Impacting Attitudes of ELL Students: Integrated Learning Communities in Introductory Science Courses

Annia K. Fayon, Emily Goff, and Irene M. Duranczyk
University of Minnesota

Abstract

In large introductory science courses at the postsecondary level, there is significant anecdotal evidence of traditionally underrepresented students disengaging from the lectures, resulting in withdrawals or failures. Because these science courses often fulfill graduation requirements and provide the students with broad introductions to basic scientific principles, success in these courses is paramount to students' success at the postsecondary level. In this paper, we illustrate how integrated learning communities contribute to the development of positive attitudes and beliefs necessary for the success of ELL students, and suggest strategies for enhancing students' self-regulation.

English Language Learners (ELL) are the fastest growing group of high school graduates in the United States (Short, 2000; Spencer, 2005). Universities have had difficulty engaging all traditionally underrepresented students in the sciences, including ELL students. With the confluence of these trends, we need to continue to develop strategies that will increase the participation of traditionally underrepresented populations in science in order for these students to have equal opportunities to pursue Science, Technology, Engineering, and Math (STEM) degrees and professions. In so doing, these students can succeed and become role models for the next generation of students entering the university and the workforce. This article highlights the benefits of a credit-bearing academic English course paired with an introductory science course in order to support ELL students' affective and cognitive development.

Background

It is well documented that traditionally underrepresented students must overcome both academic and affective barriers to success at the postsecondary level. This is true for all underrepresented students, including recent immigrants and ELL students (Moore & Christensen, 2005; Zamel & Spack, 2004). In an effort to address the academic issues, many institutions require students to take non-credit bearing courses in mathematics, reading,

For more information contact: Annia K. Fayon | University of Minnesota | Department of Postsecondary Teaching and Learning | 178 Pillsbury Dr. SE | Minneapolis, MN 55455 | afayon@umn.edu

and writing to build stronger foundations in these basic skills, particularly for ELL students. The zero-credit course, while sometimes effective in remediating students' academic difficulties, generally does not satisfy requirements for degree completion and can inhibit a student's progress towards successful and timely graduation (Boylan, 2002). With regards to affective barriers, students who are not participating in credit-bearing mainstream courses can face decreased opportunity for social networking and can suffer from decreased family and community support due to their inability to make timely progress toward a degree, which could result in students who do not persist (Boylan 1999, 2002). Providing structures within the context of mainstream, credit-bearing courses is a way for programs to support those students who might struggle with academic issues while also avoiding potential negative impacts on students' affective development and degree progress (Boylan, 2002; Ramirez, 1997).

In an acknowledgement of the effectiveness of this model and in an effort to address students' affective and academic barriers, many colleges and universities have adopted some form of credit-bearing course-based support for students who are struggling or predicted to struggle in science courses; many of these participants are ELL students. These courses can take many forms including Supplemental Instruction (SI), Learning Communities (LCs), and partnerships with learning centers that offer study skills development, among other models. In the University of Minnesota's Department of Postsecondary Teaching and Learning (PsTL), the Commanding English (CE) Program was one such program designed to support recent immigrants and ELL students.

In an effort to provide the contextualized content-based support that has been proven most effective for supporting ELL academic and linguistic abilities (Lantolf & Pavlenko, 1995; McCafferty, 1994), "CE builds language support and academic orientations into an entire credit-bearing first-year curriculum so that students can obtain a more contextualized use and understanding of academic English" (Moore & Christensen, 2005). Unlike some learning support programs for ELL students, CE students enroll in credit-bearing courses all of which meet graduation requirements at the University of Minnesota (Christensen, Fitzpatrick, Murie, & Zhang, 2005). Participants in the CE program are—for the most part—non-white students from South East Asia and Eastern Africa. During the first semester of their freshman year, CE participants enroll in PsTL 1041, "Developing College Reading," a 2-credit course paired in a learning community with a content area course. PsTL 1041 is offered as part of integrated learning communities with a variety of science, social science, and humanities courses. During the fall 2007 semester, a CE course was part of a learning community with PsTL's Introductory Earth Science course (PsTL1171). However, this option was not available to students during the spring 2008 semester so the participants from spring 2008 serve as a control group whose experiences can be compared with the treatment group of fall 2007. In this article, we present data from a self-reported attitudes survey administered during both fall 2007 and spring 2008 that illustrates the benefits of participation in an integrated learning community in the sciences for ELL students.

