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# Engagement in Learning and Student Success: Findings from the CCNA2 Course

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## **PREFACE**

This White Paper is one in a series of reports that examines the success of students enrolled in the Cisco Certified Network Associate (CCNA) Program offered through the Cisco Networking Academy. For a list of available reports, see our Web site ([www.indiana.edu/~iuteam](http://www.indiana.edu/~iuteam)).

This White Paper presents a summary of key findings concerning the relationship between student engagement in learning and student success in the second CCNA course (CCNA2) in the four-course CCNA program. We presume that the reader is familiar with the Cisco Networking Academy. A related paper (WP 05-03) reporting on student engagement is available on our Web site. A more detailed academic report concerning the research that produced these findings is forthcoming and will also be available on our Web site. That report will also provide additional background on the Cisco Networking Academy.

The Cisco Networking Academy serves more than 400,000 students at almost 10,000 “academies” located in high schools, community colleges, universities, and non-traditional settings (e.g., career centers, correctional facilities, shelters, military bases) in more than 150 countries around the world. The CCNA program is the Academy’s most popular program.

The Cisco Networking Academy offers a unique education model that combines a centralized curriculum with local control. The course and laboratory materials, the sequence of instruction, and the assessment system are all centrally developed by technical and educational experts working together with the support of Cisco Systems, Inc. All materials are delivered over the Internet, but courses are taught in the classroom by local instructors at each academy, who are free to adapt the materials to their local context. Instructional quality is supported by initial instructor training and annual professional development, as well as by an online community of instructors and 24/7 technical support. The quality of instruction is monitored through student performance on the end-of-course exams and through student course evaluations – both of which are common to all courses.

The curriculum is an applied educational curriculum designed to meet the needs of practicing network engineers. It is designed to provide both deep conceptual understanding and practical skills. Indeed, the curriculum is aligned with teaching standards for United States high school math, science, and language arts education.

This research was sponsored by the Cisco Learning Institute  
[www.ciscolearning.org](http://www.ciscolearning.org)



## Engagement in Learning and Student Success: Findings from the CCNA2 Course

### BACKGROUND AND GOAL

A previous paper (WP 05-03) has examined student engagement in the CCNA2 course in terms of reported active participation in the class, amount of effort expended, and amount of interaction with the instructor. Students in both high schools and community colleges reported modestly higher levels of engagement in the CCNA2 course than in the other courses they were taking. They reported that they work hard, engage with the instructor, and actively participated in the class “sometimes” and “often” (ratings between 2 and 3 on a 4-point scale).

The study of engagement is important for two reasons. First, there is a wealth of research suggesting that students who are more engaged learn more (see for instance Finn & Rock, 1997; Fredricks, Blumenfeld, & Paris, 2004; National Research Council & Institute of Medicine, 2004; Pascarella & Terenzini, 2005). Second, engaging students in learning is something that instructors can facilitate through the pedagogical approach they use.

In this study, we seek to confirm the linkage between student engagement and learning in the context of the CCNA2 course and the Cisco Networking Academy curriculum model. Results that indicate that engagement is related to success in this course would suggest that student performance could be further improved by helping instructors to adopt teaching strategies that engage students more effectively.

Additionally, since this study focuses on a large number of students taking the same CCNA2 exam, this study presents an opportunity to make an important confirmation of earlier research, which has typically been based on student reports of learning or more general measures of learning. This data set also permits us to examine relationships in more detail to determine whether the engagement variables have a varying impact on students with different characteristics.

### WHAT WE DID

Student engagement was assessed through an online survey (see appendices), which was administered during the last half of the CCNA2 course (see WP 05-03 for more details). Performance was measured using the students’ first attempt at the final exam (students may repeat the exam if they do not pass the first time). A total of 1,506 high school

There is a wealth of research that suggests that students who are more engaged learn more.

Engaging students in learning can be facilitated through pedagogical approaches.

students from 523 academies and 2,609 community college students from 587 academies in the U.S. and Canada completed the survey.

