AC 2005-39: EVALUATION OF A LIVING-LEARNING COMMUNITY FOR ENGINEERING FRESHMEN

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Evaluation of a Living-Learning Community For Freshmen Engineering Students

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Abstract
The idea of learning communities is not new or novel, however, its role in retaining, engaging, and intellectual development for engineering students has yet to be fully explored. There are numerous learning community studies that quantitatively measure grades and retention, and more recently studies that include engagement as measured through individual and national survey instruments. However, the vast majority of these studies are directed at general freshmen populations and not at engineering students specifically. Additionally, drawing direct causality from the learning community to the outcomes is still problematic. Controlling all the other variables that can affect grades, retention, and engagement from an experimental standpoint in an academic setting is difficult at best; consequently, a more effective methodology for evaluating a learning community program may be examining several pieces of evidence that "point" in a particular direction. This evaluative study considers a body of evidence collectively - similar to vector math – by adding the magnitude and direction of each piece of evidence to determine a relative measure of success for the program with respect to the program goals.

Background

To understand this evaluation process, it is necessary to first understand the type of learning community that was developed and why this method may be particularly useful for engineering students. Second, a review of evaluation methodology for other learning communities sheds light on different ways of conducting a program evaluation. Finally a discussion of the measures and expected outcomes for this evaluation is provided.

Type of learning community and justification

Learning communities can take many forms. Most concisely Shapiro and Levine[1] identify four major types of learning communities: 1) paired or clustered courses; 2) cohorts in large courses or first-year interest groups; 3) team-taught courses; and 4) residential learning communities. Most learning communities fall within these categories or are combinations of these primary types. The learning community for this evaluation is a combination of three of these general types: clustered courses, first-year interest group, and residential. This learning community model was designed to mitigate high attrition rates and inadequate student preparedness and increase engagement in college activities.

With only one half of a percent of the average postsecondary student body enrolling in engineering,[2] and only half of those students remaining in engineering,[3] many professional associations and governmental agencies are concerned about the state of engineering education. Factors causing students to switch from engineering[4, 5] include: institutional factors (i.e., the college "chilly" climate versus a more nurturing high school experience and lack of personal contact with faculty), differing high school and college faculty expectations as well as student expectations, and epistemological assumptions (relating to the belief in the certainty of knowledge). For engineering programs this is particularly disconcerting since many will loose up to half of their students in the first year[5, 6, 4] – including those students who already have the required abilities and high school preparedness.[4] Learning communities hold promise for engineering departments as they have been shown to increase retention, improve student attitudes and engagement and increase academic achievement.[7, 8, 9, 10]

Adding an academic component to a residential structure has been suggested by several studies as a way to improve the college experience and increase retention and academic understanding.[11, 12, 7] Blimling & Hample[6] found increases in academic achievement from 0.05 to 0.2 points per quarter when restructuring residential environments around common academic themes. Other research suggests students in a residential program without an academic component are not as likely to show any differences in academic achievement or retention as their non-participating peers.[13, 14] Furthermore, research on learning communities suggests that co-curricular classes can help academic achievement, but do not necessarily show any gains in students' attitudes and engagement when compared to their peers.[15]

Based on research indicating engineering students turn away from engineering because of climate, expectations, and abilities, a learning community for engineering students that results in academic gains, retention, and engagement would be most beneficial when all three parts are combined: the residential component coupled with the common classes and the facilitation of collaborative learning and social support through the small group seminars. The learning community subject to this evaluation has all three of these parts. Entering engineering students self selected into the program and were pre-registered for up to four common classes and one of six non-credit bearing seminar groups. Students were housed on two mixed-gender floors in the same residence hall. The seminars met regularly in assigned classrooms and were facilitated by upperclassmen peers. The peer facilitators were trained prior to the beginning of the semester in mentoring, successful study strategies, and student learning and development theory and application.

Evaluation methodology literature review

Methods for evaluating learning communities have been proposed by Moore,[16] Tinto, Love, & Russo,[17] Wilkie,[18] and The Living-Learning Program Report.[19] Moore used Perry's[20] theory of intellectual development as a basis for measuring the effects of learning communities. A survey instrument, the Measure of Intellectual Development (MID) an essay-writing test derived from Perry's work was used to determine impacts from the learning community. The MID was given to learning community participants and also to peers who were then scored on a 1.0 to 5.0 system relating to where they stand in Perry's intellectual development scheme. Intellectual development was then compared between the two groups. Results from this study found that learning community participants showed further developmental gains than their non-participating counterparts.

