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The Predictive Validity of a Measure of Deep Approaches to Learning

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Abstract

Based on data collected from 383 students at three Indiana colleges and universities, this study found a positive relationship between the measure of deep approaches to learning (DAL) on the National Survey of Student Engagement and critical thinking dispositions (measured by the California Critical Thinking Dispositions Inventory). The study also found a positive relationship between the DAL measure and reflective thinking skills (measured by the Reasoning about Current Issues test) for students who had mostly A's in high school. No relationship was found between the measure of DAL and critical thinking skills (measured by the California Critical Thinking Skills Test).

The Predictive Validity of a Measure of Deep Approaches to Learning

Messick (1989) defines validity as an integrative evaluative judgment of the degree to which empirical evidence and theoretical rationales support the appropriateness of inferences and actions based on scores or other modes of assessment. This study seeks to provide further evidence of the validity of a scale intended to measure college students' deep approaches to learning (DAL) by empirically establishing its relationship to cognitively complex forms of thinking and reasoning, specifically critical thinking and reflective judgment. The literature on DAL and empirical evidence support the theoretical supposition that DAL lead to increased understanding, better thinking, and increased reasoning skills (Ramsden, 2003). Consequently, the validity of a measure of DAL is supported when the measure is positively related to indicators of "deeper" thinking and reasoning.

Deep Approaches to Learning

DAL have received more attention in recent years as colleges and universities employed active, learner-centered activities to foster essential learning outcomes (AAC&U, 2007; Tagg, 2003). In particular, the shift from passive, instructor-dominated pedagogy to active, learner-centered activities promises to take students to deeper levels of understanding, thinking, and reasoning as they apply what they are learning to real life situations (Lave & Wegner, 1991; Tagg, 2003). In essence, colleges and universities are trying to promote deeper approaches to learning so that students learn more deeply.

"Deep," rather than surface, approaches to learning focus on substance but also on the underlying meaning of the information being acquired (Marton & Säljö, 1976). In contrast, a "surface" approach is focused solely on the substance of information; in such an approach rote learning and memorization dominate (Biggs, 1989; Tagg, 2003). The goal of a surface-level

approach to studying for a test or exam is to avoid failure, whereas a student using a deep approach aims to grasp key concepts and understand the relationships of these concepts to other information they know as well as how the information applies to other circumstances (Beatie, Collins, & McInnes, 1997; Bowden & Marton, 1998).

Approaching learning deeply is important because students who use such an approach tend to earn higher grades and process information better (Biggs 1988; Entwistle & Ramsden, 1983; Prosser & Millar, 1989; Ramsden, 2003; Van Rossum & Schenk, 1984; Whelan, 1988). Using DAL is also associated with an enjoyable learning experience, while surface approaches tend to be less satisfying (Tagg, 2003). Deep approaches are characterized by a personal commitment to better understanding material, which in turn is demonstrated by activities such as drawing on a variety of resources, discussing ideas with others, and reflecting on how individual pieces of information relate to larger constructs or patterns (Biggs, 1987, 1989, 2003; Entwistle, 1981; Ramsden, 2003; Tagg, 2003). Those who use DAL tend to integrate and synthesize information with prior learning and attempt to view things from different perspectives (Ramsden, 2003; Tagg, 2003).

Deep Approaches to Learning on the National Survey of Student Engagement

Several items on the National Survey of Student Engagement (NSSE) tap experiences and behaviors indicative of DAL, such as taking courses that emphasize analyzing and synthesizing information, trying to understand alternative perspectives, and integrating one's learning across contexts. As measured on NSSE, the DAL scale is composed of three sub-scales: higher-order learning, integrative learning, and reflective learning (see Table 1 for a complete depiction of the scale, sub-scales and component items). Studies using this scale established that it is internally valid and reliable (Nelson Laird, Shoup, & Kuh, 2006, Nelson Laird, Shoup, Kuh,

& Schwarz, 2008). In addition, its validity has been supported by evidence showing the scale's positive relationship with student self-reported gains, grades, and satisfaction (Nelson Laird et al., 2008). The positive relationship with grades is not surprising given the prior research connecting DAL to outcomes, most of which focuses on grades as an indicator of academic achievement.

Deep Approaches to Learning and Outcomes

Imbedded in the work connecting DAL and outcomes is an assumption that academic achievement is a proxy for deep thought, greater understanding, and improved academic skills. Unfortunately, this area of research is limited by its near total focus on grades as an indicator of academic achievement.

According to Biggs (1987, 1995) academic achievement should be positively correlated with deep approaches and negatively with surface approaches. On the whole, research findings support his proposition. Though prior academic achievement is considered the primary predictor of current academic achievement, many still agree a positive relationship exists between students approaches to learning and such outcomes (e.g. Hall, Bolen, & Gupton, 1995; McKensie & Schweitzer, 2001; Zeegers, 2004; Zhang 2000). For example, Zeegers (2004) tested two causal models of academic achievement among first and third year Australian students in higher education in order to explore if any consistent contributors to learning outcomes exist over time. Both models indicate that even though multiple factors may contribute to learning outcomes, only a few appeared to have direct and measurable effects. He found prior academic achievement remained the best predictor of academic performance, but, once controlled for in the models, results also showed both deep and surface approaches had direct effects on overall GPA. Specifically, a deep approach showed a direct, positive effect on first- and third-year students'

overall GPA, whereas a surface approach had a direct and increasingly negative effect on students' GPA as they moved from their first- to third-year. Similarly, Zhang (2000) found US students who used DAL tended to have higher GPAs regardless of their self-rated analytical, creative, and practical abilities. And Hall, Bolen, and Gupton (1995) concluded an achieving approach, one type of deep approach to learning, significantly predicted GPA for their upper ability group.