We looked at high school and community college students separately. Using hierarchical linear regression, we also examined characteristics of the school location, the CCNA2 course, and the students as they impact student exam scores.

## WHAT IMPACTS STUDENT SUCCESS?

For high school students, we found that student effort, class participation, and interaction with the instructor are all positively related to exam scores. However, for community college students, only active participation is positively related to exam scores. In fact, interaction with the instructor is actually negatively related for the community college students, though the effect is small (see Table 1). This suggests that when we consider the students overall, engagement is important to performance for the high school students but not for the community college students.

**TABLE 1. Correlation between student achievement and engagement**

Engagement Factors	High School	Community College
Active Participation	.18 moderate	no relation
Effort	.21 moderate	.09 small
Interaction with the Instructor	.11 small	-.06 small

However, when we look at all the variables impacting exam scores, it is clear that the characteristics that students already have when they begin the class are by far the most important predictors of performance on the exam. These student characteristics have a strong to moderate relationship to exam scores (see Table 2). In contrast, the engagement variables as a group have only a weak relationship to exam scores for high school students and no significant relationship for community college students. Indeed, in addition to the student variables, the school variables also had a larger impact on exam scores than did the engagement variables. Finally, the characteristics of the class did not have a significant impact on scores for either group.

We probed these data more deeply, examining the impact of the individual variables (see column two of Table 2) on exam scores. That is, we decomposed the effects of the class of variables identified in column one. We found student performance in CCNA1 to be by far the strongest predictor of how a student would perform on the CCNA2 exam. This was true for both high school and community college students. This finding is very consistent with previous research: those who enter a course with stronger skills will also learn more in the

Engagement was important to performance for the high school students but not for the community college students.

The best predictors of student performance on the exam are the characteristics that students already have.

course. It is findings such as this that make the achievement gap in schools so difficult to overcome.

**TABLE 2. Relative relationship of four classes of variables to student performance**

Level	Variables	Relative Relation (R) to Exam Scores	
		High School	Community College
School	RTC* vs. Local Location (e.g., rural) Per capita income in the area	.20 moderate	.08 weak
Class	Class size Course length	no relation	no relation
Student	Gender Work status Credits enrolled for CCNA 1 exam score	.40 moderate	.52 strong
Engagement	Class participation Effort Interaction with instructor	.02 weak	no relation

\* RTC refers to a Regional Training Center which serves and assists other local academies.

For high school students, the second most important variable was school location: the per capita income in the area of the high school. We used this as a proxy for the socio-economic status (SES) of the school. As with prior studies of student performance, SES is a factor that is also typically a strong predictor of student learning. Students from more affluent families have the culture of education in the home and the resources to support studying and learning, so these students tend to learn more. We did not, however, find this relationship for the community college students, likely because community colleges draw their students from a much broader geographical base, and hence the per capita income of the neighboring zip code does not reflect the income of the students or their families.

A second school location variable, geographic location, was also a significant predictor of exam scores. Both high school and community college students did better on the exam if they were attending an academy in a town rather than a suburban area. It is interesting that a town location was associated with better test performance because traditionally, the better-funded suburban schools are the highest performing schools. We have no explanation for this reversal. Our classification for school location was taken from the National Center for Educational Statistics where a town is defined as a population greater than 2,500 outside a large or mid-sized central city. However, it should be noted that the suburban and town schools did no better or worse than rural or urban schools, that is to say, these comparisons were not

For high school students, the second most important variable in the linear hierarchical regression was school location: the per capita income in the area of the high school.

statistically significant. It was only the suburban-town comparison that reached significance.

Finally, gender was also significantly related to exam performance. As we found with the CCNA1 course (see WP 05-01), males did better than females in the CCNA2 exam. This was true for both high school and community college students, and, once again, the finding is consistent with previous research. Indeed, there are major educational initiatives to attract women to, and support them in, the study of science and technology because the number of women entering these fields is low and the dropout rate is high.