Love, Tinto, & Russo[17] approached evaluation by first assuming learning communities were effective ways to respond to the academic and social needs of students. Further, they sought to "casting our nets widely in an effort to be open to unexpected phenomena." The researchers suggested that by doing this, subjective value judgments were eliminated and instead an understanding developed about how each program met the needs of students at each institution and how it shaped student learning and persistence.

Wilke[18] proposed a more "institutional" method by responding to a series of questions divided into three categories: student performance, student retention, and student development. Measures were mixed using both quantitative (grades, retention, course completion, credits completed) and qualitative (students' responses to learning communities, students perceptions of themselves as learners, and difficulties encountered by students in learning communities) methods. Wilke asserts the inclusion of quantitative data despite arguments against the appropriateness of such measures, because there is value in building a case directed toward administrators for learning communities.

The National Living-Learning Communities Report[19] undertook a multi-institutional study to compare types of living-learning communities (the type of learning communities that would fall under the "residential learning communities" based on the Shapiro and Levine categories listed previously) with each other and between institutions. This study is unique as it developed a typology and a standard method of inquiry. Using Astin's[21] Inputs-Environment-Outcomes (I-E-O) theoretical framework, the study provides useful data for benchmarking residential learning communities. The I-E-O theory is one where "*outcomes* (student characteristics after exposure to college) are thought to be influenced by both *inputs* (pre-college characteristics) and *environments* (the various programs, policies, relationships with faculty and peers, and other educational experiences that impact students)."[19] A survey instrument was developed to identify inputs, the environment, and outcomes, and was administered to over 23,000 respondents in 34 colleges and universities. Researchers sought to reduce bias and internal validity threats by identifying and accounting for differences in "inputs." Doing this, researchers assert this study provides an assessment methodology for multi-institutional and like-program comparison.

Measures and outcomes for program evaluation

Elements of these evaluation schemas are intertwined in this program evaluation using both quantitative and qualitative data. We would expect students who participated in this learning community to do better in their common classes (as evidenced by higher grades in the common classes) because of additional time-on-task due to the regular seminar meeting, ready-made study group partners, and close proximity to other students taking the same classes in the residence hall. We would also expect increases in learning due to developing and practicing college level study skills as many students are not adequately prepared for the rigor of college study.[22] Another factor that could affect students' grades are the amount of student preparedness. To reduce this internal threat to validity, we measured AIN and made comparisons between the learning community students and their non-participating peers prior to grade analyses. We would also expect responses from the engagement survey indicating students were spending more time studying and working in groups than their non-participating peers.

We would expect higher rates of retention in the learning community students due to outside motivation from the other participating students as evidenced by higher retention rates in the engineering program and positive comments from the students about engineering in focus groups. Other motivators for retention in engineering include success in the common classes and having realistic and more accurate views of college expectations and would be evidenced by higher grades in the common classes and positive comments about engineering and the engineering program from open-ended questions on the survey and from the focus groups.

We would expect learning community students to be more engaged in college life. The common residence provides opportunity for ready-made study groups, quick answers to questions, common experiences for socializing and a more structured environment focused on academics. Engagement outcomes are evidenced by a survey developed at Iowa State[23] and adapted for local use. Indicators for engagement include time spent studying, working in groups, volunteering, etc. and are compared with non-participating peers. Additional evidence of engagement comes from open-ended questions on the survey qualitatively analyzed for supporting evidence tying the learning community activities to increased engagement. Comments from the focus group responses also provided evidence and insight to connections between the learning community activities and increased engagement.

Evaluation Design

The living-learning community program participants

Fifty-seven students self-selected into the "Teniwe" (Nez Pierce word meaning "to talk") program during housing registration in May, 2003 prior to entering college in August, 2003. Ethnicity and gender for the students is shown below in Tables 1 and 2.

Table 1. Ethnicity of Teniwe participants.

African American	2
Asian	8
Caucasian	39
Hispanic	2
Native American	1
Not Indicated	5
Total	57

Table 2. Gender

Male	45
Female	12
Total	57

Students were housed on two floors in one residential hall and were registered for up to four classes: math (either pre-calculus or calculus), history (world civilizations up to year 1500), chemistry, and an introductory engineering class, Innovation in Design. The students were assigned a meeting time and room for weekly small group peer-facilitated seminar classes. The two-hour weekly peer-led seminars were not credit bearing classes.

As an indicator of incoming preparedness, the admissions index number (AIN) was used. AIN is one of the primary factors used for determining admittance to the university and is calculated using a weighted combination of high school GPA and SAT or ACT scores. Table 3 lists the range, mean, and standard deviation of AIN.

