Affective Factors and Student Achievement: A Quantitative and Qualitative Study

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Abstract - The affective domain can be used to support the internalization of cognitive content and foster the development of curriculum and industry-related interests, attitudes, values, and practices. During a two-year period, using validated instruments, the authors measured student interest, value, effort, perceived competence, lack of pressure, student-peer belonging, and student-faculty belonging. Initial findings included a positive correlation between each affective factor and course grade, a significant decrease in the levels of affective factors over the course term, and a lessening of those decreases with the use of specific affective objectives and instructional strategies. The current study built upon these initial results by incorporating new quantitative and qualitative data for each affective factor. The paper reports on the results of these analyses and offers practical suggestions and instructional guidelines based upon the findings. These findings appear to be broadly applicable throughout our curriculum and could extend to other science, mathematics, engineering, and technology disciplines.

Index Terms – affective domain, affective factors, assessment, cognitive-affective integration, instructional guidelines, introductory programming course, motivation.

INTRODUCTION

Background

To pursue excellence systematically in higher education, a standard for excellence is needed. One such standard, created by the National Association of Colleges and Employers (NACE), has been recognized by ACM/IEEE Computing Curricula 2001 [1]. This standard identifies the top 10 characteristics most wanted by industry in college graduates: communication skills, honesty/integrity, teamwork skills, interpersonal skills, motivation/initiative, strong work ethic, analytical skills, flexibility/adaptability, computer skills, and organizational skills. Rather than being a statement that affective characteristics are more important than cognitive characteristics, this list’s emphasis on affective characteristics probably reflects the evident absence of these affective characteristics in many graduates.

Langdon, a prominent performance technologist, identifies four types of performance states: establishing performance, improving performance, maintaining performance, and extinguishing performance [11]. These performance states can form a useful backdrop for understanding some of the major issues facing the sciences, mathematics, engineering, and technology disciplines. Such issues include the attraction (i.e. establishing performance) and retention (i.e. maintaining performance) of high quality students (i.e. talented students engaged in improving performance). Reasons for quality students leaving these disciplines (i.e. undesirable extinguishing performance) include non-sustained student interest, boring content, the lack of social relevance, the attraction of other disciplines, poor teaching, the difficulty of discipline, curriculum overload, discouragement due to low grades, inadequate prior knowledge, an over-emphasis upon competition, group biases, an intimidating atmosphere, inadequate faculty support, inadequate peer support, class sizes, financial problems, and family responsibilities [8, 13, 16, 23, 25]. Many of these causative factors are affective in nature and act to produce a de-motivating environment that negatively affects not only those students who leave but also many persisting students.

In industry, motivational systems are integral components of initiatives to enhance productivity, individual growth, and group effectiveness [24]. In education, motivation is also seen as a necessary ingredient and the primary source of energy that leads to high performance [20]. Biologists and neurologists are reporting on the powerful impact affect has on the physical process of learning in the brain [12, 27]. Some are suggesting that affect has more influence on learning than does cognition [27]. Schunk [22] and Pintrich [20], however, describe the relationship between cognitive achievement and affective achievement as “reciprocal” (i.e. mutual interacting determinants of each other). Our experience as well indicates that excellence is fostered by integrated affective-cognitive achievement.

Purpose of Study

The purpose of this study is to provide quantitative and qualitative data and analysis about the relationship between affective and cognitive achievement. Specifically, this study seeks to answer the following questions: (1) Which of a variety of affective factors significantly correlates with course grade? (2) What is the effect size of those factors which do significantly correlate with course grade? (3) Do the levels of these affective factors increase or decrease during the semester? (4) Why do the levels of these affective factors
increase or decrease? (5) Do these correlations show gender effects? (6) Do these affective factors act as independent factors or can some be grouped together? (7) Are there any practical suggestions that can be made in terms of instruction and the learning environment?

**METHODOLOGY**

**Bloom-based cognitive framework**

Our current work is an extension of long-term efforts to improve our curriculum. In 1994 our school established a Bloom-based cognitive framework for our introductory programming sequence [7]. This effort generated materials which were transferable to other instructors and ensured that a common set of objectives were being met in these foundation courses. Though students reported that they perceived this approach to be beneficial, we did not see a sustained improvement in course-completion rates (rates commonly fell in the 30 to 50% range). It was realized that there were untreated factors, outside the cognitive domain, that were impacting student success rates.