The impact of these variables on the exam performance of high school students is illustrated in Table 3. Student A is a “disadvantaged” student in terms of the variables that impact exam scores: she is enrolled only in CCNA2, did marginal work in CCNA1, goes to school in the suburbs, and has a low income. Further, her engagement in the course is low.

Student B is a better, though not a stellar, student. However, as shown in Table 3, Student B is predicted to score 24.9 points higher on the CCNA2 final exam – a decided advantage.

As was found in CCNA1 course, males did better than females in the CCNA2 exam.

**TABLE 3. Predicted impact of variables on the exam scores of high school students**

Characteristics	Student A	Student B	Student B's test score relative to Student A's
CCNA1 test score	70	80	+5.7
Gender	Female	Male	+2.7
SUBTOTAL FOR INDIVIDUAL STUDENT FACTORS			<b>+8.4</b>
Per capita income in school area	Low 25 <sup>th</sup> percentile	High 75 <sup>th</sup> percentile	+3.8
Location of school	Suburbs	Town	+4.0
SUBTOTAL FOR SCHOOL FACTORS			<b>+7.8</b>
Participation	Low (Rating = 2)	Very high (Rating = 4)	+5.8
Effort	Low 25 <sup>th</sup> percentile	Very high 75 <sup>th</sup> percentile	+2.9
SUBTOTAL FOR ENGAGEMENT FACTORS			<b>+8.7</b>
TOTAL ADVANTAGE FOR STUDENT B			<b>+24.9</b>

The results are considerably different for community college students in that fewer variables were significantly related to test performance. As with high school students, being male, doing well on CCNA1, and living

in a town rather than a suburb were all associated with doing better on the CCNA2 exam.

One of the most interesting findings, however, concerns the impact of the engagement variables. Students who reported higher levels of interaction with the instructor actually performed more poorly on the CCNA2 exam. It would seem that in community colleges, those who are having difficulty are the ones interacting with the instructor, either because they are seeking help or because they are being contacted by the instructor because of their work or attitude. Since enrolling in the CCNA courses is a personal decision for both high school and community college students, it is unclear why this would be true in one setting but not the other

Community college students who reported higher levels of interaction with the instructor performed more poorly on the CCNA2 exam.

**TABLE 4. Predicted impact of variables on the exam scores of community college students**

Characteristics	Student A	Student B	Student B's test score relative to Student A's
CCNA1 test score	70	80	+6.1
Gender	Female	Male	+3.6
SUBTOTAL FOR INDIVIDUAL STUDENT FACTORS			<b>+9.7</b>
Location of school	Suburbs	Town	+2.9
SUBTOTAL FOR SCHOOL FACTORS			<b>+2.9</b>
Effort	Low 25th percentile	Very High 75th percentile	+2.9
Interaction with instructor	Low Rating =2	Very High Rating = 4	-3.2
SUBTOTAL FOR ENGAGEMENT FACTORS			<b>-0.3</b>
TOTAL ADVANTAGE FOR STUDENT B			<b>+12.3</b>

Table 4 shows the impact of these variables on exam scores for community college students. The “better” student is predicted to score 12.3 points higher on the exam. As with Table 3, only those variables significantly related to performance are included in Table 4.

Additionally, we used the same magnitude of difference on the variables for students A and B. That is, in both tables, students A and B scored a 70 and 80 on the exam, were at the 25<sup>th</sup> and 75<sup>th</sup> percentile on effort, and gave their interaction with the instructor a rating of 2 and 4, respectively.

## HOW DOES THE ENGAGEMENT – PERFORMANCE RELATIONSHIP CHANGE FOR DIFFERENT GROUPS?

For the community college students, the relationship between engagement and exam scores is consistent across other variables, such as class size and gender. Thus, the impact of engagement is not stronger for some groups than others. However, for the high school students, we found that the engagement variables interacted with gender, resulting in interesting implications for the impact of engagement on performance.