The STEM Achievement Gap and Learning Communities

The STEM achievement gap between white and non-white students is well documented and is usually first observed early in the elementary school years (Banks, 1997). In Minnesota, TIMSS test scores reveal an increasing gap in the 4th and 8th grades from 1995 to 2007 (Schmidt, 2010). There are many theories as to why the gap exists (Hunter & Bartee, 2003), and it is clear that the gap persists to the postsecondary level (Hill, Holzer & Chen, 2009), where enrollment gaps in STEM between white and non-white students still exists (National Science Foundation, 2009). Furthermore, ELL students are a growing segment of the non-white population in postsecondary education, particularly in Minnesota (Christensen, Fitzpatrick, Murie, & Zhang, 2005). Postsecondary science educators can contribute to closing the gap by employing techniques that encourage students to evaluate their attitudes and beliefs. A significant part of this change involves increasing the students' levels of self-awareness and metacognition, which can only serve to promote the academic success of these students.

There is a long-standing body of research that documents the benefits of learning community models on student success at the postsecondary level (Cargill & Kalikoff, 2007; Kuh, 2009; Lenning & Ebbers, 1999; Tinto, 1998; 2003). Tinto (2003), in his summary of learning communities, gives four overall positive student learning and development outcomes that resulted from the students' participation in learning communities. These students tended to (a) "form their own self-supporting groups which extended beyond the classroom" (p. 5), (b) be more actively engaged in their learning process, (c) enrich each other's learning experience and subsequently perceived themselves as having learned more, and (d) persist. Specifically in the math and sciences, Treisman (1985, 1992) observed significant benefits of collaborative learning for the success of underrepresented populations. His workshop model has been applied in a variety of settings with success (Swarat, Drane, Smith, Light, & Pinto, 2004). The small group cooperative learning model has also been shown to create an environment that promotes the exchange of ideas and allows students to "challenge their own knowledge" (p. 19).

These observed behaviors are similar in nature to those exhibited by students who are self-regulated learners. Self-regulated learners are defined by Zimmerman (1990) as those who "approach educational tasks with confidence, diligence, and resourcefulness" (p. 4). Self-regulated learning requires students to study themselves, thereby increasing their metacognitive level (Glenn, 2010; Zimmerman). Once students have these learning habits, they are more likely to succeed in other courses. In this paper, we present data that documents increasing positive attitudes and confidence towards studying science for ELL students as a result of participation in a learning community that also supports their language learning.

Methodology

A learning attitudes survey was administered to two introductory geoscience courses at the University of Minnesota (UMN) – Twin Cities campus during the academic year 2007-2008. Introductory geoscience courses at UMN fulfill the general liberal education physical science with lab and environmental theme requirements for graduation. GEO1001, "Earth and Its Environments," is a large-lecture course offered through the Department of Geology and Geophysics, with anywhere between 100 to 250 students enrolled per lecture section. Students attend 2.5 hours of lecture and 2 hours of laboratory per week. Generally, the laboratory content is independent of lecture content and students from a particular lecture are not in the same laboratory section. A course that contains the same content and fulfills the same graduation requirements is PsTL1171, "Earth Systems and Environments," offered through PsTL. Enrollments in this course are generally lower (40 to 80 students), and the lecture and laboratory content are more integrated. Overall, enrollments in GEO1001 and PsTL1171 were significantly different; however, the number of traditionally underrepresented students in both classes were similar in the fall 2007 semester ($n_{GEO1001} = 28$; $n_{PsTL1171} = 21$). The traditionally underrepresented student population in the control group from spring 2008 PsTL1171 (n = 16) mirrored that of the fall 2007 cohort.