Combined these research findings support the notion that DAL lead to higher GPAs, especially for those whose motives and strategies are aligned with their achievement approach. And while there has been an over-reliance on GPA as an indicator of deep learning, other work shows significant correlations with other learning outcomes across disciplines (Vermunt & Vermetten, 2004). For instance, Vermunt (1992) found, depending on the subject area and learning environment (i.e. distance education or traditional classroom), 25-55% of the variance on students' exam results could be explained by their approach to learning. Lonka and team (1997) showed a positive association between meaning-directed learning, a kind of deep approach, and students' portfolio grades in an innovations course study as well as medical students' achievement in preclinical and clinical courses. Others in engineering and physics found students who took a deep approach to learning were less likely to fail or withdrawal from the course (Roswell, Dawson, & Pollard, 1993) and more likely achieve a better GPA and earn more credits per year (Tynjälä, Salminen, Sutela, Nuutinen, & Pitkänen, 2005).

Scholars in the science, technology, engineering, and mathematic fields seem to have a particular interest in learning outcomes associated with DAL (NSF Advisory Committee 1996). Critical thinking is on type of thinking skill valued in these fields. For example, a study by Chapman (2001) examined the development of critical thinking skills of an introductory biology

course after deep learning skills (i.e. active and higher-order learning skills) were emphasized. Following the notion, "…students learn best when actively constructing their understanding rather than absorbing it (pg.1157)," Chapman found critical thinking and higher-order learning skills were developed when traditional content was removed to make room for more complex learning. In other words, when instructors emphasized a meaning-oriented approach (deep), rather than reproducing-oriented approach (surface), it gave students more time to deeply engage in the material–leading to the adaption of critical thinking and higher-order learning skills. Also, the study showed content knowledge was gained despite the fact that typical surface approaches to learning, such as memorization of facts, were not employed. Another study examining biochemistry students and their conceptions of and approaches to learning the course content found those with cohesive conceptions were more likely to adopt deeper approaches than those with fragmented conceptions (Minasian-Batmanian, Lingard, & Prosser, 2006). Interesting though, some students with a cohesive conception of biochemistry did not always translate into DAL. This lends some evidence to the notion that scaffolding is, indeed, necessary before students are able to engage in deep learning. Minasian-Batmanian and others (2006) emphasized the importance of building an overarching conception of the topic for students before application and integration are possible.

Purpose

While a substantial amount of evidence suggests that DAL are positively connected to academic achievement, there is an over-reliance in the literature on GPA as a measure of that outcome. Some evidence suggests positive relationships between DAL and "deeper" thinking, like critical thinking, but much more is needed. Further, the predictive validity of the NSSE DAL scale, to date, relies solely on outcome measures found on the instrument. Establishing the

relationship between the NSSE scale and accepted measures of cognitive or thinking outcomes is essential to confirming its validity as a measure of DAL. However, as some others point out, the connection between DAL and outcomes may be conditional on characteristics such as prior academic performance (Biggs, 1987; Hall et al., 1995; Minasian-Batmanian et al., 2006).

This study seeks to further validate the DAL measure contained on NSSE by establishing its empirical relationships to critical thinking dispositions and skills as well as the recognition of reflective reasoning. Further, this study examines whether the strength of those relationships varies by student characteristics.

Methods

Data Collection and Sample

The data for this study come from undergraduate students enrolled at three Indiana colleges and universities. In the spring of 2007 and 2008, students who responded to email invitations or posted flyers completed four survey instruments in proctored computer lab sessions that lasted up to two hours. For their participation, students in the study received a retail gift card worth 30 dollars.

After deletion for missing data, 383 students remained in the sample (most of the deleted cases were missing ACT or SAT scores or did not have a class standing). About 60% of the participants were women and 22% were students of color (74% White, 4% did not report a race). In high school, about 70% got mostly A's or A-'s, while 30% reported getting B+'s or below. The average ACT score for the sample was 26, after converting SAT scores to ACT scores based on the College Board's most recent concordance table (see professionals.collegeboard.com/data-reports-research). Of the students, 14% were transfer students, 94% were pursuing college full-time, 70% lived on campus, 3% were varsity athletes, and 20% were members of a fraternity or

sorority. Students were from a wide range of majors (10% in the arts and humanities, 14% in the natural sciences, 46% in professional fields including business, 18% in the social sciences including education, and 12% in other majors including undecided students).

The distribution across class years was relatively flat, with 27% first-year students, 21% sophomores, 29% juniors, and 23% seniors. We limited the sample to students 30 years or younger. Only a few older students participated in the study, which was not enough to adequately represent that population. Due to that restriction of the sample, class year and age were highly correlated. As a result, only class year was retained in the analyses.

Instruments and Measures

Each student responded to the items on the NSSE instrument (the 2007 version was used), the California Critical Thinking Dispositions Inventory (CCTDI), the California Critical Thinking Skills Test (CCTST), and the Reasoning about Current Issues test (RCI). The measure of interest from NSSE was the DAL scale (Nelson Laird et al., 2006). The overall DAL scale is a composite of three sub-scales: higher-order learning (how much students' courses emphasized high-order cognitive skills such as analysis and synthesis), integrative learning (how often students brought together ideas from different courses or contexts), and reflective learning (how often students analyzed the strengths and weaknesses of their own positions or tried to imagine alternative perspectives to their own). Table 1 contains complete item wording and reliability estimates. Each component item, the sub-scales, and the overall scale range from 1 to 4.

