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Problem-based Learning and Fourth Grade: Who Really Benefits?

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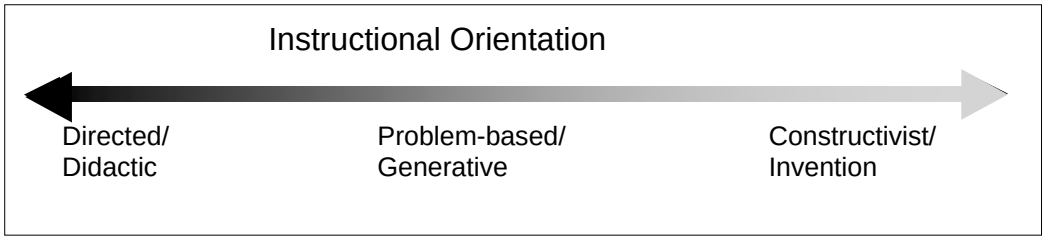
Directed learning or constructivism? Choose! This is the (perhaps oversimplified) dichotomous argument that has been taking place throughout the history of education. Currently, education is again shifting from the purely cognitive, domain-dependent instruction typical of the industrial age toward domain-independent problem-based/constructivist learning that purports to meet the needs of contemporary society. Rather than an "either/or" approach, one might think of these two learning types as lying on a continuum with directed learning on one end and constructivist learning on the other. In between the extremes lies pedagogy that has characteristics of one or the other. Another possibility is to think of the line as a ratio so the "point" at which a particular pedagogy lies is determined by the *amount* of instruction that is directed or constructivist. While such an exercise might make for an enjoyable academic discussion, even instruction that is oriented as heavily as possible, but within the constraints of contemporary learning environments is likely near the middle. Common notions are (a) purely directed instruction imposes severe limitations on the acquisition of transferable thinking skills and (b) purely constructivist/invention learning has little value in formal education, especially with high stakes standardized testing. Practically, constructivist classrooms focusing on reasoning rather than recitation, give children greater opportunities to choose and experiment (Castle & Rogers, 1993). Castle & Rogers go on to explain that children in constructivist classrooms actively engage in knowledge construction, including constructing knowledge of rules and their importance in a

classroom community (p. 77). In considering children's authentic learning on one end and high stakes testing on the other, we prefer the middle ground in which the monikers "problem-based learning" or "generative learning" are found, because of their implication of moderation or combination of methods (see Figure 1). Therefore, problem-based learning is an instructional design theory that encompasses many methods, including directed learning and also addresses the (a) affective, (b) cognitive, and (c) psychomotor domains of learning (Reigeluth, 1999).

Figure 1.



A typical description of problem-based learning is the five-step process offered by O'Neill (1992): 1. Explore phenomena or ideas; 2. Conjecture; 3. Share hypotheses with others; 4. Revise original thinking; and 5. Present learning. Moreover, problem-based learning is appropriate in the elementary school classroom (Katz & Chard, 1989; Chard, 1998-a; Chard, 1998-b). Theoretically problem-based learning may lead to the use of a holistic approach and therefore is more beneficial to knowledge acquisition and transfer. In addition to involvement of real scenarios, problem-based learning requires that the "big picture" is laid out at the outset and subsequently students begin to work on parts. Conversely, traditional learning is more likely to work first on parts moving toward the "big picture" last. As a whole, problem-based learning is more a top-down approach and more holistic whereas the traditional is bottom-up and more discrete. Green and Gredler (2002) posit in their review of constructivism for school-based practice that moving from whole to part is assumed to be effective because holists believe that students are more motivated to learn narrow skills (the parts) when they see the larger context into which these skills fit (p. 58).

