# Integrated Use of Bloom and Maslow for Instructional Success in Technical and Scientific Fields

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## Abstract

University instructors are faced with many challenges, especially in the science and technology fields. Often instructors are not formally trained in educational techniques. Course content is dynamically changing and must be the focus of the instructional effort. This is compounded by the high economic incentives of these disciplines, which continue to drive enrollments upward while still not satisfying industry demand for skilled graduates. The School of Computer and Information Sciences at the University of South Alabama has devoted much time and resources in recent years to address these concerns. With the initial support of NSF-CCD grants, a cognitive-based approach to define introductory computer science courses was established. This approach was based on the explicit use of behavioral objectives of Bloom's taxonomy. This framework has continued to be used successfully as these courses were adapted to include new paradigms, programming languages, and concepts. These courses still meet the underlying curricular goals and have not required substantial re-invention. New faculty have become involved in these courses with limited oversight by senior faculty who were the original developers. With this transition successfully accomplished, another concern, student motivation, critical and pervasive throughout the learning process, was identified and targeted. The initial grants mention that some factors might be outside of faculty control. However, since the cognitive-based approach is stable, those previous factors, such as motivation, can now be addressed. The work of Maslow provides a framework that can be easily integrated into the existing Bloom cognitive-based framework. Students will be guided toward cognitive and affective-based rewards with a vocabulary and reflective framework consistent with Maslow. Through reflection, students will anticipate and recognize how the achievement of specific goals satisfies deeper objectives in their overall intellectual growth and self-actualization. By participating in self-reflection, students will be able to carry associated self-regulated learning habits into later courses and achieve a more active role in their learning experiences. While at first being an expected behavior that is prompted by the educational setting, motivated learning should ultimately become an internalized life-habit. This approach prepares students to embark on careers that require the practice of lifelong learning. This effort to address the motivation factor should not disturb but rather extend, complement, and complete our prior work.

## Introduction

Students specializing in computer engineering, computer science, information science, and information technology are required to enroll in our university's introductory programming sequence. Significant efforts, supported by NSF-CCD grants, have been expended to improve the experience of the students in these early courses.[7, 8, 9, 10, 21, 22, 23] These efforts led to the establishment of a Bloom-based cognitive approach to define objectives in the introductory programming sequence. This approach is based upon the six levels of Bloom's cognitive taxonomy: ***knowledge, comprehension, application, analysis, synthesis,*** and ***evaluation***.[3] Use of these levels in explicit learning objectives allows for a standard identification of the extent to which learning objectives should be achieved.

Further progress in recent years has been difficult, as efforts have been held back by the accommodations made for larger student enrollments, efforts to incorporate new course content, and the lack of specific affective objectives. In this regard, many of our students have poorly established learning habits, an inadequate vision of computer-related disciplines, and a myriad of personal difficulties all of which impinge on student success. Other issues not treated by the cognitive-based approach also remain including academic misconduct and drop and failure rates that sometime exceed fifty percent. Affective objectives can provide an opportunity to methodically deal with the attentive, emotional, attitudinal, and ethical dimensions of learning.[14] In the past year, however, course content has become stable, class sizes were reduced, and a pilot study was completed. The purpose of the pilot study was to confront problems largely external to the cognitive domain, build student motivation, and achieve affective objectives as part of the students' learning process. Central to the pilot study was the integration of both Bloom's affective taxonomy and Maslow's model of motivation into the existing cognitive-based framework. Bloom's affective taxonomy provides a metric for the student's internalization of learning objectives. The five hierarchical levels identified by the taxonomy are: ***receiving***, ***responding, valuing, organization***, and ***characterization***. Maslow's theory of motivation is based on a hierarchy of needs: ***physiological needs*** (labeled as "basic" needs in our educational context), ***security needs, belongingness needs, esteem needs,*** and ***self-actualization needs***. The assessment of the pilot study indicates that the students valued the particular learning experiences unique to the pilot study and demonstrated higher success rates.

**Pilot study**

In the Fall 2000 semester, while class sizes in the introductory programming sequence were high, the students were encouraged to accept a set of "commitments to quality" corresponding to each of the major modules of the course. These commitments were first presented in lectures and in the following semester were added to a required supplemental handbook. The initial goal was for students to move beyond prompted compliance and attain a level of internalization consistent with the personal preference and commitment described at Bloom's third affective level of valuing. Examples of such commitments are: consistent practice of reflective problem-solving, creation of meaningful documentation, writing cohesive methods, and constructing reusable classes.