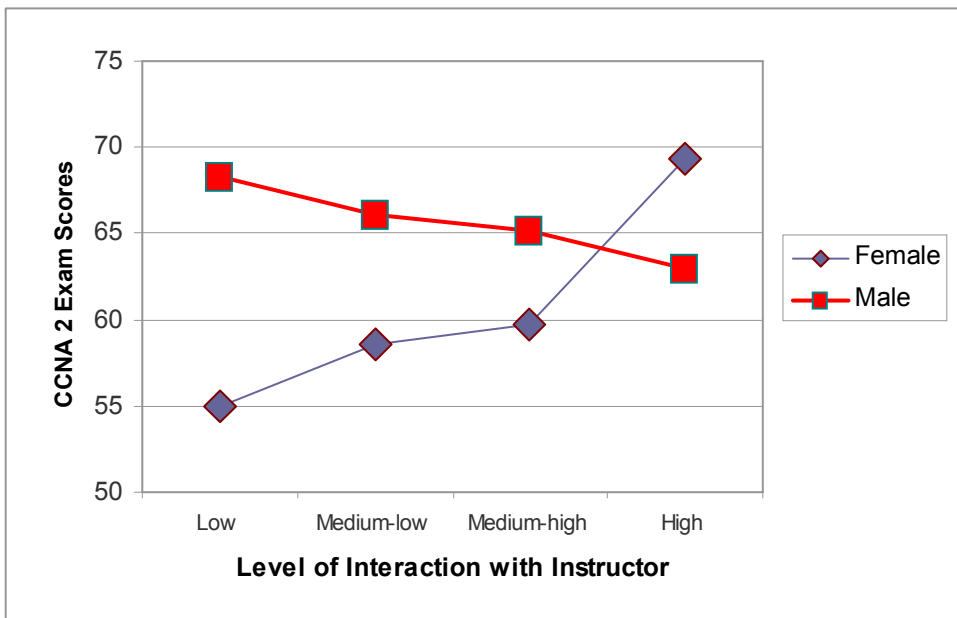
Perhaps most intriguing is the finding that increasing interaction with the instructor is associated with lower scores for high school males but higher scores for high school females. As seen in Figure 1, this is a fairly dramatic shift with males losing about 5 points and females gaining about 15 points as the amount of interaction with the instructor increases. We would expect everyone to benefit from interacting with the instructor, so we find these data puzzling.

It may be that the student rating of interaction with the instructor reflects different types of interactions for the two groups. The males may be less verbal in the classroom, and hence, may interact with the instructor primarily when they are having problems or are singled out to meet with the instructor. For females who tend to be more verbal, the interactions may reflect their learning initiatives, and thus, high interaction may reflect more motivated female students. Of course, this is only speculation, but it does suggest that we need a deeper understanding of the nature of student interaction with the instructor.

Increasing interaction with the instructor is associated with lower scores for high school male students but higher scores for high school females.

In high schools, male and female students who participate more in class did better on the final exam, with one exception.

**FIGURE 1. Impact of level of interaction with instructor and gender on performance for high school students**



Female students who reported expending a lot of effort and participating very frequently did poorly in comparison to other students.