Since experts from several fields agree that a critical thinker must possess both a set of thinking skills and the habits of mind necessary to use those skills (American Philosophical Association, 1990), students' critical thinking was measured in this study using a pair of instruments suitable for undergraduates. The CCTDI, a 75-item questionnaire, measures whether

a person habitually exhibits the mindset of an ideal critical thinker (Facione, Facione, & Giancarlo, 1998). The CCTST, a 34-question multiple-choice test, measures whether a student has the analytic, inferential, and evaluative skills of critical thinking as well as the ability to reason inductively and deductively (Facione, Facione, Blohm, Howard, & Giancarlo, 1998).

Instruments like the CCTST have been criticized for their inability to capture the type of reasoning involved in making evidenced-based judgments regarding issues about which reasonable people disagree (i.e., ill-structured problems). King and Kitchener's (1994) model of reflective judgment is, in part, based on their response to this inherent problem in tests of critical thinking skills. Though King and Kitchener used interviews to probe students' epistemic cognition, the RCI is a web-based test of how well students recognize the different levels of reasoning within the King and Kitchener model (Wood, Kitchener, & Jensen, 2002).

Analysis

To establish the relationship between DAL, as measured on NSSE, and the three thinking outcomes, each outcome was regressed on the DAL scale controlling for student background characteristics (gender, race/ethnicity, age, high school grades, and ACT composite score) and college experience measures (enrollment status, living on campus, Greek membership, class standing, major). In addition, we used interaction terms to test whether the strength of the relationship between DAL varied by any of the background characteristics and college experience measures in the model. All dependent measures were standardized and all independent measures were mean-centered prior to entry into the models. Interactions terms were products of the centered DAL measure and the other centered independent variables. Interaction terms were retained in a model only if they were found to be statistically significant ($p < 0.10$).

Limitations

This study has two primary limitations. First, the cross-sectional nature of the study rules out controlling for pre-test scores for the outcome measures. Even though we do control for ACT composite score and high school grades, the lack of pre-test measures places limits on the causal claims that can be made based on this study, which is one reason we talk about the relationships among the measures and not how DAL caused the thinking outcomes. Though a more expensive undertaking, a longitudinal study of these relationships is a logical next step in the validation of the DAL measure. Second, the NSSE measure of DAL captures students' overall use of deeper learning strategies. Other work in this area suggests that the use of DAL is context bound (e.g., for a particular learning task) (Biggs, 1987; Ramsden, 2003). If the learning of thinking skills and dispositions is also context bound, then one could imagine that a small number of well-designed learning tasks could have an equivalent or greater effect on a students' thinking as a general emphasis on DAL across contexts that are not as well designed. While it is likely that both context-specific and overall approaches influence the outcomes being studied, the existence of context-specific effects could attenuate the effects observed for overall use of DAL.

Results

The regression models explained a significant amount of variance in the three outcome measures. The independent variables explained 33% of the variance in the CCTDI total score, 31% of the variance in the CCTST total score, and 11% of the variance in the RCI overall score ($p < 0.01$ for all). The models suggest a positive relationship between the NSSE DAL scale and critical thinking dispositions and that the direction of the relationship between the DAL scale and the overall RCI rating depends on high school grades. There appears to be a very weak or no relationship between the DAL scale and students' scores on the CCTST.

DAL and Critical Thinking Dispositions

The correlation between the DAL scale and the CCTDI total score was fairly high ($r = 0.44$; $p < 0.001$) suggesting a pretty strong connection between the use of DAL and the amount students are disposed to critical thinking. After controls, the DAL scale maintained a strong positive relationship with students' CCTDI total scores (see Table 2). In fact, a one-point difference on the DAL scale (e.g., averaging a response of "often" rather than "sometimes") was associated with a nearly one standard deviation difference on the CCTDI total score ($B = 0.96$; $p < 0.001$). However, the relationship was not stable across all groups of students. In particular, the relationship was stronger for students with higher high school grades. Based on the model, which included an interaction term for high school grades and DAL (the only interaction term that was significant), we estimated that a one-point difference on the DAL scale was associated with a six-tenths of a standard deviation difference on the CCTDI total score for students with mostly B+'s or below in high school (about 30% of the sample) and with a 1.1 standard deviation difference for students with mostly A's or A-'s in high school. Figure 1 depicts the relationship between the DAL scale and the CCTDI total score for these two groups of students.

DAL and Critical Thinking Skills

The correlation and regression coefficient for the DAL scale and CCTST total score were quite small ($r = -0.003$ and $B = -0.04$; $p > 0.10$ for both). This suggests that for the average student there is very little or no relationship between using DAL and critical thinking skills. In addition, no interaction terms were significant (so no interaction terms appear in Table 3), suggesting that this effect—or lack of effect—is relatively consistent across student groups. That said, it is worth noting that, with only 383 cases, the lack of interactions may be due in part to lack of statistical power. When the interaction term for DAL and high school grades was

included in the model, as it was for the CCTDI total score, and separate coefficients were estimated for students with mostly B+'s and lower in high school versus those with mostly A's or A-'s, the coefficient for the lower grade group was negative (approximately -0.18) and the coefficient was still close to zero, but positive, for the higher grade group (approximately 0.03). This is a pattern that is more pronounced for the RCI rating.