During the fall 2007 term, PsTL1171 was taught as part of a learning community called "The Face of the Earth." Students enrolled in this learning community participated in the partner CE course, PsTL1041, "Reading in the Content Area" that used the content from the earth science course to address the academic and affective needs of ELL students. Students who participated in this learning community were all enrolled in the same laboratory section of PsTL1171.

The CLASS instrument (Adams et al., 2006) was administered to students enrolled in both GEO1001 and PsTL1171 in the fall 2007 and spring 2008 terms to assess student attitudes towards learning in the sciences. This instrument was first designed to measure student attitudes towards learning in physics (Adams et al.), and has since been modified for the Earth sciences. For this study, the items on the original physics CLASS instrument were slightly modified to reflect attitudes towards geology, the Earth sciences, and the physical sciences in general (Figure 1). Some of the statements in this survey have been grouped to represent general areas of attitudes and beliefs (Adams et al. Table 1). The attitudes and beliefs measured also reflect the student's level of self-awareness and self-regulation, in other words the student's metacognitive level. In general, the survey is administered to students at the beginning (PRE) and end (POST) of a semester. Students respond on a 5-point Likert scale in agreement or disagreement with each statement, and responses are then compared to the opinions of science professionals; favorable responses are those that are in agreement with the expert opinions. Because we are primarily interested in the students' final attitudes and beliefs, we analyzed and present here only POST-responses.

Here are a number of statements that may or may not describe your beliefs about learning geology.

Choose one of the five choices that best expresses your feeling about the statement. If you don't understand a statement, leave it blank. If you have no strong opinion, choose C.

A. Strongly Disagree B. Disagree C. Neutral D. Agree E. Strongly Agree

1. A significant problem in learning physical geology, is being able to memorize all the information I need to know.
2. When I am solving a science problem, I try to decide what would be a reasonable answer.
3. I think about geology and the environment in everyday life.
4. It is useful for me to do lots and lots of problems or examples when learning a science.
5. After I study a topic in geology and feel that I understand it, I have difficulty understanding problems or applications on the same topic.
6. Knowledge in geology consists of many disconnected topics.
7. As geologists learn more, most geological principles we use today are likely to be proven wrong.
8. When I solve a geological problem, I locate an equation that uses the variables and plug in the values.
9. I find that reading the text in detail is a good way for me to learn geology.
10. There is usually only one correct approach to solving a geological problem.
11. I am not satisfied until I understand why something works the way it does.
12. I cannot learn geology if the teacher does not explain things well in class.
13. I do not expect equations to help my understanding of the ideas; they are just for doing calculations.
14. I study physical geology to learn knowledge that will be useful in my life outside of school.
15. If I get stuck on a problem on my first try, I usually try to figure out a different way that works.
16. Nearly everyone is capable of understanding science, in particular physical geology, if they work at it.
17. Understanding a scientific concept in physical geology basically means being able to recall something you've read or been shown.
18. There could be two different correct values to a geological problem if I use two different approaches.
19. To understand material from this course, I discuss it with friends and other students.
20. I do not spend more than five minutes stuck on a problem before giving up or seeking help from someone else.
21. If I don't remember a particular concept needed to solve a problem on an exam, there's nothing much I can do (legally!) to come up with it.
22. If I want to apply a method used for solving one geological problem to another, the problems must involve very similar situations.
23. In doing a problem, if my calculation gives a result very different from what I'd expect, I'd trust the calculation rather than going back through the problem.
24. In science, particularly physical geology, it is important for me to make sense out of formulas and concepts before I can use them correctly.
25. I enjoy solving geological problems.
26. In geology, mathematical formulas express meaningful relationships among measurable quantities.
27. It is important for the government to approve new scientific ideas before they can be widely accepted.
28. Learning physical geology changes my ideas about how the world works.
29. To learn geology, I only need to memorize answers to sample problems.
30. Reasoning skills used to understand geology can be helpful to me in my everyday life.
31. We use this statement to discard the survey of people who are not reading the questions. Please select agree (option D) for this question to preserve your answers.
32. Spending a lot of time understanding where geological concepts and formulas come from is a waste of time.
33. I find carefully analyzing only a few geological processes in detail is a good way for me to learn geology.
34. I can usually figure out a way to solve problems in geology and other sciences.
35. The subject of geology has little relation to what I experience in the real world.
36. There are times I solve science problems more than one way to help my understanding.
37. To understand geology, I sometimes think about my personal experiences and relate them to the topic being analyzed.
38. It is possible to explain geological concepts without mathematical formulas/symbols.
39. When I solve a problem in geology, I explicitly think about which geological principles apply to the problem.
40. If I get stuck on a geology problem, there is no chance I'll figure it out on my own.
41. It is possible for geologists to carefully perform the same analysis and get two very different results that are both correct.
42. When studying geology, I relate the important information to what I already know rather than just memorizing it the way it is presented.