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Table 3. AIN for Teniwe participants

Mean	Std Dev.	Minimum	Maximum	N
68.68	15.83	32	93	57

Control groups

There are three control groups used in this evaluative study; one for the grade analysis, another for the engagement survey analysis, and a third for retention measures. The control groups are not mutually exclusive; i.e. some students are likely included in multiple groups; however, because the analysis was independent for each measure, no students were double counted.

Grade control group

The control group for grade analysis consists of entering freshmen graduated from high school in May 2003, living in the same residence hall (but not necessarily the same floor), with a declared major of engineering, construction management, or architecture, and in the age range of 17-19. Demographics, gender, and AIN are shown in Tables 4, 5, and 6.

Table 4. Demographics for grade analysis control group

African American	2
Asian	8
Caucasian	121
Hispanic	5
Native American	1
Not Indicated	22
Total	159

Table 5. Gender of grade analysis control students

Male	140
Female	19
Total	159

Table 6. AIN of grade analysis control students

Mean	Std Dev.	Minimum	Maximum	N*
68.96	19.974	16	99	141

* There are actually 159 students in the control group; however, not all incoming students have an AIN (such as home schooled students). This table includes only those students with an AIN which is why the N (number included in the analysis) is different between demographics and AIN.

Retention control group

The control group for retention includes only those control students *not* in architecture or construction management. This was done because the "switching" analysis between LLC and control students could be biased because architecture and construction management at this institution are highly competitive programs that accept a limited number of students into their programs. Many students begin in those programs but over half do not certify (are not allowed to continue the program) the following year. Consequently, retention is higher *in college* but not in those programs as students switch out after the first semester. The following year about half of those remaining students do not certify in their desired major but continue in other programs at the same institution. For purposes of retention in *engineering*, the students declaring construction management or architecture were not included in the analysis. Demographics and AIN of the retention control group are shown in tables 7, 8, and 9.

Table 7. Ethnicity of retention control students.

Asian American/Pacific Islander	24
Black	10
Native American/Alaskan	2
Hispanic	14
Caucasian	253
Not Indicated	28
Total	331

Table 8. Gender of retention control students.

Male	281
Female	50
Total	331

Table 9. AIN of retention control students

Mean	Std Dev.	Minimum	Maximum	N*
67.05	19.480	19	99	321

* There are actually 331 students in the control group; however, not all incoming students have an AIN (such as home schooled students). This table includes only those students with an AIN which is why the N (number included in the analysis) is different between demographics and AIN.

Engagement control group

The control group for engagement analysis consisted of engineering students enrolled in the engineering class, Innovations in Engineering that completed both the pre-and post-engagement survey. The engineering class is designed to be taken during the first year and the majority of students are; however, the group does include some non-freshmen students. The demographics and AIN for the engagement students are shown in Tables 10, 11, and 12.

Table 10. Ethnicity of engagement control students.

Asian American/Pacific Islander	9
Black	2
Native American/Alaskan	2
Hispanic	4
Caucasian	124
Not Indicated	24
Total	165

Table 11. Gender of engagement control students.

Male	142
Female	23
Total	162

Table 12. AIN of engagement control students

Mean	Std Dev.	Minimum	Maximum	N*
68.44	20.087	16	99	146

* There are actually 162 students in the control group; however, not all incoming students have an AIN (such as home schooled students). This table includes only those students with an AIN which is why the N (number included in the analysis) is different between demographics and AIN.

Summary comparison of Teniwe and control students

The ratio of gender and ethnicity between the LLC and control students was essentially the same. Tables 13, 14, and 15 outline the demographics and AIN of the freshmen students.

Table 13. Summary ethnic percentage comparison of Teniwe and control groups

Group	Asian American/ Pacific Islander (%)	Black (%)	Native American/ Alaskan (%)	Hispanic (%)	Caucasian (%)	Not Indicated (%)	Total
Teniwe	14	3.5	1.8	3.5	68.4	8.8	57
Control grades	5	1.5	.6	3.4	76.1	13.8	159
Control retention	7.3	3	0.6	4.2	76.4	8.5	329
Control engagement	5.6	1.2	1.2	2.5	76.5	13	165

Table 14. Summary Gender comparison of Teniwe and control groups

Group	Male (%)	Female (%)
LC	78.9	21.1
Control grades	88.1	11.9
Control retention	84.9	15.1
Control engagement	85.8	14.2

Table 15. Summary AIN mean and standard deviation of Teniwe and control groups

Group	AIN Mean	AIN Std. Dev.
LC	68.68	15.83
Control grades	68.96	19.974
Control retention	67.05	19.480
Control engagement	68.44	20.087

Instruments and methodology

Student preparedness analysis

AIN was used as a measure of student preparedness. Independent-samples t-test was performed including Levene's test for equality-of-variance. All statistical analyses were run on SPSS v 11.5.