DAL and Overall RCI Rating

As with the CCTST total score, the correlation and regression coefficient for the DAL scale and the overall RCI rating were relatively weak, though positive ($r = 0.04$ and $B = 0.10$; $p > 0.10$ for both). While this suggests that there is little relationship between the DAL scale and the overall RCI rating, it actually masks dramatic differences in effect by high school grades. In Table 4, the coefficient for the interaction between the DAL scale and high school grades was positive, large, and significant ($B = 0.75$, $p < 0.01$), suggesting that the relationship between DAL and reflective judgment was greater for students with mostly A's and A-'s in high school than for students with mostly B+'s or below. In fact, using the model, we estimated that the effect for the students with higher high school grades is 0.33—a one-unit increase in the DAL scale corresponds to a third of a standard deviation increase in the overall RCI rating. We estimated the relationship for students with lower high school grades is stronger, but negative (0.42)—a one-unit increase in the DAL scale actually corresponds to over a two-fifths of a standard deviation decrease in the overall RCI rating. Figure 2 depicts this interaction between DAL and high school grades.

Some Additional Findings: High School Grades, DAL, and the Outcomes

When we started our analyses, it was unclear whether high school grades would play such a key role in our findings. That our measure of high school grades moderated the effect of

DAL warrants examination of the distribution of DAL scale scores as well as the correlations between the DAL scale and the outcomes by high school grade group.

First, however, it is worth noting that our high school grade measure is not ideal. Over half of the students in the sample (52%) reported earning mostly A's in high school with an additional 18 percent indicating that they got mostly A-'s. Together then 70% of our sample earned A's of some sort while in high school. Of the remaining 30%, over half indicated getting mostly B+'s in high school and the others got B's or lower. Given such a skewed distribution and based on some initial analyses, we chose to dichotomize high school grades.

Interestingly, the distribution of DAL scale scores is nearly identical for the two grade groups. On average, without employing controls for other characteristics, students who reported getting mostly A's or A-'s averaged only 0.07 higher on the DAL scale than their peers with lower high school grades (the means were 2.81 and 2.88, respectively). The 25^{th} and 75^{th} percentile scores were nearly identical for the two groups, but the median was slightly higher (2.89 versus 2.75) for the higher-grade group. Consequently, divergent distributions on the DAL scale do not likely explain the variability in the relationship between the DAL scale and the outcomes.

Further, the correlations between the DAL scale and the outcomes, when examined by grade group, largely confirm the regression findings. For those students with higher high school grades, the correlations were 0.49 ($p < 0.001$), -0.004 ($p > 0.10$), and 0.14 ($p < 0.14$) with the CCTDI total score, the CCTST total score, and the overall RCI rating, respectively. For those with lower grades in high school the corresponding correlations were 0.33 ($p < 0.001$), -0.06 ($p > 0.10$), and -0.17 ($p < 0.10$).

Discussion and Implications

The logic for this study, taken from the literature (e.g., Ramsden, 2003; Tagg, 2003), was fairly straightforward—the more one adopts DAL, the deeper one will learn. This deeper learning should be reflected in our measures of critical thinking and reflective judgment. So, if the NSSE DAL scale is valid, it should be positively associated with critical thinking skills and dispositions as well as one's ability to recognize reflective judgment.

Our results suggest, that the DAL scale had a fairly strong positive relationship with critical thinking dispositions, having the "habits of mind" typical of a critical thinker (Facione et al., 1998). This suggests that, even after controlling for student characteristics, the more a student is exposed to higher level cognitive tasks in class, thinks reflectively about learning, and integrates ideas and concepts across contexts, the more that student will view him or herself as a critical thinker, having characteristics like open-mindedness and inquisitiveness.

The strength of the relationship between DAL and critical thinking dispositions was not equal for all groups of students. Controlling for the other variables in the model, the relationship was stronger for students who got A's in high school than for students with lower grades pre-college. From the student engagement perspective, this result is a bit of a surprise because other findings show a compensatory effect for student engagement on outcomes (Kuh, Cruce, Shoup, Kinzie, & Gonyea, 2008). In our study, however, we find DAL—what some would consider a type of student engagement—had a stronger connection to an outcome for the group that starts out with a relative advantage. Based on work from those that study DAL though (e.g., Biggs, 1987; Hall et al., 1995), the difference between grade groups is not entirely unexpected. Their work suggests DAL may be more effective for higher ability students.

Beyond critical thinking dispositions, our results suggest that the connection between the DAL scale and the two measures of thinking skills is not straightforward. For the CCTST total score, there appears to be almost no relationship to the DAL scale. With increased power in our analyses, we may find a very weak positive relationship for students who had mostly A's in high school, but that is likely to be accompanied by a weak to moderate negative relationship for students who received B+'s or lower in high school. For reflective judgment, such opposing relationships were stronger. For students with high school grades in the A's, a moderate positive relationship between the DAL scale and RCI rating existed, but for those with lower high school grades there was a moderate negative relationship. That the use of DAL might actually be negatively associated with outcomes is troubling and goes beyond what was found in previous studies of DAL (e.g. Hall et al., 1995).

The pattern of findings across the outcomes suggests that the predictive validity of the DAL scale deserves further investigation. It would appear that, net the effects of the other predictors, engagement in DAL as measured on NSSE, is positively associated with students viewings themselves as having the mental characteristics (e.g., trustworthiness) associated with critical thinkers. Yet, for students who did not perform as well academically in high school, increasing use of DAL may, on average, actually coincide with lower levels of critical and reflective thinking, as measured by the CCTST and RCI.