The diverse student responses to this initial effort, led to the identification of three groups of students:

- ***Non-achievers***: those students who failed to demonstrate the cognitive objectives of the course (roughly 30-40% of the class),

- ***Survivors:*** those students who passed the course but whose experiences in the course were typically marked by frustrations, low motivation, or modest affective growth (roughly 50-60% of the class),
- ***Excellers:*** those students who achieved cognitively and also demonstrated strong affective achievement in terms of motivation and the internalization of course-related behaviors (roughly 10-20% of the class).

Following Maslow's investigative approach, the research focused primarily on the excellers.[18] Informal feedback was obtained from the excellers to determine what experiences led to their successes. Surprisingly, the excellers never said, "I succeeded because I am smart." Examples of responses for those with recent course-related affective experiences were:

- "I wanted to live up to the instructor's belief in me."
- "The instructor cared about us on a professional and personal level and that brought the very best out of me."
- "In this class I did not just sit there – I met great people and started to see where I was going."

This feedback demonstrated in-class affective growth that positively contributed to the students' success. Other students had a pre-existing motivating vision before entry into our university:

- "I received awards in high school and ultimately realized that the important thing was to simply do the things that were meritorious."
- "I was encouraged by my friends who were also interested in academics."
- "I'm preparing myself to be a person, who in the future, can be counted on by others in important matters."

Each of the excellers had a personal vision that motivated them toward high achievement. The overall feedback and interaction with excellers underscored the importance of handling personal issues, gaining confidence through the successful completion of challenging tasks, receiving positive feedback, and the pursuit of meaningful personal values.

The initial data from the excellers suggested that the surviving and non-achieving student populations might benefit from sharing similar experiences. To test the hypothesis, it was decided that the educational setting should be used to further stimulate and guide more students to experiences that would encourage a broader realization of the desired affective growth with enhanced cognitive results as well. In Fall 2001, two approaches were tried: a self-reflective approach and a discussion-based approach.

**The self-reflective approach**

The self-reflective approach was used in two sections of the second semester of the introductory programming sequence. These students had previously not been exposed to the affective domain, only the pre-existing Bloom cognitive domain; this would be their initial exposure to the affective domain. These students were now required to use the following reflective tool based upon Bloom and Maslow's work. Use of this chart was intended to motivate the development of good habits in relation to the successful completion of programming assignments. This chart evolved into the "Bloom-Affective/Maslow" chart or "BAM" chart.

| Bloom's taxonomy<br><br>Maslow's needs | Receiving Support needed | Responding Actions needed | Valuing | Results: positive and negative | Lessons learned Organization Habits |
|---|---|---|---|---|---|
| Self-actualization needs | | | | | |
| Esteem needs | | | | | |
| Belongingness needs | | | | | |
| Security needs | | | | | |
| Basic needs | | | | | |

(chart should cover an entire page in landscape orientation)

**Figure 1: Bloom-Affective/Maslow chart**

The chart should be introduced to students as a tool for organized achievement, vision development, and the resolution of problems impeding the students' education. First the chart should be explained as needed. The students should be provided an opportunity to develop their reflections, and a period of meaningful class discussion should follow. To fill out the BAM chart, a student begins at the basic level and moves upward toward self-actualization. The basic needs should be understood as those needs that must be satisfied before significant progress can be made. Basic needs include the mastery of prerequisite knowledge, access to the required textbooks, the tools necessary to complete projects, course accommodations for personal disabilities, the management of personal problems, the ability to regularly attend class, a receptive attitude to learn, and a willingness to do what is necessary to complete the required tasks. Various insecurities can also block student progress and must be resolved quickly. Such insecurities might include unfamiliar subject matter, undeveloped skills, uneven course pace, or ambiguous objectives. At the belongingness level, the learner is moving from a sense of security toward a sense of growing competence. Affective experiences resulting from achievement at this level include sustained confidence, positive feedback, and synergy with others. Students have a high need for self-respect and respect from others with whom they come in contact. At the esteem level, students should identify personal aspirations or course goals relevant to the assignment, which will motivate the students throughout the project and upon completion provide a sense of high accomplishment and self-esteem. Positive feedback for achievement is essential at this level. From an educational perspective, self-actualization needs could be described as the goals corresponding to the student's fullest completion of a significant learning endeavor. Research indicates that students, who set specific goals to be met, will attain higher levels of motivation and achievement.[2, 15, 25]