Grade comparison analysis
Final class grades were used to determine academic gains between the Teniwe students and control peers. Common class grades (math, world civilization, chemistry, and engineering) were collected and analyzed by class using Kruskal-Wallis independent samples test which uses a chi-square statistic to evaluate differences in mean ranks[24]. Institutional grade data was used by querying students by their college identification number and membership in the class. For example, in the chemistry class there were 48 Teniwe students and 157 of the control students out of a total student class population of approximately 300.

Retention analysis
Retention from fall 2003 to fall 2004 between Teniwe and control students was analyzed using the Crosstabs procedure in SPSS which applies a Pearson χ^2 for a 2x2 (Teniwe/ Control x retained/not retained) contingency table analysis Institutional data for enrollment status was collected on the 10th day of the semester which is the official date administrators use to indicate official enrollment. Additional analysis compared the frequency of switchers out of engineering between the Teniwe and control students again using the Crosstabs procedure Pearson χ^2 test after removing student data from students who did not return. Interest codes which are collected each year and used for assigning an advisor were used to determine if the Teniwe or control students had switched out of engineering. The crosstabs procedure using Pearson χ^2 2x2 contingency table analysis and the associated effect size, φ, where .01 is small, .02 is medium, and .03 is large[24] was used to determine significant differences between the two groups.

Engagement survey
Attitudes toward college and level of engagement evaluations were made from individual responses to a survey originally developed at Iowa State University[23]and modified for use in the local institution. The survey was administered as a pre- and post-survey administered during the second and 15th week of the fall 2003 semester to all three sections of the Innovations in Engineering classes.

T-tests were performed comparing control and Teniwe students on items that addressed activities promoting learning and persistence, satisfaction with learning environments, and student estimates and actual time spent on activities. Responses to the open ended questions were coded and those with the highest frequencies are reported. Confirmatory factor analysis of seven scales underlying the set of knowledge and ability items for the pre- and post-surveys were analyzed separately using a promax solution with pairwise deletion of missing data. Reliability analysis for each scale was performed using Cronbach's alpha. For each scale a repeated measures analysis of variance was performed with data from the students who completed both pre- and post-surveys. Interactions using paired sample *t*-tests to determine significance at the 95% level were used to assess whether Teniwe students reported learning more during the semester than their non-participating peers. In depth analysis of the survey and results have been reported a previous paper.[25]

Mid-term assessments
Mid-term assessments were given during the 8th week of school in the seminar class to assess alignment with program goals and the student's assessment of progress meeting those goals. Thirty-two surveys were completed and returned out of 57 participants. Of the 57 participants in

the program 30 students attended the seminar regularly (5 or more times) and 27 attended occasionally (less than 5 times). Four questions were asked on the mid-term assessment surveys:

1. What are three strengths of your engineering Teniwe peer group?
2. What are three things about the engineering Teniwe peer-group you would change?
3. How has school been going so far?
4. Do you have other comments?

Responses to the mid-term assessments were coded as themes emerged around the four questions. Data from the assessments was used to restructure parts of the seminar in an effort to align students and program goals and to assess impacts of the program.

Focus groups

During the last week of classes in the first semester, all three seminars had focus group assessments conducted by a trained facilitator not associated with the College of Engineering. As an added incentive for increased participation, pizza was provided during those meeting times. Twenty-seven students attended one of the three focus groups that were held in the same classrooms as the regular seminar meetings and lasted 60 minutes. The sessions were recorded and then qualitatively analyzed by the facilitator coding themes emerging from each general question. The focus group results were further grouped into three general categories:

1. Issues pertaining to the LLC and perceived effects on students' attitudes and engagement
2. The relationships with the peer-facilitators; and
3. The students' general perceptions regarding college, the engineering program, the Teniwe program with general praises or criticisms.

Results

AIN results

Control students had a slightly higher AIN that the Teniwe students. AIN analysis included Levene's test for equality-of-variance which was not violated; consequently, results from the independent samples t-test T(196) = .092, p = .927, indicated Teniwe students were not significantly different than the control group with respect to incoming preparedness. Table 16 outlines the mean, standard deviation and number of students.

Table 16. Mean and standard deviation of AIN

Group	Mean	Std. Deviation	N
Control	68.96	19.974	141
Teniwe	68.68	15.832	57

Grade results

Initial grade analyses were performed using the non-parametric Kruskal-Wallis test. Analyses revealed Teniwe students had higher grades in the introduction to engineering class and pre-calculus but not significantly. Control students had higher grades in chemistry, world civilization, and calculus but not significantly. Table 17 details the grade analysis.