Two issues deserve greater attention in future work. First is whether lower ability students understand the items in the DAL scale the same way higher ability students do. A difference in understanding may explain the findings of this study, but would also indicate that the scale needs further development or the use of the scale should be limited to those students for whom the scale items are understood best. Second, it may be that using DAL helps shape the

ways all students view themselves as thinkers, but that the benefit to thinking skills is only in certain areas (e.g., thinking about ill-structure problems) and only for some students. This would suggest that the logic upon which the study was built needs qualification, namely that the effects of adopting DAL are not evenly spread across all students and may actually be negative for some students. Further study is needed to sort out for whom and in what ways adopting DAL can be detrimental. This latter type of study may have critical instructional implications, such as finding that the blend of challenge and support, that developmental scholars like Kegan (1994) posit essential for cognitive development, is off for underprepared college students. Such students might be cognitively "in over their heads," which, as Kegan suggests, could produce the detrimental effects on thinking skills. If so, underprepared students might need more support (or scaffolding) to meet the challenge of the tasks they encounter that encourage or require DAL.

Conclusion

The results of this study add, to some degree, to the evidence that the NSSE DAL measure is valid. However, the findings suggest that further study is needed to better understand for whom it is valid, in what circumstances DAL produce desired outcomes, and for what types of outcomes it is a particularly salient predictor.

References

American Philosophical Association (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction*. The Delphi Report Executive Summary: Research findings and recommendations prepared for the committee on pre-college philosophy. (ERIC Document Reproduction Service No. ED315423)

Association of American Colleges & Universities (2007). *College learning for the new global century*. Washington, DC: Author.

Beatie, V., Collins, B., & McInnes, B. (1997). Deep and surface learning: A simple or simplistic dichotomy? *Accounting Education, 6*(1), 1-12.

Biggs, J. B. (1987). *Student approaches to learning and studying*. Hawthorn, Victoria: Australian Council for Educational Research.

Biggs, J. B. (1988). *Approaches to learning and to essay writing*. Buckingham: Open University Press. In R.R. Schmeck (ed.) *Learning Strategies and Learning Styles*. New York, NY: Plenum.

Biggs, J. B. (1989). Approaches to the enhancement of tertiary teaching. *Higher Education Research and Development, 8*, 7-25.

Biggs, J. B. (1995). Learning in the classroom. In J. Biggs & D. Watkins (Eds.), *Classroom learning: Educational psychology for Asian teacher* (pp. 147-166). Singapore: Prentice-Hall.

Biggs, J. B. (2003). *Teaching for quality learning at university*. Buckingham: Open University Press.

Bowden, J. & Marton, F. (1998). *The university of learning.* London, England: Kogan Page.

Entwistle, N.J (1981). *Styles of learning and teaching: An integrated outline of educational psychology for students, teachers and lecturers*. Chichester: Wiley.

Entwistle, N. J. & Ramsden, P. (1983). *Understanding student learning*. London: Croom Helm.

Facione, P. A., Facione, N. C., & Giancarlo, C. A. (1998). *The California critical thinking disposition inventory test manual (Revised).* Millbrae, CA: The California Academic Press.

Facione, P. A., Facione, N. C., Blohm, S. W., Howard, K., & Giancarlo, C. A. (1998). *The California critical thinking skills test manual* (Revised). Millbrae, CA: The California Academic Press.

Hall, C. W., Bolen, L. M., & Gupton, R. H. (1995). Predictive validity of the Study Process Questionnaire for undergraduate students. *College Student Journal,* 29, 234-239.

Kegan, R. (1994). In over our heads: The mental demands of modern life. Cambridge, MA: Harvard University Press.

King, P. M. & Kitchener, K. S. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass.

Kuh, G. D., Cruce, T. M., Shoup, R., Kinzie, J., & Gonyea, R. M. (2008). Unmasking the effects of student engagement on first-year college grades and persistence. *Journal of Higher Education, 79*, 540-563.

Lave, J. & Wegner, E. (1991). *Situated learning: Legitimate peripheral participation*. New York, NY: Cambridge University Press.

Lonka, K., Keikkila, A., Lindblom-Ylanne, S., & Maury, S. (1997). Are epistemologies related to study activities in innovative courses? Paper presented at the 7th Conference of the European Association for Research on Learning and Instruction, Athens, Greece.

Marton, F. & Säljö, R. (1976). On qualitative differences in learning I: Outcome and process. *British Journal of Educational Psychology*, 46, 4-11.

McKensie, K. & Schweitzer, R. (1997). Who succeeds at university? Factors predicting academic performance in first year Australian university students. *Higher Education Research and Development*, 20, 21-33.

Messick, S. (1989). Validity. In R.L. Linn (Ed.), *Educational measurements*, (3rd ed., pp. 13-103). New York: Macmillian.

Minasian-Batmanian, L. C., Lingard, J., Prosser, M. (2006) Variation in Student Reflections on Their Conceptions of and Approaches to Learning Biochemistry in a First-Year Health Sciences' Service Subject. *International Journal of Science Education*, 28(15).

Nelson Laird, T. F., Shoup, R., & Kuh, G. D. (2006, May). *Measuring deep approaches to learning using the National Survey of Student Engagement*. Paper presented at the Annual Forum of the Association for Institutional Research, May, 2006, Chicago, IL.

Nelson Laird, T. F., Shoup, R., Kuh, G. D., & Schwarz, M. J. (2008). The effects of discipline on deep approaches to student learning and college outcomes. *Research in Higher Education, 49*, 469-494.