Figure 1. CLASS Survey as Modified for Geology.

Table 1

The Original Grouping of CLASS Items

Categories for Grouping Questions	Question Numbers
Personal interest: Feeling a personal interest in / connection to geology	3, 11, 14, 25, 28, 30
Real world connection: Seeing the connection between geology and real life	28, 30, 35, 37
Problem solving general	13, 15, 16, 25, 26, 34, 40, 42
Problem solving confidence	15, 16, 34, 40
Sense making / effort: Exerting the effort needed toward sense-making is worthwhile	11, 23, 24, 32, 36, 39, 42
Applied conceptual understanding: Understanding and applying a conceptual approach and reasoning in problem solving, not memorizing or following problem solving recipes	1, 5, 6, 8, 21, 22, 40
Conceptual understanding: Understanding that geology is coherent and is about making sense, drawing connections, reasoning not memorizing, making sense of geology	1, 5, 6, 13, 21, 32

Results

The data were first analyzed by comparison of the mean post-survey responses for the traditional underrepresented student population as a function of course (GEO1001 and PsTL1171) and academic term (fall 2007 and spring 2008) using SPSS (2007). In this paper, we highlight the statistically significant results from our analyses, and these data are reported in Tables 2-5. Mean responses from the fall 2007 cohort—which was the group that included those students who were enrolled in the integrated learning community—revealed a statistically significant difference, $p<0.05$, in the category of Problem Solving Confidence, with students from PsTL1171 responding more favorably than students in GEO1001. The same analysis of responses for the two introductory geoscience courses in the spring 2008 term did not reveal any statistically significant differences among traditionally underrepresented students.

Based on these results and the categorical nature of the responses, individual student responses were analyzed using a Mann-Whitney test (Tables 2, 3). This test determines differences based on the ranking of individual student responses, not the mean of the group. Effect size (r) for each z-value was also calculated. The following size effect standard was used: $r = 0.10$, a small effect (accounting for 1% of the total variance), $r = 0.30$, a medium effect (accounting for 9% of the total variance), and $r = 0.50$, a large effect (accounting for 25% of the total variance). Results of this analysis again revealed statistically significant differences, $p<0.05$, in the same category, Problem Solving Confidence ($Mdn_{GEO1001}$ = 25, $Mdn_{PsTL1171}$ = 75) for the fall 2007 cohort (Table 3), with students from the learning community responding significantly more favorably, reporting higher problem solving confidence with a moderate effect size (Table 3). Statistically significant differences, $p<0.05$, are also noted for the Real World Connections ($Mdn_{GEO1001}$ = 50, $Mdn_{PsTL1171}$ = 75). The students who participated in the integrated learning community more often reported seeing the connection between geology and real life than those students who did not participate in the integrated learning community. Differences in Problem Solving, General ($Mdn_{GEO1001}$ = 37.5, $Mdn_{PsTL1171}$ = 62.50) were also noted.