At each level in the project planning phase, a student proactively identifies or discovers what support is needed (Bloom affective level 1: receiving), what student actions are needed (Bloom affective level 2: responding), and what kinds of values (Bloom affective level 3: valuing) must be attended to in order to produce a quality product. In retrospect, the student should note the positive and negative results of their effort and note lessons learned, the relations between relevant project values (Bloom affective level 4: organization), and habits to be internalized (Bloom affective level 5: characterization). An important issue for students in the introductory programming sequence is time management. This issue should be given particular importance in the lessons learned column (we collected data which demonstrated that many students spend far too without taking the necessary steps to satisfy the associated basic and security needs). Students often found the simple identification of necessary supports and actions needed as highly enlightening. Many students expressed surprise at the fact they could now control the outcome of their programming assignments and several saw how this could positively affect their future careers. This ability of college students to control their cognitive and affective achievements is documented also in the work of McKeachie.[20]

**The discussion approach**

Also in Fall 2001, the discussion approach was used in one section of the first semester of the introductory programming sequence. This approach involved numerous class discussions about the students' cognitive-affective potential. During these discussions students were encouraged to confidently order their learning experiences around the works of Bloom,[3, 14] Maslow,[17] Polya,[24] Whitehead,[28] Armstrong,[1] and others. Some of the principle subject matter discussed in the class, not including Bloom and Maslow whose work was previously described, is provided below with relevant classroom implications and experiences.

One valuable discussion tool was G. Polya's, *How To Solve It*.[24] Polya's four step problem-solving methodology: ***understand the problem, devise a plan, implement the plan***, and ***evaluate the effort***. This methodology was already central to the introductory programming sequence.[8, 23] But until recently our school's presentation of Polya's method was limited only to its cognitive dimension. A further look at his approach indicated the inclusion affective components as well. For example, while explaining the first step, Polya insists that difficult problems require not only an understanding but also a high motivation to achieve the solution. In relation to the second step, Polya extols the virtues of diligence, perseverance, adapting oneself to the trials at hand, and creating opportunities actively. During the third step, Polya reminds students to develop habits that lead toward the cautious and practiced development of incremental solutions. Finally, with regards to the fourth step, Polya offers the following encouragements: evaluation leads to further insight and whenever one discovery is made many more are near. All of these thoughts found practical application in the classroom as the students sought to overcome various difficulties. One particular student, who faced numerous problems, became known to all as the "where-there's-a-will-there's-a-way-guy." Integrating these affective strategies increased student confidence and motivation.

Another valuable tool for both instructor and student was Alfred North Whitehead's work, *The Rhythm of* Education,[28] in which he describes a cycle for successful learning consisting of three periods: romance, precision, and generalization. This technique provides a simple framework for instructors,[12] often untrained in formal educational techniques, to enhance their course content without unduly disturbing the pre-existing cognitive-based material. Many students have provided positive feedback and demonstrated cognitive achievement when this approach is practiced. Whitehead's cycle begins with a period of romance where students should attend to the wealth of possibilities inherent in the new subject. In this period, the learner should become fascinated with the broad significance of the idea and be motivated to actively pursue the more precise and more generalized investigations that follow. During the period of precision, students should understand that they must concentrate on mastering the relevant data collection techniques, notations, procedures, and problem-solving strategies. In the final period of generalization, students are guided to discover the worth of their learning efforts and appreciate the realized patterns, meaning, and general applications. This cyclical approach has provided a sequencing template for the integration of cognitive and affective objectives: the period of romance provides an ideal opportunity for the inclusion of affective objectives, the period of precision provides an appropriate venue for cognitive objectives, and the period of generalization provides the moment where the further growth in each domain as well as the interconnection between the domains can be explored in a conclusive manner.

Self-efficacy is a critical issue for many students in the introductory programming sequence. Frequently, students just disappear in the first few weeks of the course with no explanation. It is assumed these students have low self-confidence and simply panic when confronted with the unfamiliar and difficult task of programming. Class discussion, addressing the students' uncertainty and feelings of inadequacy, can calm some fears. Students have been encouraged by Thomas Armstrong, who in his work, *Awakening Genius in the Classroom*,[1] declares that all learners have a great potential for genius and achievement. Armstrong backs up his claim with scientific data, biographical accounts, and educational research. This ability of ordinary people to reach extraordinary achievement is also supported by the works of Horn,[13] Weisberg,[27] and Martinez.[16] Moreover, the research of many points to the potential of great learning opportunities which can in a short period of time propel students toward high levels of success.[1, 5, 11, 14, 19, 26, 28] Through these self-efficacy discussions students in the pilot class were motivated to pursue excellence. This observation is supported by the percentage of A's (31%) received in the pilot section, versus the percentage of A's (15%) in the control sections.