**Early affective initiatives**

In Fall 2000, in order to address these untreated factors and to promote student excellence, an affective initiative was introduced in some course sections. Students were encouraged to make specific “commitments to quality” which were associated with each of module of the course. The rationale behind these commitments to quality was to encourage students to move beyond compliance to instructor assignments and achieve a level of internalization consistent with personal preference or valuing that is level 3 in Krathwohl’s affective taxonomy [10]. Examples of such commitments are: the practice of reflective problem-solving, creation of meaningful documentation, writing cohesive methods, and constructing reusable classes. This set of commitments to quality was incorporated into the established cognitive framework in the form of a student handbook. This effort led to the identification of three groups of students: non-achievers, survivors, and excellers. We then hypothesized that survivors and non-achievers could benefit from the cognitive-affective experiences of the excellers.

We tested this hypothesis by introducing two affective initiatives during 2001 and 2002: the discussion approach [5, 6], which encouraged students to self-regulate their cognitive and affective growth through numerous classroom discussions, and the self-reflection approach [5, 6], which involved the use of a tool called the BAM (Bloom-Affective-Maslow) chart, which was designed to assist students in attaining course-related goals through self-reflection. These two affective initiatives were based on the works of Bloom [3], Krathwohl [10], Polya [21], Maslow [14], and Whitehead [26]. These initiatives did not replace but were integrated into our school’s existing Bloom-based framework. The integration of these initiatives resulted in an enhancement of our school’s existing Bloom-based framework [6].

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Beginning with the affective sections, course completion rates began to improve [6]. This improvement has also begun to generally apply to other sections not incorporating specific affective objectives as well (typical course completion rates now commonly fall in the 55 to 70% range). We believe that this trend has resulted from an ongoing dialog, which occurs in the form of weekly meetings, between all course instructors in these introductory programming courses. Specifically, it appears that the cognitive content is enriched by the cooperation between the instructors and that from an affective perspective the course is being taught in a more learner-centered manner.

**Current study**

This study was conducted in Fall 2003. The students in the study were students in our introductory programming course which is a two-semester sequence, CIS 120 and CIS 121. There were five sections of CIS 120 with 114 total students. One of those sections used the specific affective initiatives described in our previous publications [5, 6], while the other sections were taught in a more traditional manner using the Bloom-based cognitive framework established at our university [7]. There were three sections of CIS 121 with 42 total students, and all three sections were taught with integrated affective objectives (this developing set of these objectives remain a work in progress).

**Comparison of sections**

This study does not compare affective sections to non-affective sections for three primary reasons. First, such comparisons would be invalid due to the confounding variables of different instructors, different lab assistants, and the strong potential for significantly different student groups in the sections. Second, and perhaps most importantly, is the fact that such competition among instructors would jeopardize the positive developments which appear to occur as a result of the collaboration that exists between all the course instructors. This collaboration benefits both affective and non-affective sections. Third, a valid comparison between sections would require a single standardized objectives-based instrument which does not exist for our course at this time.

**Assessment instruments**

This study, in order to better understand the affective domain and its relation to cognitive success, used two validated instruments, the Intrinsic Motivation Inventory (IMI) [15] and Anderson-Butcher’s Belonging Scale [2]. Each is tailor able to specific programs and we tailored each to our Computer and Information Science (CIS) environment. The IMI has a broad set of affective scales from which researchers can chose specific scales. From the larger set, we chose interest/enjoyment, value/usefulness, perceived competence, effort, and the lack of pressure. Anderson-Butcher’s Belonging Scale measured belonging, defined by the collective aspects of connectedness, commitment, and engagement [2]. The belonging factor contained two sub-factors: student-peer belonging and student-faculty belonging.
Our tailored IMI and Anderson-Butcher’s Belonging Scale were administered together as pretests and posttests using a seven point Likert scale gauging agreement or disagreement with the presented item.

In an earlier study [16], we found that these affective factors generally dropped significantly from pretest to posttest. To check the validity of these results and gain insight into affective factors contributing to these drops, we added a midterm instrument to our pretest and posttest instruments. In the midterm instrument, students were asked whether three specific affective factors (e.g. value, interest, and effort in CIS) had increased, stayed the same, or decreased. Then, for each of these factors, the students were asked to provide qualitative data in the form of two or three thoughtful sentences which explained why each factor increased, stayed the same, or decreased for them. We limited each student to 3 affective factors in order to obtain thoughtful responses in a 10 to 15 minute time frame. The pretest, posttest, and midterm instruments were administered anonymously but coded so that the responses could be matched with course grades by a researcher.