Table 17. Results from grades analysis.

Class	Treatment	Rank	N	p
Introduction to Engineering	Teniwe	112.12	49	.053
	Control	95.35	149	
Chemistry	Teniwe	60.44	48	.457
	Control	65.64	157	
World Civilization	Teniwe	68.78	49	.179
	Control	78.76	101	
Pre-Calculus	Teniwe	37.61	31	.058
	Control	28.79	34	
Calculus	Teniwe	30.45	10	.839
	Control	31.70	52	

Retention results

Retention from fall 2003 to fall 2004 in the institution was virtually the same (no significant difference found) between the Teniwe and control students when excluding architecture and construction management majors, Pearson χ^2 (1,N=386)=.955, p=.33. Results can be found in Table 18 below.

Table 18. Teniwe and control without architecture and construction management.

Fall 2003 to Fall 2004	Not Retained	Retained	Total	Percentage Retained
Teniwe	6	51	57	89.5%
Control	51	278	329	84.5%

A two-way contingency table analysis was conducted to evaluate whether Teniwe students were retained at higher rates than the control group, Pearson χ^2(1,N=329)=6.252, p=.012, φ=.14. Table 19 details the results of the switching analysis.

Table 19. Retention *in engineering* to Fall 2004

	Stayed in Engineering	Switched	Total	Percent Retained
Teniwe	41	10	51	80.4%*
Control	173	105	278	61.8%

* significant at p=<.01

Engagement survey results

A brief summary of results for this survey is provided here. For in depth analyses and information please refer to the previous paper detailing the engagement survey and results.[25]

Teniwe students were more engaged in activities that promote learning and persistence and spending more time in those activities than their peers. Most compelling was response to the question, "do you plan to continue your studies in engineering?" where 94% of the Teniwe students intended to continue their studies in engineering versus 77% of their non-participating peers. Non-significant results regarding critical thinking and teamwork indicate further work is needed with both the structure of the Teniwe program and the survey instrument.

Control and Teniwe students were mixed when they reflected on the number of opportunities they had to participate in activities that promote learning and persistence such as being able to see connections among classes, able to connect personal experience with class learning, and better understanding the nature of their anticipated major. Although only one significant difference was found, Teniwe students took advantage of these opportunities more often than their counterparts. Teniwe students reported having more opportunities to interact with people from different backgrounds (M = 7.20, SD = 1.29) than their control counterparts (M = 6.53, SD = 1.69), $t(106) = 2.922$, $p = .004$ on a 1 = strongly dissatisfied to 9 = strongly satisfied Likert scale.

Responding to questions about what students did during their non-class time, LLC students spent significantly more hours in study groups (M= 4.62, SD = 3.05) than non-Teniwe students (M = 2.53, SD = 2.77), consistent with the nature of learning communities, $t(191) = 4.389$, $p < .01$. Control students spent more time at paid work (M = 1.91, SD = 4.62) than Teniwe students (M = 0.56, SD = 2.63), $t(143) = -2.506$, $p = .013$.

When asked to rate their knowledge and abilities, students responded similarly to their pre-survey responses. No significant differences between Teniwe and control students in their estimates of knowledge and abilities were found, although control students still rated their written communication abilities higher, though not significantly, than the Teniwe students, as they did on the pre-survey. Knowledge, diversity, teamwork, oral communication, and time management were all rated higher by Teniwe students than control students, although the results were not significant.

The repeated measures analysis to determine changes in the Teniwe and control groups and changes between the pre- and post-surveys found significant differences in the groups taken as a whole between their pre and post responses for knowledge, written communication, and oral communication. However, there were no significant difference between the pre and post-survey responses of the Teniwe group compared to the control group from beginning of the semester to the end.

Responses to open-ended questions about the Teniwe program revealed several aspects that were beneficial to the students. The vast majority of students were anxious to meet new friends but were worried about time management and grades; indicated they meet new friends, improved their grades and improved time management and study skills. Teniwe students perceived the peer-facilitated groups to be an opportunity to work through concepts and problems they had with class work, which, in turn they believed, improved their grades. Peer-facilitated groups were used as a method of time management by regularly using the time for completing homework, again mitigating some of their concerns over their abilities to manage time. Teniwe students developed relationships with their upper-classmen facilitators often asking for advice and finding university resources through them thus learning how to seek help and become more independent in the university environment. Survey results confirm that all Teniwe students believed they had a better understanding of university resources, university policies and procedures and knowledge about engineering by the end of the semester. Students were particularly satisfied living in the same residential hall having other engineering majors where they helped each other and studied together.