**Assessment of pilot study**

Instructional success in the pilot study was measured through use of questionnaires, observation of the classes, and student success as measured by course grades. It should be noted that the size of the pilot study was relatively small with regards to our total program. Only one of the five sections of the first semester of the introductory programming sequence and two of the three sections in the second semester of the introductory programming sequence were included in the pilot study.

To measure whether the blending of the cognitive and affective objectives was perceived as a positive experience by the students, we added a small questionnaire to our regular end-of-the-semester course survey. In this questionnaire, students were asked to use a 5-point Likert scale to assess the worth of various learning resources in relation to their overall achievement in the course. The scale ranged from low impact (1) to high impact (5). These results, shown in Table 1 and Table 2, indicate that the students valued the blending of the cognitive and affective objectives with scores of 4.87 (with 100% giving a score of 4 or 5), indicating extremely high positive impact, and 3.63 (with 84% giving a score of 4 or 5) also demonstrating a positive impact.

| Learning resource | Average Response (5-point scale) | Per cent of students indicating high impact (responses of 4 and 5) |
|---|---|---|
| The lecture in general | 4.56 | 100% |
| The blending of cognitive and affective course objectives in the lectures | 4.87 | 100% |
| The lab experience | 3.31 | 50% |
| The ownership of a laptop | 3.81 | 63% |
| The Supplemental Instruction program | 3.92 | 67% |
| The textbook | 3.37 | 50% |
| The supplemental handbook | 4.00 | 77% |

**Table 1: Pilot study assessment of learning resources in the first semester of the introductory programming sequence.**

| Learning resource | Average Response (5-point scale) | Per cent of students indicating high impact (responses of 4 and 5) |
|---|---|---|
| The lecture in general | 4.22 | 88% |
| The blending of cognitive and affective course objectives in the lectures | 3.63 | 84% |
| The lab experience | 3.33 | 50% |
| The Supplemental Instruction program | 3.53 | 52% |
| The textbook | 4.28 | 90% |

**Table 2: Pilot study assessment of learning resources in the second semester of the introductory programming sequence.**

Another assessment was a comparison between the success rates of the sections that participated in the pilot study and those that did not. The significance of these results is unclear due to the confounding variable of the different instructors in the various sections. However, the cognitive course content and pace were virtually identical. The sections participating in the pilot study showed 15% higher success rates as compared to the success rates of the control group.

| | Control Group Success Rate | Pilot Study Success Rate |
|---|---|---|
| **First semester introductory programming sequence** | 46% | 61% |
| **Second semester introductory programming sequence** | 53% | 68% |

**Table 3: Success rates from initial enrollment (% of students receiving A, B, or C)**

Through student reflections on the BAM chart and through observation of class discussions, it was also apparent that the students at least perceived a significant impact on their learning. Comments such as the following were recorded on BAM charts:

- "This program was a whole lot better than the first one. I was ready to drop my major (computer engineering) but now I love this."
- "I felt like I obtained awesome success."
- "I am actually wishing that we had a Java 3 class."
- "After doing a lot of practice, the program began to fall together and things became easier to understand."

In the first semester group, the central theme of the class became: "Where there is a will there is a way." This group also demonstrated strong appreciation of Bloom and Polya that is often lacking in the first semester of the programming sequence.

Each of the assessment methods used: self-test questionnaires, observation of the classes, and student grades, point to a positive impact on the learning process when affective and cognitive approaches are integrated. This positive impact is supported by Bloom who found that up to one-fourth of the variance on achievement in standardized tests is a result of affective factors,[4] that affective growth can occur in short period of time,[5] and that growth in either the cognitive or affective domain can lead to and enhance success in the other domain.[14]

**Current work**

Due to the positive results of the pilot study, beginning in Spring 2002, both approaches are being introduced into the first and second semesters of the introductory programming sequence. We are continuing the use of the self-reflection tool while incorporating the motivational approaches of Bloom, Maslow, Whitehead, and Polya into the teaching methods and learning objectives of these beginning courses. Additional tools are being developed based on the success of previous tools and the need for other types of self-reflection more appropriate to courses such as software engineering, advanced application development, and senior project. We are planning workshops for instructors that will demonstrate the methods and techniques of our approach. We are beginning to incorporate affective objectives into the introductory programming sequence lab experience, and we are developing affective objectives to be integrated with the existing cognitive objectives for the introductory programming sequence. We will continue to assess our work and are developing new instruments such as a much needed drop-assessment mechanism.