Table 2

Mann-Whitney Test Ranks (2 Independent Samples): Underrepresented Populations in an Introductory Geology With(1171) and Without(1001) Integrated Learning, fall 2007

Ranks				
	Introductory Geology	*n*	Mean Rank	Sum of Ranks
Personal Interest	With Integrated Learning	21	20.60	792.50
	Without Integrated Learning	28	28.30	432.50
	Total	49		
Real World Connections	With Integrated Learning	21	28.95	608.00
	Without Integrated Learning	27	21.04	568.00
	Total	48		
Problem Solving General	With Integrated Learning	21	29.19	613.00
	Without Integrated Learning	27	20.85	563.00
	Total	48		
Problem Solving Confidence	With Integrated Learning	21	30.17	633.50
	Without Integrated Learning	27	20.09	542.50
	Total	48		

Table 3

Mann-Whitney Test Statistics (2 Independent Samples): Underrepresented Populations in an Introductory Geology With(1171) and Without(1001) Integrated Learning, fall 2007

Test Statistics				
	Personal Interest	Real World Connections	Problem Solving General	Problem Solving Confidence
Mann-Whitney U	201.5	190	185	164.5
Wilcoxon W	432.5	568	563	542.5
Z	-2.018	-1.999	-2.063	-2.53
Asymptotic Sig. (2-Tailed)	0.044	0.046	0.039	0.011
r	-0.29	-0.29	-0.30	-0.34

Students from the learning community reported higher problem-solving strategies, as measured in questions 13, 15, 16, 25, 26, 34, 40 and 42 on the survey with a medium effect size (Table 3). With regard to the Personal Interest category, PsTL1171 students reported feeling a personal interest in and connection to geology with a small to moderate effect size (Table 3). The GEO1001 students responded more unfavorably for questions related to this category than those students from PsTL1171 ($Mdn_{GEO1001}$ = 16.67, $Mdn_{PsTL1171}$= 0.00). (Table 3). There were no differences in responses between the underrepresented student populations enrolled in geology coarses without the integrated learning componet (GEO1001 and PsTL1171, spring 2008).

To assess whether or not the differences in post-survey responses were a function of participation in the integrated learning community paired with PsTL1171 and not to the course structure (GEO1001 – large lecture, PsTL1171 – small lecture), post-survey responses from PsTL1171 fall 2007 (small lecture, integrated learning community) were compared to student responses from PsTL1171 spring 2008 (small lecture, however in this case *not* paired with a CE course in an integrated learning community) (Table 4, 5). Both PsTL1171 courses were similar in size and were taught by the same faculty member. This analysis revealed significant differences in more than half of the categories measured on the CLASS survey (Table 5). Students in PsTL1171 fall 2007, the integrated learning community, responded more favorably in all beliefs and attitudes toward learning geosciences when combining all the categories on the survey ($Mdn_{PsTL1171\ fall\ 2007}$ = 60.0, $Mdn_{PsTL1171\ spring\ 2008}$ = 42.31) with a medium to large effect.