RESULTS

Bivariate correlations using Pearson correlation coefficients were calculated for the pretest and posttest scores for each affective factor with course grade. The Pearson correlation coefficient, $r$, is an effect size statistic. This statistic, in the behavioral sciences interprets values of .10, .30, and .50 as small, medium, and large effects, respectively [9] (see column 2 of Table I). None of the affective pretest scores showed a significant correlation with course grade. However, all of the posttest scores showed a significant correlation with course grade. The correlations between the posttest affective factor scores and course grade are shown in Table I. This table also provides a column for representative responses from students who stated that the affective factor increased for them during the semester.

Correlations with course grades by subgroups

The women ($n = 48$) in this study had higher but not significantly different grades than men ($n = 107$). The women’s grades also appeared to be more sensitive to effects of the affective factors than men’s grades. All posttest affective factor scores for women significantly correlated with course grade. By comparison, only perceived competence and lack of pressure for men ($n = 107$) correlated with course grade.

Posttest scores for students making A, B, or C grades ($n = 81$) showed significant correlations with perceived competence, lack of pressure, and value. Posttest scores for students making D, F, or W (withdrawal) grades ($n = 9$) showed a significant correlation with belonging and effort. The DFW group has a very small sample size, and we did not get posttest data from students who had already dropped the course, thus any interpretation should be viewed with caution, but it seems to suggest that this group is acknowledging a problem with the effort they put forth and with their ability to meaningfully belong to the class.

| TABLE I |
| SAMPLE STUDENT RESPONSES SHOWING INCREASES IN FACTORS |

<table>
<thead>
<tr>
<th>Posttest Factor</th>
<th>Pearson Coefficient</th>
<th>$p$-value*</th>
<th>Student response representing an increase in the factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest</td>
<td>$r(88) = .217$</td>
<td>$p = .040$</td>
<td>“Now that I actually know what working with programs is somewhat like, I find I enjoy it! I also like the challenge that problem solving involves.”</td>
</tr>
<tr>
<td>Value</td>
<td>$r(88) = .350$</td>
<td>$p = .001$</td>
<td>“The value I place in this class on a scale of 1-10 would be a 10. Because we are a team in here and I know that I am an asset to my team. I have to be here.”</td>
</tr>
<tr>
<td>Effort</td>
<td>$r(88) = .257$</td>
<td>$p = .025$</td>
<td>“My instructor has high expectations and I, like others, respond to that positively and work harder in this class as well as other classes.”</td>
</tr>
<tr>
<td>Perceived Competence</td>
<td>$r(88) = .446$</td>
<td>$p &lt; .0005$</td>
<td>“I learned how to manage my time a little better to get these assignments done.”</td>
</tr>
<tr>
<td>Lack of Pressure</td>
<td>$r(88) = .298$</td>
<td>$p = .004$</td>
<td>“Since I have stayed up-to-date on material, and am better at comprehending the material, I do not feel as pressured when doing my work and studying.”</td>
</tr>
<tr>
<td>Overall Belonging</td>
<td>$r(88) = .352$</td>
<td>$p = .001$</td>
<td>“Before I took CIS 120 I didn’t know for sure I wanted to go into computer science for a living. Now I am sure this is what I want to go into.”</td>
</tr>
<tr>
<td>Faculty Belonging</td>
<td>$r(88) = .236$</td>
<td>$p = .025$</td>
<td>“I feel that the people I’ve met - teachers and peers, have helped me to feel wanted here. It is nice to know that someone is usually always here, even after work hours.”</td>
</tr>
<tr>
<td>Peer Belonging</td>
<td>$r(88) = .228$</td>
<td>$p = .031$</td>
<td>“I feel better because I am with many people. I am alike but still different and diverse. We all share common goals via computers, which helps us all get along and have fun.”</td>
</tr>
</tbody>
</table>

*For factor’s correlation with course grade

High intensity instrument items

Some insight into these affective factors may be gleaned from an identification of the items with the highest Pearson coefficient for each factor or sub-factor as shown in Table II. Use of these items might include a basis for conversation breakers with students in class or during office hours. For example, an instructor interested in a student’s valuing of a course could ask a student to state personal goals and describe...
how this class can help student attain those goals. Instructors might also want to support students’ belonging by observing behavior during group work and having students fill out peer evaluations in order to determine how each member is accepted.