Unfortunately, while many schools use the vernacular of problem-solving and constructivist learning, few really commit to instructional environments in which "the teacher is learning at the same time as the kids and with the

kids" (Papert, 2002, Section 6), likely because of the discomfort that results from venturing into the unknown. However, Papert continues that, unless teachers are willing to embrace new learning situations, schools will "never get out of the bind of what the teachers can do is limited by what they were taught to do when they went to school." (Section 6). Likewise, Nimmo (2002) comments that because educators are resistant to growth, they usually end up staying in the comfort zone of using teaching strategies they know best and restraining their cultural perspectives. "Educators need to read beyond the planning books, acknowledge and proactively respond to the myriad of unplanned possibilities that arise to avoid such risks," Nimmo concludes. Consequently, educators will be forced into unfamiliar areas of knowledge and experiences.

Student Differences

Unquestionably, students are different from each other and their academic success reflects those differences (Collinson, 2000). Often examined are demographic differences such as gender, cultural background, and socioeconomic status (SES). For example, Caldwell & Ginther (1996). posit that even though low SES is highly correlated with low academic achievement, some low SES students are still academically successful, reasoning that the differences in achievement might be associated with differences in learning styles.

Relatedly, readings abound that look at learning styles and preferences, teaching styles and preferences, and the need to match pedagogy to student types (Beck, 2001; Ford & Chen, 2001; Grasha & Yangarber-Hicks, 2000; Robotham, 1999; Soles & Moller, 2001; Twigg, 2001), all of which often leads to the question: So problem-based learning seems to be good for our students, but which students benefit the most? Put another way: Are there particular student differences or characteristics that might indicate what *type* of student benefits from varied learning environments?

Sense of Community

A common theme in problem-based learning environments is the social aspect of learning which becomes viable and effective through students' sense of community. Ostensibly, the more a student feels part of a cooperative, friendly atmosphere, including peers, teachers, staff, parents,

and community members, the more they will learn, and be willing to learn. Schaps, Lewis & Watson (1997) posit that “a strong sense of classroom community contributes to positive student outcomes” (p. 14). In understanding the significance of sense of community, what proactive classroom teachers should do to create such a positive climate that benefits learning is another issue. Among related studies on building a strong sense of community (e.g., Krall & Jalongo, 1998/1999; Nimmo, 2002), there are quite a few empirical suggestions, and even checklists for educators to reference and use in their classroom. Krall & Jalongo suggest that teachers should be regarded as role models and that in the process of developing classroom communication skills, they be nonjudgmental and respectful of each child's right to privacy and self-preservation—an approach that leads to a caring community in the classroom. They go on to conclude that while working toward the goal of creating community in the classroom, teachers should keep the overarching purpose of education uppermost in their mind. While the teachers begin their teaching, “children begin schools with wonder, excitement, curiosity, and a large measure of concern about whether or not they will succeed and be treated fairly” (p. 87). As a whole, in their study on a constructivist classroom community, Castle & Rogers (1993) posit that “a sense of classroom community can be achieved early in the school year by engaging children in thinking about, discussing and agreeing on a set of classroom rules” (p. 78). Hence, promotion of problem-solving skills, knowledge acquisition and transfer, and ability of social skills creates a caring sense of classroom community, which is important to academic success.

Bryant (1999) elucidates that classroom community interaction is certainly valuable. On one hand, the classroom becomes a place filled with friendliness and caring. On the other hand, students respond to one another more openly and grow stronger personally. She summarizes:

> Classroom community implies strong personal connections among learners. It integrates deliberately selected interactions called rituals, rites and ceremonies that enable students to make the transition from the outside world to the world within the classroom. Classroom communities promote student interactions and encourage students to make choices and work together in positive, supportive ways. The physical, emotional and cognitive skills of learners are considered in a classroom community. (p. 110)

The relationship between sense of community and academic success is quite complex and surely involves other factors. For instance, Schaps *et al*. (1997) uncover in their survey study that schools serving low-income students typically show lower levels of classroom community than schools serving more affluent ones. They then suggest that creating a high sense of community may help level the playing field for poor children. Presumably, sense of community is highly associated with motivation to learning. As stated, once the children feel they are part of the learning community, they are motivated and able to learn more effectively. Caldwell & Ginther (1996) posit in their empirical study that "for low SES elementary students, motivational (internal) rather than environmental (external) factors predict achievement" (p. 141). Perhaps this is not only true for children from low SES families, but also may be true for all children; students with high sense of community should do better academically because they are motivated and perhaps their level of anxiety is minimized. On the other hand, one can also surmise that not all students want to benefit, nor will they benefit from a high sense of community.