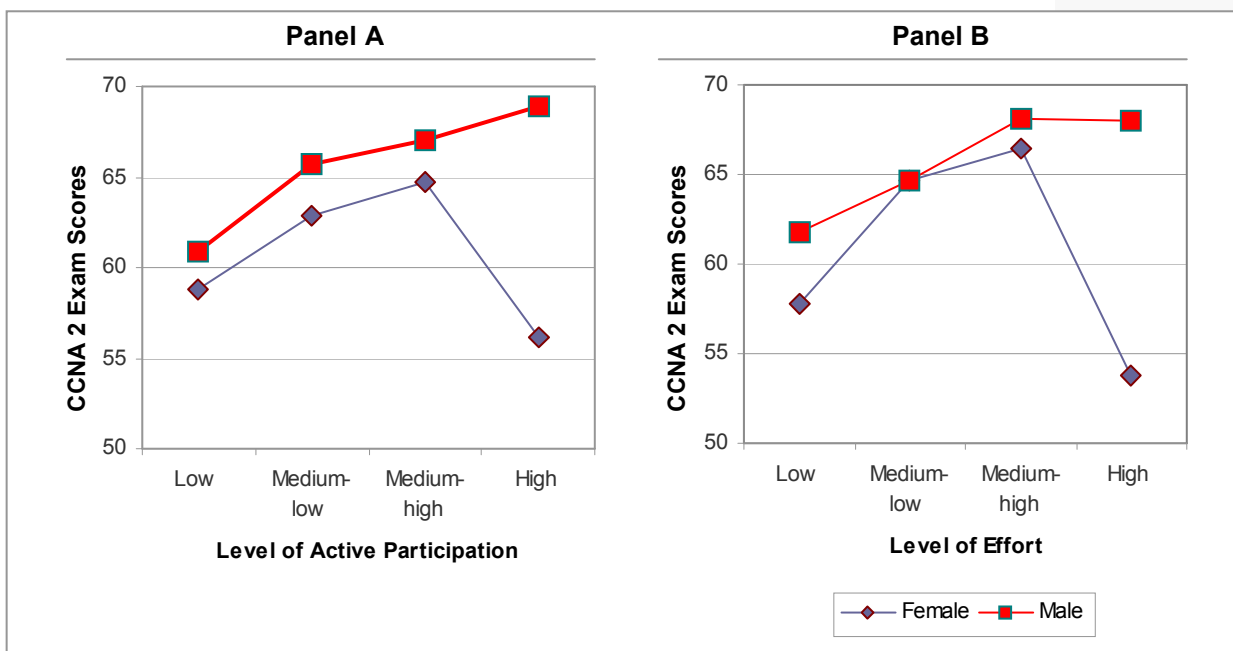
In high schools, male and female students who participate more in class did better on the final exam, with one exception (see figures 2 & 3). The exception is that those female students who reported expending a lot of effort in the class or participating very frequently did very poorly on the exam (see Figure 2). Indeed, this subgroup of the highest engaged females (as indexed by reported effort or participation) received the lowest exam scores of any of the other female or male subgroups. The mean scores are about 13 points lower for high school females in the upper quartile of reported effort as compared to females in the third quartile. Similarly, the scores fall almost 6 points from the third to the fourth quartile of reported level of participation in the class.

One interpretation of this is that the very high levels of effort and class participation are indicators of a female student being overwhelmed by the demands of the course. For example, a very high level of class participation may reflect asking a lot of questions because of confusion. However, this is not an entirely satisfactory hypothesis since we would expect the same to be true for male students. Additionally, by this hypothesis, we would expect these students to be interacting with the instructor a lot, yet we find that high levels of interaction lead to better exam scores. Again, the nature of the active participation and level of effort need to be explored more deeply.

Increased effort leads to greater test performance for both high school and community college students.

Increased participation in class is associated with better performance for only high school students.

**FIGURE 2. Impact of active participation (panel A) and effort (panel B) and gender on exam performance for high school students**



## DISCUSSION AND CONCLUSIONS

The goal of this research was to determine if increases in student engagement are related to increases in test performance. The findings reveal that increased effort led to greater test performance for both high school and community college students. Motivating students to work hard does indeed pay off. However, increased participation in class was associated with better test performance for only the high school students. No similar relation to performance was found for the community college students.

There is a second exception to the overall positive relationship for these two engagement variables. High school females who reported a very high level of effort or participation performed more poorly on the final exam. There is a precipitous drop off for test scores for these “most” engaged high school females. The interpretation of these results is difficult, and the findings certainly do need to be replicated. However, a possible interpretation is that a very high level of “engagement” may reflect female students who are struggling very hard and eventually doing poorly – but not giving up. This would be consistent with other findings that females tend to struggle in the sciences.