**TABLE II**

<table>
<thead>
<tr>
<th>Factor</th>
<th>Item</th>
<th>Pearson Coefficient</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived</td>
<td>I am satisfied with my performance in this course.</td>
<td>( r(88) = .536 )</td>
<td>( p &lt; .0005 )</td>
</tr>
<tr>
<td>Competence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Value</td>
<td>I think that this course is important because it will help me obtain my goals.</td>
<td>( r(88) = .366 )</td>
<td>( p &lt; .0005 )</td>
</tr>
<tr>
<td>Effort</td>
<td>It is important for me to do well in this course.</td>
<td>( r(88) = .364 )</td>
<td>( p &lt; .0005 )</td>
</tr>
<tr>
<td>Lack of</td>
<td>I have been very relaxed while programming on my laptop.</td>
<td>( r(88) = .362 )</td>
<td>( p &lt; .0005 )</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>I think that I have been a valued member of this class.</td>
<td>( r(88) = .331 )</td>
<td>( p = .003 )</td>
</tr>
<tr>
<td>Belonging</td>
<td>I have been accepted by the course instructor.</td>
<td>( r(88) = .247 )</td>
<td>( p = .019 )</td>
</tr>
<tr>
<td>Faculty</td>
<td>Learning computer language syntax has not held my attention.*</td>
<td>( r(88) = .245 )</td>
<td>( p = .020 )</td>
</tr>
<tr>
<td>Belonging</td>
<td>I have been accepted by the students in this class.</td>
<td>( r(88) = .217 )</td>
<td>( p = .040 )</td>
</tr>
</tbody>
</table>

*scored as a reversal

**Decreases in affective factors**

In a smaller study in Spring 2003 [16], we administered similar pretests and posttests and found that the levels of affective factors dropped significantly over the course of the semester in the first semester of our introductory programming course (all factors dropped except student belonging). Paired-samples \( t \) tests performed on the differences between the pretest and posttest scores in the current study confirm these significant drops in all affective factors. In contrast to these findings, however, the quantitative responses at mid-semester indicate that the students perceive their affective factors as generally increasing. For example, 55% of student at mid-semester report that their interest has increased, while 34% report that their interest has remained the same, and only 11% report a decline in interest (yet the pretest-posttest difference for interest indicates a significant negative drop). The only affective factor not following this pattern in the mid-semester instrument is the lack of pressure where 57% of students report a decline in the lack of pressure (i.e., an increase in pressure). Several hypotheses might explain the discrepancies between the pretest/posttests results and the midterm results including: (1) that the students’ affective levels drop after midterm, (2) that the pretest scores are indicative of beginning-of-the-semester idealism, and (3) the posttests are indicative of end-of-the-semester burn-out. As a follow-up to this study, we are at the time of this writing administering the pretest at the 1/3 mark of the semester and the posttest at the 2/3 mark of the semester to get a better sense of this pattern.

**Grouping affective factors**

A factor analysis was also performed on our 38-item posttest instrument. The purpose of this analysis was to investigate if any of the factors from the tailored IMI and Anderson-Butcher’s Belonging Scale instruments might act as single factors in our environment or in our discipline. Using the scree plot produced by the analysis and the maximum likelihood criteria for the factor analysis, five independent factors were identified. The identified five factors were (1) competence and lack of pressure, (2) value and interest, (3) effort, (4) peer belonging, and (5) faculty belonging. A representative response from our midterm instrument indicating a link between perceived competence and lack of pressure is: “Due to the hard nature of this course and my doing well in it, I feel that the pressure has decreased, because if I can do it in this course then I can do it in my other CIS courses.” The link between value and interest is similarly expressed in another response: “Being shown what can be accomplished with programming, I would definitely say that my interest has increased.”

**Qualitative analysis**

Qualitative responses from the midterm instrument were analyzed using a phenomenological approach [19] which identifies key sentences, interprets them, and identifies recurring features. Several themes emerged from the student responses using this approach for each of the factors.

The responses for competence and pressure were combined for analysis due to the results of the factor analysis. Those reporting decreases in these factors often mentioned information overload, programming taking up too much time, programs being too hard and becoming increasingly difficult, inadequate assistance, and the course being much more difficult than other courses. Those reporting increases in competence and lack of pressure often mentioned the satisfaction which comes through challenge, having a good instructor, learning useful skills, solving problems, and learning in a friendly environment.