Table 4

Mann-Whitney Test Ranks (2 Independent Samples): Underrepresented Populations in PsTL Introductory Geology With (fall 2007) and Without (spring 2008) Integrated Learning

Ranks				
	Introductory Geology	*n*	Mean Rank	Sum of Ranks
All Categories	With Integrated Learning	21	22.76	478.00
	Without Integrated Learning	15	12.53	188.00
	Total	36		
Personal Interest	With Integrated Learning	21	22.38	470.00
	Without Integrated Learning	16	14.56	233.00
	Total	37		
Real World Connections	With Integrated Learning	21	22.50	472.50
	Without Integrated Learning	16	14.41	230.50
	Total	37		
Problem Solving General	With Integrated Learning	21	22.62	475.00
	Without Integrated Learning	16	14.25	228.00
	Total	37		
Problem Solving Confidence	With Integrated Learning	21	22.24	467.00
	Without Integrated Learning	16	14.75	236.00
	Total	37		
Sense Making /Effort	With Integrated Learning	21	23.43	492.00
	Without Integrated Learning	16	13.19	211.00
	Total	37		

Table 5

Mann-Whitney Test Statistics (2 Independent Samples): Underrepresented Populations in PsTL Introductory Geology With (fall 2007) and Without (spring 2008) Integrated Learning

Test Statistics						
	All Categories	Personal Interest	Real World Connections	Problem Solving General	Problem Solving Confidence	Sense Making / Effort
Mann-Whitney U	68	97	94.5	92	100	75
Wilcoxon W	188	233	230.5	228	236	211
Z	-2.876	-2.219	-2.332	-2.368	-2.155	-2.883
Asymptotic Sig. (2-Tailed)	0.004	0.026	0.02	0.018	0.031	0.004
Exact Sig. [2*1-tailed Sig.)]	0.003*	0.029*	0.023*	0.019*	0.037*	0.004*
r	-0.48	-0.36	-0.38	-0.39	-0.35	-0.47

**Note:* Not Corrected for Ties.

Using the CLASS categories, a significant difference, $p<0.05$, in Personal Interest was indicated, with the fall 2007 cohort having a more positive interest in and connection to geology ($Mdn_{PsTL1171\ fall\ 2007} = 66.67$, $Mdn_{PsTL1171\ spring\ 2008} = 41.67$) with a medium effect. This effect size is larger than the effect size for the difference between the large lecture course and the integrated learning course reported previously. The difference between the groups when looking at Real World Connections ($Mdn_{PsTL1171\ fall\ 2007} = 75$, $Mdn_{PsTL1171\ spring\ 2008} = 50$) is quite similar in effect size to the Personal Interest grouping. The integrated learning section espouses more connections between their lives and geology concepts and ideas. Problem Solving General ($Mdn_{PsTL1171\ fall\ 2007} = 62.50$, $Mdn_{PsTL1171\ spring\ 2008} = 43.75$) and Problem Solving Confidence ($Mdn_{PsTL1171\ fall\ 2007} = 75$, $Mdn_{PsTL1171\ spring\ 2008} = 50$) for the integrated learning community yield a medium effect and indicate that the integrated learning community has students identifying with confidence and useful strategies for problems solving. A new area of differences between the groups is Sense Making/Effort ($Mdn_{PsTL1171\ fall\ 2007} = 71.43$, $Mdn_{PsTL1171\ spring\ 2008} = 42.86$). In this category there is a medium to large effect with the integrated learning community participants identifying with more favorable responses. Integrated learning community participants exert the effort needed for and see the value of sense-making.

Discussion

These differences in attitudes and beliefs overwhelmingly illustrate the benefits of participation in an academically integrated learning community for a growing segment of the traditionally underrepresented student population—ELL students. The integrated learning approach is of particular importance for increasing the level of students' self-awareness and self-regulation in learning science, which can subsequently engage students in the sciences and contribute to the academic success of this population (Zimmerman, 1990). Engagement, retention, and success of this student population are particularly critical in the context of the STEM achievement gap.

The results presented here document the benefits of integrated learning for ELL students in the introductory geoscience course. PsTL1171, taught as an integrated learning community, created an environment in which students were supported in their reading of the textbook and encouraged to practice problem solving techniques. The statistically significant difference in Problem Solving Confidence supports this conclusion. Furthermore, students in the integrated learning community were able to identify and relate Earth science concepts to their own lives, supporting the increased level of engagement. However, there were no statistically significant differences in the responses to statements we have identified as relating to self-regulation (statements 2, 10, 12, 17, 18, 19, 20, 29, 38).