NSF Advisory Committee (1996) *Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering, and Technology* (Arlington, VA: National Science Foundation Directorate for Education and Human Resources).

Prosser, M. & Millar, R. (1989). The "how" and "why" of learning physics. *European Journal of Psychology of Education*, 4, 513-528.

Ramsden, P. (2003). *Learning to teach in higher education*. London: RoutledgeFalmer.

Rose, R. J., Hall, C. W., Bolen, L. M., & Webster, R. E. (1996). Locus of control and college students' approaches to learning. *Psychological Review,* 79, 163-171.

Rowell, J. A., Dawson, C. J., & Pollard, J. M. (1993). First year university physics: Who succeeds? *Research in Science and Technological Education,* 11, 85-94.

Tagg, J. (2003). *The learning paradigm college.* Boston, MA: Anker.

Tynjälä, P., Salminen, R. T., Sutela, T., Nuutinen, A., & Pitkänen, S. (2005). Factors related to study success in engineering education. *European Journal of Engineering Education,* 30(2), 221-231.

Van Rossum, E. J., & Schenk, S. M. (1984). The relationship between learning conception, study strategy and learning outcome. *British Journal of Educational Psychology, 54*, 73-83.

Vermunt, J. (1992). *Learning styles and regulation of learning processes in higher education: Towards process-oriented instruction in autonomous thinking.* Swets & Zeitlinger, Amsterdam.

Vermunt, J. D. & Vermetten, Y. J. (2004). Patterns in student learning: Relationships between learning strategies, conceptions of learning, and learning orientations. *Educational Psychological Review,* 16(4), 359-384.

Whelan, G. (1988). *Improving medical students' clinical problem-solving.* In P. Ramsden (ed.) *Improving learning: New perspectives.* London, England: Korgan Page.

Wood, P. K., Kitchener, K. S., and Jensen, L. L. (2002). Considerations in the design and evaluation of a paper-and-pencil measure of epistemic cognition. In Hofer B., and

Pintrich P. (eds), *Personal epistemology: The psychology of beliefs about knowledge and knowing*, New York: Lawrence Erlbaum Associates, pp. 277–294.

Zeegers, P. (2004). Student learning in higher education: A path analysis of academic achievement in science. *Higher Education Research and Development,* 23(1), 35-56.

Zhang, L. (2000). University students' learning approaches in three cultures: An investigation of Biggs's 3P model. *The Journal of Psychology,* 134(1), 37-55.

Appendix

Independent Variables

Name	Description
Female	0 = Male; 1 = Female
Race[a]	White[b], Student of color, Preferred not to respond
Non-U.S. Citizen	0 = U.S. citizen; 1 = non-U.S. citizen
First generation	0 = one or more parents with college degree; 1 = no parents with college degree
Mostly A's or A-'s in h.s.	0 = Mostly B+'s or lower in h.s.; 1 = Mostly A's or A-'s in h.s.
ACT composite score	Integer values ranging from 12 to 36 (SAT scores were converted to ACT scores when needed and provided)
Transfer	0 = started at this college; 1 = transferred
Full-time	0 = Part-time; 1 = Full-time
Live on campus	0 = live within driving distance, 1 = live on campus or within walking distance
Varsity athlete	0 = non-athlete; 1 = varsity athlete
Greek membership	0 = no membership, 1 = fraternity or sorority member
Class standing[a]	First-year student[b], Sophomore, Junior, Senior
Major[a]	Arts and humanities[b], Natural science (and engineering), Professional (including business), Social science (including education), Other majors (including undecided)
Deep approaches to learning	Combination of 3 subscales (see Table 1)

[a] Dichotomous indicator created for each group (0 = not in group, 1 = in group)
[b] Reference group

Table 1
NSSE Deep Approaches to Learning Scale, Subscales, and Component Items

Deep Approaches to Learning (α= .64)
Combination of the three subscales listed below
Higher-Order Learning[a] (α= .75)
Analyzed the basic elements of an idea, experience, or theory, such as examining a particular case or situation in depth and considering its components
Synthesized and organized ideas, information, or experiences into new, more complex interpretations and relationships
Made judgments about the value of information, arguments, or methods, such as examining how others gathered and interpreted data and assessing the soundness of their conclusions
Applied theories or concepts to practical problems or in new situations
Integrative Learning (α= .64)
Worked on a paper or project that required integrating ideas or information from various sources
Included diverse perspectives (different races, religions, genders, political beliefs, etc.) in class discussions or writing assignments
Put together ideas or concepts from different courses when completing assignments or during class discussions
Discussed ideas from your readings or classes with faculty members outside of class
Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)
Reflective Learning (α= .78)
Examined the strengths and weaknesses of your own views on a topic or issue
Tried to better understand someone else's views by imagining how an issue looks from his or her perspective
Learned something that changed the way you understand an issue or concept

Note: Except where noted, variables were measured on a 4-point scale (1=Never, 2=Sometimes, 3=Often, 4=Very Often)
[a] Responses for component items were 1=Very little, 2=Some, 3=Quite a bit, 4=Very much

Table 2
CCTDI Total Score Regression Results (n = 383)