Learning Style

Learning style could be said to be a "biologically and developmentally imposed set of personal characteristics that make the same teaching/learning strategy effective for some and ineffective for others" (Collinson, 2000, p. 42). On the other hand, learning style theories can be defined as a pedagogical response to the recognition of student differences based on the belief that students are unlikely to succeed academically if taught with a so-called "one-size-fits-all" approach. Educators need to understand how students process information in consideration of improved learning outcomes. Although quite a few empirical studies prove significant improvement of learning outcomes by matching teaching strategies to learning style, Shaughnessy (1998) documents, in his interview about learning styles with Rita Dunn, that teachers need not adapt to each child's learning style. Instead, teachers should explain learning styles to their students so that they are able to realize there is no inferior or superior style. Moreover, teachers also need to have alternative instructional methods and resources for a given set of materials in order to instruct students with different learning styles. As a whole, Collinson concludes that if the preferred learning style of elementary students could be accurately identified, then educators could use the learning profile as a way to design

classroom environments and, as a result, their teaching strategies should enhance the learning of all students.

While elementary students are clearly in early developmental stages, thus making definitive identification of particular learning styles difficult, inventories are still useful for making broad stroke conclusions (Shindler, 2002). Over the past decades, researchers have been developing instructional and theoretical models to explain differences between how students acquire and process information (Burns, Johnson & Gable, 1998). Among all of them, the Myers-Briggs Type indicator (MBTI) is one of the remarkable learning style inventories. The MBTI covers four Jungian dimensions and presents 16 learning profiles. Of the four dichotomous dimensions, extroversion versus introversion is the most commonly recognized. Kiersey & Bates (1984) define an extrovert learner as one who needs people as a source for regenerating his/her energy, whereas an introvert learner is one who prefers solitude to recover energy. They describe extroverts (E) as prepared to "enter into group activities and to accept the idea of others" whereas introverts (I) tend to be "slow to volunteer in the classroom, hesitating in sharing their ideas with others, and need privacy" (p. 101). Moreover, extroverts tend to focus on external reality (the outer world) and direct their attention toward people and objects, whereas introverts attend more to internal reality (the inner world) and concentrate more on concepts and ideas (O'Brien, Bernol, & Akroyd, 1998).

Finally, in their empirical study on two groups with different academic achievement, Burns et al. (1998) postulate that "learning style preferences may or may not account for part of what identified a student as academically superior" (p. 282). Currently, it is commonly acknowledged that learners are different and that recognizing and accommodating these differences can be helpful (Burns et al.).

The Study

An opportunity to explore whether or not student differences may have a relationship with success was provided by an elementary school that includes both problem-based/constructivist and directed pedagogies. The school is an urban Science, Math and Technology Magnet school located in a mid-Atlantic city. The school population is approximately equal in terms of black vs. non-black and free lunch vs. paid lunch. The school committed

to a problem-solving/constructivist learning environment in 1995 and has been rewarded with rising scores on the State Standards of Learning from 1999 (the first year of SOL testing) through 2005 with full accreditation beginning in 2003-2004 (Newport News Public Schools, 2004) Finally, the school received the 2004 Elementary Program of Excellence award, International Technology Educators Association (ITEA), and the 2003 Virginia Technology program of the Year award from the Virginia Technology Educators Association (VTEA) (Newsome Park, 2004)

The Curriculum

In brief, each class devises a project that will last one semester. The students choose the topic (e.g., Wetlands: To build or not to build [2nd grade]; Houses and Homes [1st grade]; Care and Treatment of Domestic Animals [3rd grade]; Fire Departments and Community Services [4th grade]) and then determine what Standards of Learning (SoLs) can be accommodated by the project. Instruction varies widely, but the overall intent is for students to learn via active learning and problem solving. The SoLs that cannot be accommodated in the projects, or are not learned well, are taught via directed learning.