Self-regulated learners are defined by Zimmerman (1990) as those who "approach educational tasks with confidence, diligence, and resourcefulness" (p. 4). Self-regulated learning requires students to study themselves, thereby increasing their metacognitive level (Glenn, 2010; Zimmerman). Once students have these learning habits, they are more likely to succeed in other courses. We have evidence that the integrated learning community participants were more engaged and had more confidence in their problem solving, which are necessary but not sufficient components of self-regulation (Schraw & Brooks, 1998). Self-regulation requires confidence, cognition (skills and knowledge of a particular discipline), and metacognition (thinking about one's thinking). A more complete longitudinal survey would be required to assess the level of students' success in subsequent course work.

Implications for Integrated Learning Support

ELL students who participated in the integrated learning community exhibited greater gains in positive attitudes towards learning science, which can potentially increase retention and persistence of this population of students. The integrated learning model exposes students to multiple perspectives of one discipline and encourages them to demonstrate their knowledge in multiple formats. This model also increases students' self-efficacy. Ideally, students will develop the habits of self-regulated learning.

According to Zimmerman (1995), self-regulated learning "involves more than metacognitive knowledge and skill, it involves a sense of personal agency to regulate other sources of personal influence, such as emotional processes, as well as behavioral and social-environmental sources of influence" (p. 218). In this integrated learning community, as with all learning communities, the affective barriers are addressed by promoting a student community. In the CE program students share their experiences in the United States as recent immigrants and ELL students. Overcoming the affective barriers is a clear benefit of these integrated learning communities. However, in the case we present here, an increased level of self-regulation was not observed. Proposed strategies to improve on this aspect are to provide students with structured, guided self-reflection, model the self-monitoring process during problem solving, and set clear goals (Hofer, Yu, & Pintrich, 1998). These strategies can be employed through collaborative teaching among learning assistance professionals and faculty.

Conclusion

While we present the positive effects observed for a general geoscience course, the benefits of integrated learning and the adaptation of self-regulating behaviors go beyond this one discipline. In theory, self-regulation is a transferable skill that will allow students to succeed in any learning endeavor. With increased student success comes increased engagement, which can possibly contribute to reducing the achievement gap in all STEM areas.

References

Adams, W. K., Perkins, K. K., Podolefsky, N. S., Dubson, M., Finkelstein, N. D., & Wieman, C. E. (2006). A new instrument for measuring student beliefs about physics and learning physics: The Colorado Learning Attitudes about Science Survey. *Physical Review Special Topics, Physics Education Research, 2*(1), 1-14.

Banks, J. A. (1997). Multicultural education: Characteristics and goals In J. A. Banks & C. A. McGee Banks (Eds). *Multicultural education: Issues and Perspectives* (3rd ed; pp 3-31). Boston: Allyn & Bacon.

Boylan, H.R. (1999). Exploring Alternatives to Remediation. *Journal of Developmental Education, 22*(3), 2-8.

Boylan, H. R. (2002). *What works: Research-based best practices in developmental education*. Boone, NC: Continuous Quality Improvement Network with the National Center for Developmental Education.

Cargill, K., & Kalikoff, B. (2007). Linked psychology and writing courses across the curriculum. *Journal of General Education, 56*(2), 83-92.

Christensen, L. Fitzpatrick, R., Murie, R., & Zhang X. (2005). Building voice and developing academic literacy for multilingual students: The Commanding English model. In J. L. Higbee, D. B. Lundell, & D. R. Arendale (Eds.), *The General College vision: Integrating intellectual growth, multicultural perspectives, and student development* (pp.155-184). Minneapolis: University of Minnesota, General College, Center for Research on Developmental Education and Urban Literacy.

Glenn, D. (2010). How students can improve by studying themselves. *Chronicle of Higher Education, (56)*22, A1, A10, A12.