Mid-term assessment results

Overall, the students liked the time to work together in the seminar groups and were usually doing homework. They suggested adding a credit for the seminar class and would like to have more time to work on homework. Common themes that emerged from each question on the mid-term assessments are listed in Table 20.

Table 20. Common themes from mid-term qualitative assessment

What are three strengths of your engineering Teniwe peer-group?	Group discussions Work on homework together Same classes Social interactions No distractions Help from peer-facilitators with homework and understanding concepts Same living arrangements
What are three things about the engineering Teniwe peer-group you would change?	Offer credit Closer to dorm Don't like prepared activities *(referring to cross-class connection activities prepared by faculty for this seminar class)* Have an agenda/calendar Have two meetings a week for one hour Nothing
How has school been going so far?	Lots of homework Confusing teachers Good Fast-paced A lot more work than I thought
Any other comments?	Teniwe was a good idea Enjoy homework help Helps to have other people explain things Having pizza is good

Based on the mid-term comments, program administrators altered the scheduled activities for the remainder of the semester to include more homework time and additional help with conceptual knowledge from the common classes.

Focus group results

End-of-semester focus groups revealed students' perceptions of the program and added insight to variables that likely contributed to their college experiences.

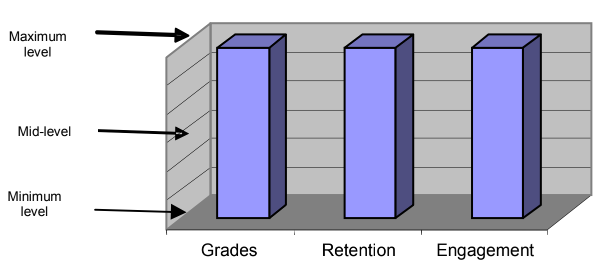
Overall, students participating in the focus groups would recommend the program to family and friends. Common advantages of the program included making new friends, ready-made study groups, and motivation to spend more time on schoolwork. Table 21 outlines key findings from the focus groups.

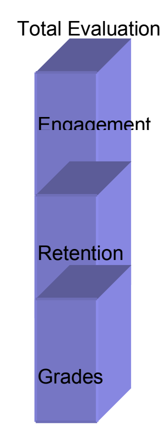
Table 21. Key findings from focus groups.

Learning community and perceived effects on attitudes and engagement	• Community developed by the program helped students "get on track as a new student" • Groups exceeded expectations because facilitated getting through homework • Lack of accountability (i.e. credit) caused group members to be more disruptive and "goof around" • Living arrangements beneficial because they know they have help outside of the classroom living next door to them • Residential arrangement most important aspect of program followed by class schedule, then weekly peer group meetings • Beneficial for developing time management and scheduling skills • Studying for tests effectively • Didn't like two-hour sessions would prefer two, one-hour sessions • students believed they benefited more than their non-participating peers because of the peer group structure which mediated additional study group time and motivation
Relationships with the peer-facilitators	• Helpful for issues pertaining to "navigating the college system" but not for learning course content • Peer-facilitator was not an engineering major and therefore was unable to answer questions related to future engineering studies and careers • Perceived as caring and hard-working • Viewed peer-facilitators as friends and role models
General perceptions regarding college, the engineering program, and Teniwe program general comments	• students were staying in engineering • Students would recommend the program to friends and family members • Would like forum for discussing different engineering fields • Move seminars to dorms • Match classes and seminar content more closely

Conclusion

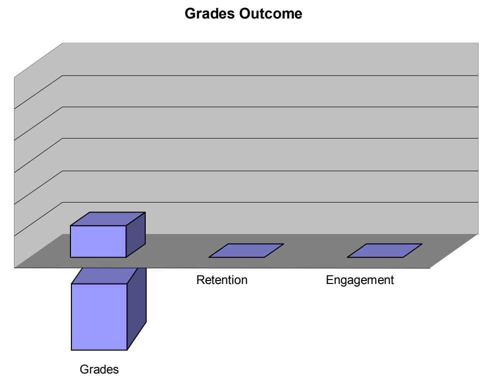
The evaluation for this learning community considers the body of evidence; the grades, retention, engagement, and the student evaluations of the program. Each piece is analyzed for its contribution to each objective and added. Reasoning that each objective is equally important, each category would be worth 1/3 of the total. Conceptually this could be viewed as a bar chart, with each outcome contributing to a portion of the total in each category.