The final engagement variable, interaction with the instructor, yielded surprising results. Community college students as a whole and high school males all show a negative relationship between interaction with the instructor and test performance. It is only for high school females that we found the expected positive relationship. These results are surprising since our scale is taken from the National Survey of Student Engagement (NSSE), where the items are meant to predict more engagement and hence higher levels of learning.

We suspect, however, that our mixed findings reflect a mixture of positive and negative reasons for interacting with the instructor. Our survey items do not indicate who initiated the interaction, and for 4 of the 6 items, there is no indication of positive or negative motivation for the interaction. Thus, a high level of interaction with the instructor may reflect problem students being called to discuss behavior or performance problems or excelling students who are approaching the instructor to further discuss the concepts and expand their understanding.

The relationship of test performance to interaction with the instructor is most interesting. For community college students, there is a negative relationship: higher levels of interaction with the instructor are associated with poorer test performance. Likewise, for high school students, increased interaction with the instructor by males is associated with lower test performance. However, high school females show just the opposite relationship: the more they interact with the instructor, the higher their test performance.

Community college students as a whole and high school males all show a negative relationship between interaction with the instructor and test performance. Only for high school females was there a positive relationship.

In sum, the overall results of this study suggest that an investment in pedagogical training of all instructors, but especially high school teachers, *may* lead to an improvement in student performance. Since this is a correlational study, we cannot conclude with certainty from the results that greater engagement causes increased performance. However, prior research on engagement, as well as theories of learning, strongly suggest this causal relationship (see, for example, Pascarella and Terenzini, 2005). Consequently, the Cisco program, and education practice more generally, would benefit from research that tests this causal relationship, for instance a study in which some instructors were trained and supported in using pedagogical practices that focus on the “engagement” of students.

If such a causal relationship is found, it would suggest that instructors should be trained in strategies for motivating students to give the course their best effort, and, for high school students, to design lessons to maximize active participation through projects and discussion.

The findings also suggest different approaches for different students, including approaches that are gender specific. For example, if female students seem to be working extremely hard and are working intensely with other students, the instructor should intercede to counsel the student since it would suggest there are performance problems. This would not be a concern for males.

Other findings from this research call for policy decisions concerning the goals of the CCNA program. Our focus on engagement is based on the belief that the goal of education is to help all students learn. Thus, an effective educational program, based on this goal, would reach out to provide opportunities to less able students. However, if the goal is primarily to assure a high level of performance in CCNA courses, then our findings suggest that other strategies would clearly be more effective, from the perspective of both the overall performance expectations and the investment to achieve that performance. That is, our findings indicate that individual differences in students are very strong determinants of success in the program. In particular, students who are male, have high ability, are motivated, and are from a higher socio-economic area tend to perform very well in the CCNA courses.

In essence, the findings suggest two distinct policies. One is deliberately selecting more able students to assure high scores in the program. The other is training high school teachers to be more learner-centered and to better engage students so that female students and less able students in less economically developed areas can achieve higher scores.

The overall results of this study suggest that an investment in pedagogical training of all instructors, but especially high school teachers, may lead to an improvement in student performance.

The findings suggest two distinct policies.  
1) Deliberately select more able students to assure high scores in the program.  
2) Train high school teachers to be more learner-centered and to better engage students so that female students and less able students in less economically developed areas can achieve higher scores.