**Development of affective objectives**

We are beginning to develop affective objectives. First we measured the students' attitudes and beliefs about a variety of factors affecting instructional success. This survey used a 5-point Likert instrument and a Bloom-based instrument to measure affective objectives. Examples from these instruments are shown in Figures 2 and 3.

I am committed to quality work in this course.
☐ Strongly disagree ☐ Disagree ☐ Don’t know ☐ Agree ☐ Strongly agree

I believe that I am developing good problem-solving habits.
☐ Strongly disagree ☐ Disagree ☐ Don’t know ☐ Agree ☐ Strongly agree

I don’t expect my home life and work schedule to cause problems for me in this course.
☐ Strongly disagree ☐ Disagree ☐ Don’t know ☐ Agree ☐ Strongly agree

I often think of new ideas about how to apply concepts.
☐ Strongly disagree ☐ Disagree ☐ Don’t know ☐ Agree ☐ Strongly agree

**Figure 2: Likert scale instrument to measure affective objectives**

| **Statement** | **Response** |
|---|---|
| Working diligently for a course and putting forth one’s best effort is an important student responsibility. | __ N/A __ Aware __ Obey __ Value<br>__ Integrated value __ Crucial part of who I am |
| | |
| Immediately beginning work on assignments is an important student responsibility. | __ N/A __ Aware __ Obey __ Value<br>__ Integrated value __ Crucial part of who I am |
| | |
| A student must order his or her life outside of class such that it does not unreasonably interfere with studies. | __ N/A __ Aware __ Obey __ Value<br>__ Integrated value __ Crucial part of who I am |
| | |
| Coming up with relevant and creative thoughts is an important student responsibility. | __ N/A __ Aware __ Obey __ Value<br>__ Integrated value __ Crucial part of who I am |

**Figure 3: Bloom-based instrument to measure affective objectives**

Initial results from preliminary data suggest that the Bloom-based response scale, when compared to a 5-point Likert scale, produces a broader distribution of student responses. The Bloom-based scale offers two important advantages. First it is content-based as opposed to being based on high or low perceptions of agreement or internalization, and secondly it offers a direct one-to-one mapping from student responses to the associated Bloom affective level.

From the data gathered from both instruments, we are determining what affective priorities are most needed in the curriculum. Affective objectives will be formulated to address pressing problems not treated by the pre-existent cognitive-based approach. Bloom describes four steps for stating affective objectives: [5]

1. Identify a general construct such as valuing, enjoyment, or attention.
2. Specify component constructs within the broader construct.
3. Express each component construct using actions verbs such as accepts, obeys, and seeks.
4. Determine situations that demonstrate the presence or lack of constructs.

This methodology will guide the current development of affective objectives being undertaken in Spring 2002. The results of this continued work will be reported at a future date.

## Conclusions

The goal of our described effort is to begin the work of systematically addressing issues that were not addressed by our established cognitive-based approach. These non-addressed issues include student motivation, student problems external to the educational setting, high failure rates, academic misconduct, and other issues belonging more to the affective domain. The chosen and described instructional approach integrates the works of Bloom and Maslow. These works provide complimentary and compatible frameworks that support our overall goal of addressing cognitive and affective objectives in an integrated format. Bloom's work forms a foundation for the creation of affective and cognitive objectives with the identification of specific target levels of achievement. Maslow's work provides a more personal framework where students can identify their own cognitive-affective objectives through self-reflection and handle many external problems without instructor intervention. Support for this integrated approach was also found in Whitehead's periods of learning which provide a simple framework that orders the presentation and sequencing of affective and cognitive objectives. Particularly appropriate for the introductory programming sequence, Polya's work provides students with a direct mechanism for a concurrent experience of cognitive and affective pursuits within a single problem-solving strategy.

The pilot study combined theory and practice. It was built upon the pre-existing cognitive-based framework. The pilot study also draws upon and builds upon other mature educational experiences using Bloom[10] and Maslow.[6] The pilot study demonstrated positive results and now serves as the basis of this emerging work. Practical examples and experiences have been provided to assist in the implementation of similar endeavors that might be undertaken by others. Specific contributions of this work include the use of the Bloom-Affective/Maslow reflection tool, the Bloom-based instrument to measure affective objectives, as well as the specific structure of our proposed integrated framework. Realized benefits include a 15% increase in students successfully completing the introductory programming sections in the pilot study, and strong student appreciation for both the discussion approach and the reflective approach as learning resources. Anticipated benefits include a better understanding of the students entering the introductory programming sequence, higher student motivation and less frustration, greater retention, and more successful students who will better fill the demand from industry for high quality graduates.

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