Hill, C. J., Holzer, H. J., and Chen, H. (2009). *Against the tide: Household structure, opportunities and outcomes among white and minority youth*. Kalamazoo, MI: Upjohn Institute.

Hofer, B. K., Yu, S. L., & Pintrich, P. R. (1998). Teaching College Students to be self-regulated learners, in D. H. Schunk and B. J. Zimmerman (Eds.), *Self Regulated Learning, from teaching to self-reflective practice* (pp. 57-85). New York: Guilford Press.

Hunter, R. C., & Bartee, R. (2003). The achievement gap: Issues of competition, class, and race. *Education and Urban Society, 35*(2), 151-160.

Kuh, G.D. (2009). What student affairs professionals need to know about student engagement. *Journal of College Student Development, 50*(6), 683-706.

Lantolf, J.P., & Pavlenko, A. (1995). Sociocultural theory and second language acquisition. *Annual Review of Applied Linguistics, 15*, 108-124.

Lenning, O.T., & Ebbers, L.H. (1999). The Powerful Potential of Learning Communities: Improving Education for the Future. *ASHE-ERIC Higher Education Report, 26*(6), pp. 173.

McCafferty, S. G. (1994). Adult second language learners' use of private speech: A review of studies. *The Modern Language Journal, 78*, 421-436.

Moore, R. & Christensen, L. (2005). Academic behaviors and performances of Generation 1.5 students who succeed in college science courses. *The Learning Assistance Review, 10*(2), 17-29.

National Science Foundation. (2009). *Women, Minorities, and Persons with Disabilities in Science and Engineering*. Retrieved from http://www.nsf.gov/statistics/wmpd/

Ramirez, G.M. (1997). Supplemental instruction: The long-term impact. *Journal of Developmental Education, 21*(1), 2-9.

Schmidt, W. H. (2010). *Looking Beneath the Surface: What we can learn from the Minnesota TIMSS Science Results*. Presented at SciMathMN, February 21, 2010, Minneapolis, MN. Retrieved from http://www.scimathmn.org/

Schraw, G., & Brooks, D.W. (1998). *Helping Students Self-Regulate in Math and Sciences Courses: Improving the Will and the Skill*. Retrieved from http://dwb.unl.edu/chau/SR/Self_Reg.html

Short, D. J. (2000). What principals should know about sheltered English instruction. *NASSP Bulletin, 84*(619), 17-27.

Spencer, J. (2005). *Final school funding price tag still blank*. Houston Chronicle, pp. A1, A4.

Swarat, S., Drane, D., Smith, H.D., Light, G., & Pinto, L. (2004). Opening the gateway: Increasing Minority Student Retention in Introductory Science Courses. *Journal of College Science Teaching, 34*(1), 18-23.

Tinto, V. (1998). Colleges as communities: Taking research on student persistence seriously. *Review of Higher Education, 21*(2), 167-177.

Tinto, V. (2003). Learning better together: The impact of learning communities on student success. *Higher Education Monograph Series, 2003-1*, Higher Education Program, School of Education, Syracuse University.

Treisman, P.U. (1985). *A study of the mathematics performance of black students at the University of California, Berkeley*. Unpublished doctoral dissertation, University of California, Berkeley.

Treisman, P.U. (1992). Studying students studying calculus: A look at the lives of minority mathematics students in college. *The College Mathematics Journal, 23*(5), 362-372.

Zamel, V., & Spack, R. (2004). *Crossing the curriculum: Multilingual learners in college classrooms*. Mahwah, NJ: Erlbaum.

Zimmerman, B. J. (1990). Self-regulated learning and academic achievement: An overview. *Educational Psychologist, 25*(1), 3-17.

Zimmerman, B. J. (1995). Self-regulation involves more than metacognition: A social cognitive perspective. *Educational Psychologist, 30*(4), 217-221.