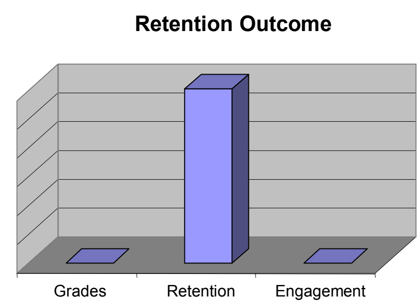


Additionally, improvements in specific areas could be identified. Following is a discussion of the outcomes separated into the three categories aligning with the objectives of this learning community program: increased academic achievement, increased retention, and increased engagement and a visual relative contribution from that outcome to each objective category.

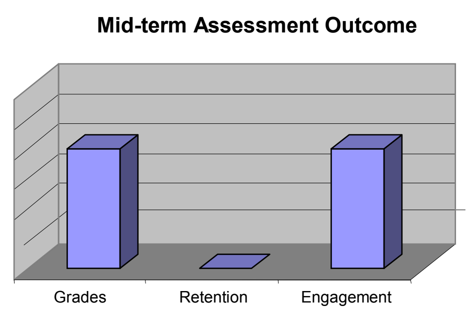
Grades
Teniwe students had higher grade rankings than the control group in the engineering and pre-calculus classes but not significantly. Control students had higher grade rankings in western civilization, calculus, and chemistry but not significantly better. Consequently the grade outcome appears to account for a relatively small contribution to the grades objective because the Teniwe students did not have significantly higher grades and their grades ranked higher in only two of the five classes analyzed.



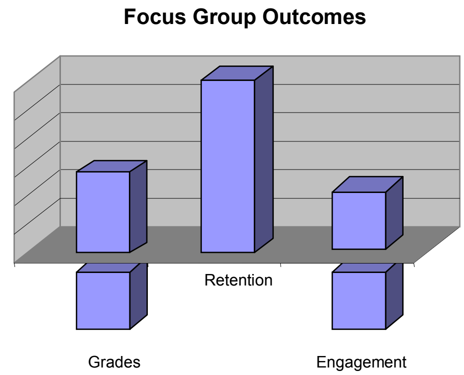
Retention
Retention in the institution between Teniwe and control students was essentially the same. Retention in engineering was significantly greater for the Teniwe students than the control (80% versus 62%) group when architecture and construction management students were removed from the control group. Considering an average incoming engineering freshmen class of 450 students, approximately 81 additional students (or 18% more students) would persist in engineering with this treatment. Significantly higher retention in engineering would account for a relatively large contribution to the retention objective.



Mid-term assessments
The mid-term assessments indicated students were studying more in groups and felt more prepared for tests (contributing to grades objective). They were making new friends – friends that they might not have found if not for the program (contributing to engagement). Students were more motivated to do homework because of the weekly peer-facilitated group meetings (contributing to grades and engagement). These outcomes contribute to the grades and engagement objectives at relatively high amounts.

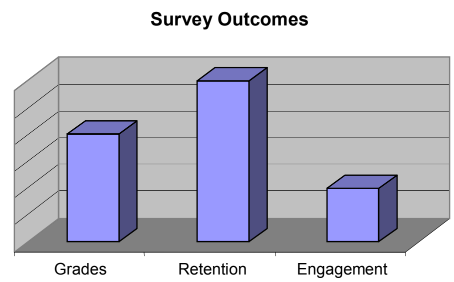


Focus Group Results



Focus group results confirmed that students perceived they studied more and performed better academically than their non-participating peers (contributing to grades). Weekly seminar activities appeared to be busy work possibly indicating no perceived coherence between the activities and their classes (subtracts from engagement and grades). All the students intended to remain in engineering (contributes to retention). Students indicated they believed that their success in college was benefited by the common housing arrangements, the common classes, and the weekly peer-facilitated groups, in that order.