## RELATED READINGS

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## ORIGINAL SURVEYS

- Community College Survey of Student Engagement (CCSSE)  
<http://www.ccsse.org/>
- High School Survey of Student Engagement (HSSSE)  
<http://ceep.indiana.edu/hssse/index.html?reffromnsse=index.htm>
- National Survey of Student Engagement (NSSE)  
<http://www.iub.edu/~nsse/>

## APPENDICES

### Engagement Constructs: Reliability and ratings on individual items

#### Appendix 1: Community College Students

	<b>Cisco</b>	<b>Comparison</b>
	Mean (SD)	Mean (SD)
<b>Active Participation (Alpha* = .621)</b>	2.63 (0.62)	2.47 (0.69)
Asked questions in class or contributed to class discussions	3.01 (0.87)	2.94 (0.88)
Worked with other students in groups during class	3.05 (0.87)	2.64 (0.98)
Worked with other students in groups outside of class	1.98 (0.99)	1.92 (0.98)
Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)	2.48 (0.90)	2.38 (0.91)
<b>Interaction with Instructor (Alpha* = .823)</b>	2.27 (0.74)	2.20 (0.76)
Talked about future education plans with a teacher or an assistant	2.28 (0.98)	2.19 (0.99)
Talked about career plans with a teacher or an assistant	2.25 (0.97)	2.16 (0.98)
Discussed ideas from your readings or classes with teachers outside of class	2.05 (0.93)	2.04 (0.92)
Received prompt written or oral feedback from your teacher or an assistant on assignments or class work	2.76 (0.96)	2.67 (0.93)
Interacted with your teacher or an assistant outside the classroom	2.15 (0.98)	2.09 (0.97)
Received mentoring or personal support from your teacher or an assistant	2.12 (1.00)	2.04 (0.97)
<b>Effort (Alpha* = .752)</b>	3.00 (0.64)	2.84 (0.66)
Worked harder than you thought you could to meet teachers' standards or expectations	2.66 (0.93)	2.49 (0.93)
Memorizing facts, ideas, or methods	3.23 (0.79)	2.96 (0.86)
Understanding information and its meaning	3.29 (0.79)	3.15 (0.79)
Applying what you are learning to practical problems or new situations	3.12 (0.90)	2.94 (0.92)
Creating new, more complex interpretations and relationships by combining ideas and information in new ways	2.73 (0.98)	2.67 (0.95)

\*Cronbach's Alpha (Cohen, 1988)

## Appendix 2: High School Students

	<b>Cisco</b>	<b>Comparison</b>
	Mean (SD)	Mean (SD)
<b>Active Participation (Alpha* = .678)</b>	2.51 (0.66)	2.37 (0.69)
Asked questions in class or contributed to class discussions	2.86 (0.89)	2.73 (0.93)
Worked with other students in groups during class	3.09 (0.91)	2.82 (0.95)
Worked with other students in groups outside of class	1.72 (0.94)	1.79 (0.95)
Discussed ideas from your readings or classes with others outside of class (students, family members, co-workers, etc.)	1.94 (0.98)	1.81 (0.94)
<b>Interaction with Instructor (Alpha* = .866)</b>	2.19 (0.77)	1.96 (0.77)
Talked about future education plans with a teacher or an assistant	2.32 (1.03)	1.95 (1.01)
Talked about career plans with a teacher or an assistant	2.36 (0.96)	2.13 (0.94)
Discussed ideas from your readings or classes with teachers outside of class	2.34 (1.02)	1.90 (0.99)
Received prompt written or oral feedback from your teacher or an assistant on assignments or class work	2.54 (0.97)	2.41 (0.95)
Interacted with your teacher or an assistant outside the classroom	2.01 (1.01)	1.82 (0.96)
Received mentoring or personal support from your teacher or an assistant	2.03 (1.01)	1.85 (0.96)
<b>Effort (Alpha* = .811)</b>	2.89 (0.72)	2.68 (0.74)
Worked harder than you thought you could to meet teachers' standards or expectations	2.43 (0.98)	2.28 (0.98)
Memorizing facts, ideas, or methods	3.10 (0.90)	2.89 (0.95)
Understanding information and its meaning	3.17 (0.90)	2.89 (0.95)
Applying what you are learning to practical problems or new situations	3.04 (0.97)	2.66 (1.03)
Creating new, more complex interpretations and relationships by combining ideas and information in new ways	2.68 (1.05)	2.54 (1.04)

\*Cronbach's Alpha (Cohen, 1988)