	B	SE of B	β
Constant	-0.01	0.04	
Female	0.09	0.09	0.04
Race			
White		*reference group*	
Student of color	-0.15	0.12	-0.06
No race indicated	-0.31	0.24	-0.06
Non-U.S. Citizen	-0.36	0.20	-0.08†
First generation	0.15	0.11	0.06
Mostly A's or A-'s in h.s.	0.21	0.10	0.10*
ACT composite score	0.05	0.01	0.23***
Transfer	-0.02	0.14	-0.01
Full-time	-0.13	0.23	-0.03
Live on campus	0.03	0.11	0.01
Varsity athlete	0.16	0.26	0.03
Greek membership	-0.25	0.11	-0.10*
Class standing			
First-year student		*reference group*	
Sophomore	-0.18	0.13	-0.07
Junior	0.27	0.12	0.12*
Senior	0.18	0.13	0.08
Major			
Arts and humanities		*reference group*	
Natural sciences	-0.19	0.18	-0.06
Professional	-0.37	0.15	-0.18*
Social science	-0.26	0.17	-0.10
Other majors	-0.29	0.19	-0.09
Deep approaches to learning	0.96	0.10	0.44***
Interaction terms			
DAL x Mostly A's or A-'s in h.s.	0.50	0.20	0.11*
Multiple R		0.58	
R-squared		0.33	
Standard Error		0.84	
F		8.53***	

† p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001
Note: Dependent variable standardized and all independent variables mean-centered prior to entry into the model; interaction terms are products of mean centered variables.

Table 3
CCTST Total Score Regression Results (n = 383)

	B	SE of B	β
Constant	0.00	0.04	
Female	-0.09	0.09	-0.04
Race			
White		*reference group*	
Student of color	-0.60	0.12	-0.25***
No race indicated	-0.53	0.24	-0.10*
Non-U.S. Citizen	-0.15	0.21	-0.03
First generation	0.20	0.11	0.08†
Mostly A's or A-'s in h.s.	0.39	0.10	0.18***
ACT composite score	0.08	0.01	0.36***
Transfer	0.21	0.14	0.07
Full-time	0.07	0.23	0.01
Live on campus	0.13	0.11	0.06
Varsity athlete	-0.24	0.26	-0.04
Greek membership	-0.11	0.11	-0.04
Class standing			
First-year student		*reference group*	
Sophomore	-0.12	0.13	-0.05
Junior	0.10	0.12	0.04
Senior	0.21	0.14	0.09
Major			
Arts and humanities		*reference group*	
Natural sciences	-0.16	0.19	-0.05
Professional	-0.34	0.16	-0.17*
Social science	-0.26	0.18	-0.10
Other majors	-0.30	0.20	-0.10
Deep approaches to learning	-0.04	0.10	-0.02
Interaction terms			
No interaction terms significant			
Multiple R		0.56	
R-squared		0.31	
Standard Error		0.85	
F		7.77***	

† p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001
Note: Dependent variable standardized and all independent variables mean-centered prior to entry into the model; interaction terms are products of mean centered variables.

Table 4
Overall RCI Rating Regression Results (n = 383)

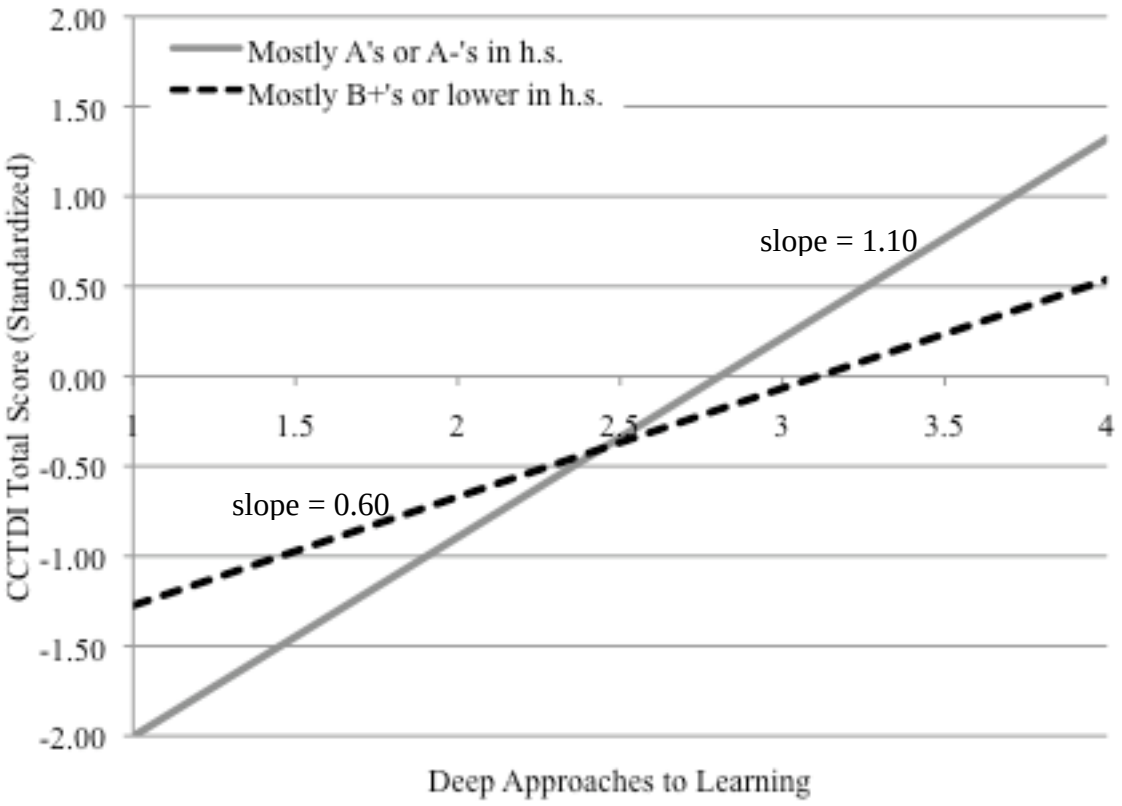
	B	SE of B	β
Constant	-0.01	0.05	
Female	0.09	0.11	0.05
Race			
White			
Student of color	-0.36	0.14	-0.15**
No race indicated	0.15	0.27	0.03
Non-U.S. Citizen	0.19	0.23	0.04
First generation	0.02	0.13	0.01
Mostly A's or A-'s in h.s.	0.17	0.12	0.08
ACT composite score	0.01	0.01	0.05
Transfer	0.01	0.16	0.00
Full-time	-0.14	0.26	-0.03
Live on campus	0.08	0.12	0.04
Varsity athlete	-0.08	0.30	-0.01
Greek membership	-0.06	0.13	-0.03
Class standing			
First-year student			
Sophomore	-0.29	0.15	-0.12†
Junior	-0.01	0.14	0.00
Senior	0.12	0.15	0.05
Major			
Arts and humanities			
Natural sciences	-0.04	0.21	-0.01
Professional	-0.32	0.18	-0.16†
Social science	-0.20	0.20	-0.08
Other majors	-0.41	0.22	-0.13†
Deep approaches to learning	0.10	0.11	0.05
Interaction terms			
DAL x Mostly A's or A-'s in h.s.	0.75	0.23	0.16**
Multiple R		0.32	
R-squared		0.11	
Standard Error		0.97	
F		2.06**	