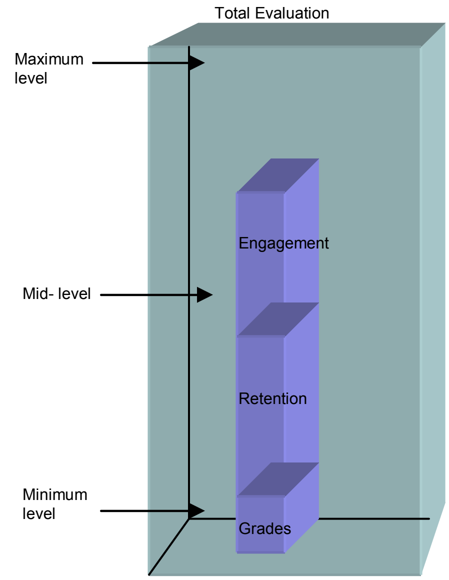
Survey results



Survey results suggested several aspects of the program were seen to be beneficial to the students. The vast majority of students were anxious to meet new friends but were worried about time management and grades. Teniwe students indicated they did meet new friends, did improve their grades and improved time management and study skills (contributing to grades and retention). Students perceived the peer-facilitated groups to be a learning opportunity to work through concepts and problems they had with class work, which, in turn, improved their grades. Students also used the peer-facilitated groups as a method of time management by regularly using the time around the study groups for completing homework, again mitigating some of their concerns over their abilities to manage time (contributing to grades). Students developed relationships with their upper-class facilitators, often asking for advice and finding university resources through them, thus learning how to seek help and become more independent (contributes to engagement). Survey results confirm that all students (both Teniwe and control) believed they had a better understanding of university resources, university policies and procedures and knowledge about engineering by the end of the semester. Teniwe students were particularly satisfied living in the same residential hall with other engineering majors, allowing them to help each other and study together. Overwhelmingly Teniwe students indicated they planned to continue their engineering studies more so than the control group (large contribution to retention).

Summative evaluation from all factors

All results, both quantitative and qualitative indicate a living-learning community is a valid vehicle for increasing retention, academic achievement, and engagement for engineering students. Most surprising, however, was the lack of significant academic gains as evidenced by grades despite the increased time on academic tasks. The mid-term assessments, focus groups, and engagement survey all indicated Teniwe students were spending more "time-on-task" academically than their control counterparts. Because of the additional time spent on academics, it would be expected grades would increase – but they did not. Consequently an overall ranking would indicate a program performance slightly higher than mid-level with areas for improvement in the grades (primarily) and to some extent engagement (referring to more of the critical thinking and other activities that promote engagement).



Which elements are most important? Results from this semester indicate all three parts: common residence and classes with a linking seminar are all important and necessary. The common residence increases student motivation to study by developing relationships with peers so when one student is stuck there is almost always someone nearby that they can work with. Developing good study habits early in a college career is especially important to engineering students as the coursework is rigorous and jam-packed and may be an area that is lacking in this model based on the grades outcome. The common classes provide the medium and common context for developing good study habits and peer motivation for studying but may not in and of themselves cause an increase in grades contrary to what has been found in other research.[15] However, students have the opportunity to gage their time management and academics with their peers because they are in the same classes, thus giving the student a vehicle for developing self regulation.

A common concern of Teniwe students was the perception that the weekly seminar required them to participate in activities that they believed were "busy work." Although the activities were developed by faculty from the common classes, the majority of activities did not have any direct effect on the student's grade in that class nor did the student make connections between activities and classes. Consequently, this is likely the reason behind the "busy work" perception and possibly could have contributed to the lower grades.

A common problem educators face is the benefits of many educational activities are not readily apparent to the students; however, latent learning from these types of activities is often cited when students reflect at the end of their college careers. This presents a problem when evaluating a new program - much like a parent requiring their child to eat their vegetables. The child is reluctant to eat vegetables even though it is good for them in the long run. Balancing this "latent" learning with students' perceptions of the program is an enormous challenge. On the other hand, the legacy of a program cannot be overlooked by administrators as the influence of peers and advisors can have a negative effect on a student's ability to be receptive to a new treatment or program if the program has a poor reputation based on a student's immediate reaction that might possibly change later.

Recommendations for improvements to program

Although students expressed the most concerns about the weekly seminar class, this class time was crucial. Researcher observations of interactions between the students in the seminar classes and their linked classes indicated they did not naturally form groups – even when they live with and take the same classes with their peers. An additional mechanism was required that essentially "forced" the students together. That "force," for this study, was the weekly seminar group meetings. Because the seminar class was the most controversial, it is for this part of the program that the majority of recommendations are made. First, class activities must be tied to the common classes through assignments or as part of their grade so the students perceive validity in the seminar work. Second, involve trained graduate students interested in teaching with the academic portion of the seminar along with the peer leaders to assist with content knowledge activities. Third, schedule the seminar class for two, one-hour periods twice a week with time available after class if students wish to continue studying in the same room. Additionally, it may be just as effective and logistically more accommodating if there were two, rather than three linked classes.

As with any program, a learning community must remain fluid and responsive to its stakeholder needs. This particular program appears to have a positive impact on students. Continuous ongoing assessment and evaluation will refine this program while retaining and addressing specific issues and areas of increased need while potentially retaining an increasing number of engineering students.

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