langan, "A Cognitive-Based Approach to Introductory Computer Science Courses: Lessons Learned", SIGCSE'95 Technical Symposium, March 1995, Nashville, TN.

[Doran 1996] M. v. Doran, "A Framework to Consider CIS Projects By Non-Majors Entering CIS Graduate Programs", Association for Information Systems, 2nd Americas Conference on Information Systems, August 16-18, 1996, Phoenix, AZ.

[Doran 1997] M. V. Doran and D. D. Langan, "Student Perspective on Learning Based on A Cognitive-Based Approach", International Association for Computer Information Systems 1997, October 2-4, 1997, St. Louis, MO.

[Friedman 1997] F. Friedman and E. Koffman, *Problem Solving, Abstraction, and Design Using C++ (2nd ed)*, Addison Wesley, 1997.

[IS 1997] Information Systems: The DPMA Model Curriculum for a Four Year Undergraduate Degree, 15'97, Park Ridge IL.

[Landry 1997] J. P Landry, J. H. Pardue, M. V. Doran and R. J. Daigle, "The Influence of Group Labs on Student Adoption of Software Methodologies: An Empirical Test", 3rd Americas Conference on Information Systems, August 15-17, 1997, Indianapolis, IN.

[Langan 1996] D. D. Langan, M. V Doran, D. L. Feinstein and H. E. Longenecker, "A Cognitive-Based Approach to the Implementation of the Introductory Computer Science Programming Sequence", American Society for Engineering Education, Summer Symposium, June 1996, Washington D.C.

[Pardue 1991] J. H. Pardue, M. V. Doran, H. E. Longenecker, "A Methodology for Group Learning in the Computer Science Environment", 29th Annual ACM Southeast Regional Conference, Auburn, AL, April 1991, pp 341-343.

[Pardue 1994] J. H. Pardue, M. V. Doran and H. E. Longenecker, "Student Perception of Benefits of a Structured CS1 and CS2 Lab Environment", The Journal of Computer and Information Systems, Volume XXXIV, number 4, summer 1994 pp 40-43.