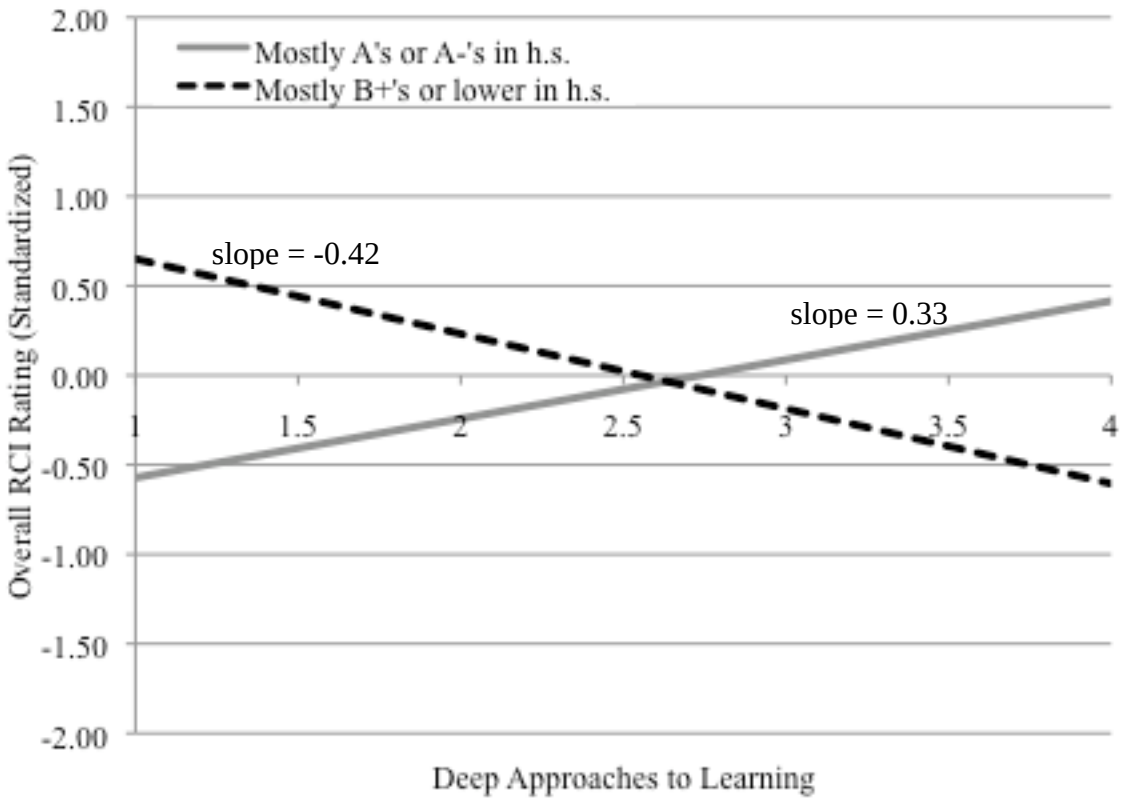
† p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001
Note: Dependent variable standardized and all independent variables mean-centered prior to entry into the model; interaction terms are products of mean centered variables.

Figure Captions

Figure 1. Relationship between DAL and CCTDI Total Score by High School Grades

Figure 2. Relationship between DAL and Overall RCI Rating by High School Grades


2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
CCTDI Total Score (Standardized)
Mostly A's or A-'s in h.s.
Mostly B+'s or lower in h.s.
slope = 1.10
slope = 0.60
1
1.5
2
2.5
3
3.5
4
Deep Approaches to Learning


2.00
1.50
1.00
0.50
0.00
-0.50
-1.00
-1.50
-2.00
Mostly A's or A-'s in h.s.
Mostly B+'s or lower in h.s.
slope = -0.42
slope = 0.33
1
1.5
2
2.5
3
3.5
4
Overall RCI Rating (Standardized)
Deep Approaches to Learning