Several themes also emerged from the student responses concerning value and interest. The results of these factors were also combined for analysis due to the results of the factor analysis. There were some conspicuous differences between male and female responses. Men often mentioned the challenging aspect of CIS, the coolness of CIS, interest in programming, and control over machines as reasons for their interest and value levels increasing. Women often mentioned the societal importance of computing, pair programming, and teamwork as reasons for their interest and value levels increasing. Women and men also often mentioned good instruction, wanting to learn more, and career opportunities. The men and women reporting declining interest and value most often mentioned the difficulty of programming assignments.
Several themes also emerged from the student responses concerning effort. Students often attributed their increases in effort to the necessity of responding to a very difficult course, having a good instructor with high expectations, wanting to increase their knowledge, wanting good grades, being prepared to succeed in the next class, and looking forward to a rewarding career. Students indicating improving effort also mentioned positive self-confidence, challenge, motivation, and enjoyable classroom participation.

Several themes also emerged from the student responses concerning belonging. Reasons for decreases in belonging centered upon the students’ poor performance in the class. Other reasons were lack of interest, isolating work, and exclusion from subgroups. Increases were attributed to getting to know other students, making good grades, working in teams, positive experiences interacting with peers and faculty, and the strengthening of the decision to be a CIS major.

**PRACTICAL SUGGESTIONS**

In an effort to reduce or remove the decreases in affective factors and to promote student excellence, we recommend the establishment of course specific affective objectives that support the curriculum. These affective objectives provide direction for cognitive-affective development and provide standards for instructors who may implement the objectives using the methodologies of the instructors choice. These instructional efforts, however, must be assessable in order to evaluate their effectiveness.

Assessment is not as straight forward as cognitive assessment, but can be facilitated by the use of active learning and cooperative learning which also have been shown to associated with high learner achievement [4, 17]. Active and cooperative learning activities provide opportunities for instructors to assess not only what students know but what they choose to do. Organizing students into groups also facilitates this assessment by lowering the number of assessments that must be made. Active and cooperative learning also tend to lessen the amount of pressure on students. This lessening of pressure and fear opens up the possibilities for the student’s intrinsic reward system to become engaged and for dynamic learning to take place [27].

Listed below are specific suggestions that we have implemented to support a cognitive-affective model of achievement.

- **Student-faculty belonging:** Forming meaningful relationships with students and encouraging them to come to your office during office hours
- **Student-peer belonging:** Encouraging students to join learning communities through group work, supplemental instruction programs, and peer-mentoring
- **Self-regulated learning:** Encouraging students to develop their own vision of success that justifies the large effort that they will need to put forth to succeed in the discipline
- **Goal-setting:** Encouraging students to make class-specific plans on how they will succeed in the course
- **Effective assignments:** Giving students well-designed and reasonable assignments
- **Positive reinforcement:** Praising students when they achieve and excel
- **Course connections:** Finding numerous opportunities to connect the class with the “real world” and with other courses in the curriculum
- **Active and cooperative exercises:** Designing classes rich in active learning exercises, discussion, cooperative learning, group work, and problem solving
- **Break the routine:** Providing ways to break the routine and to have fun in class with games or other alternative learning experiences
- **Mainstream the content:** Teaching toward the middle of the class’ aptitude in order to encourage meaningful classroom-wide participation
- **Challenge the excellers:** Providing further opportunities for the excellers to excel by pointing them toward good resources which will enable them to pursue personal goals beyond the course expectations
- **Implement integrated affective objectives:** Leverage the affective domain to support the internalization of cognitive content and foster the development of curriculum and industry-related interests, attitudes, values, and practices
- **Small class sizes:** Limit the introductory course class sizes reasonably (e.g. 25 to 30 students)
- **Establish performance:** Provide students with high quality guided opportunities to develop their skills and establish themselves in the program, so that the introductory courses are characterized by establishing performance rather than by extinguishing performance.

**CONCLUSION**

This study recommends the use of affective initiatives which are designed to realize specific affective objectives. Affective development is promoted by NACE [1] and associated in the literature with student cognitive achievement. Several practical instructional suggestions, such as active and cooperative learning are proposed as straightforward means to implement and assess affective objectives. All affective factors, in this study, as measured by posttest scores showed significant correlations with course grade. Two gender effects were also found in this study: (1) women’s course grades are more sensitive to affective factors and (2) women express an interest in the social dimensions of computing and learning more often. The affective factor correlations with course grade in this study lend support to the reciprocal relationship between the cognitive and affective domains for CIS disciplines. It was also found that in our CIS environment that interest and value acted as a single affective factor, and that lack of pressure and perceived competence also acted as a single factor. Qualitative data was used to provide further insight to further describe the relationship between the specific affective factors and cognitive achievement. The results of this study may be limited by the specifics of our environment.
An unanswered question from this study, which is being studied further, concerns the changes in affective levels over the course of the semester.

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