Research Questions

To date, school academic achievement for the entire metropolitan area in which the experimental school is located, is based on student groups—such as entire grade-levels—as measured by averaged standardized test scores and/or course grades. Unfortunately, most of the questions on the Standards of Learning tests are low-level, knowledge-type questions, which have little to do with real-world thinking skills. Therefore, the school is interested not only in how well their students can perform on SoL-type questions, but also attempts to identify whether or not students are achieving at higher cognitive levels (i.e., above the knowledge and comprehension levels on Bloom's taxonomy (Bloom, Englhart, Furst, Hill & Krathwhol, 1956), or above the concept level on Merrill's taxonomy (1994). This interest led to research question one: **What effect does a problem-based instructional environment have on student achievement measured hierarchically?**

Because of the common belief that the type of learning environment may affect achievement, the second research question posed was: **What effects**

do vary learning environments have on elementary students' academic achievement measured hierarchically? This question was posed in an attempt to drill down into question one to see if an examination of all five classes as a group masked differences that might occur based on potentially varied pedagogy among the five fourth-grade teachers. This approach was prompted by the assertion of a school authority that not all teachers were truly "on board" the constructivist approach to which the school had committed itself

Next, based on question two, in an effort to explore what types of students seem to benefit from varied pedagogies, the third question posed was: **What is the relationship between elementary student's learning styles and achievement in a constructivist environment of varied fidelity?**

Because much of the literature clearly suggests that cooperative learning is important for social and cooperative learning, the fourth question posed was: **What effects do varied learning environments have on elementary student's sense of community?**

Lastly, a desire to explore potential connections between students' learning styles and sense of community as related to academic performance led to research question five: **What is the relationship between elementary student's learning style, sense of community and academic achievement?**

Method

Sample

The sample consisted of 116 fourth grade students in five different classes; 71 black, 35 white, 2 Asian, 4 American Indian, and 4 Hispanics; 25% receive free lunch, 15% reduced lunch and 14% direct lunch; 56% live in one-parent households and 39% live in 2-parent households.

Independent Variables

Direct vs. Problem-based Instruction

The original intent was to separate learning objectives taught via problem-based/constructivist pedagogy and those taught via direct instruction. This delineation was based on initial discussion with school personnel with indicators the overall instructional approach was constructivist with a minor portion directed. The purported difference was based on the overall curricular approach. The fourth grade classes were to choose constructivist problems that would incorporate as many of the state Social Studies Standards of Learning as possible. Standards not met through the chosen projects would be taught via directed instruction. However, when the researchers met with the five fourth-grade teachers, a variety of overall pedagogies ranging from mostly directed to mostly constructivist was clearly evident, supporting the earlier assertion of the school official. In fact, the researchers were informed that equating the instructional strategies of the five teachers was folly as there were definite differences. So, the focus necessarily changed from a dichotomous pedagogical approach to different learning objectives to one that compared student achievement among the individual teachers. We were unable to clearly define the pedagogical approach of the five teachers through a pedagogy survey or through queries of the principal. This change is not intended to cast any negative connotations but, rather, to simply clear identification of the general teaching methodology of individual teachers is difficult. This problem was compounded by the simple fact that any given teacher, no matter what his/her overall philosophical beliefs, will vary their teaching methodology depending on a myriad of factors from time constraints, to on-the-fly assessments of the efficacy of a given teaching strategy on any given day. Therefore, we chose to look at the classes as entities unto themselves and continue to investigate the holistic teaching approach of the cooperating teachers. Because this is a pilot study intended to begin the foundation for more intense, clarified, and rigorous research, a comparison among the teachers seemed acceptable. Nonetheless, in order to differentiate among the teachers, a survey was created to identify pedagogical orientation along the directed<->constructivist continuum (See Figure 1). This data was triangulated through conversations with each teacher and with the school principal resulting in the identification of each teacher's overall orientation. Two of the five teachers were clearly different with Ms. Black oriented more toward constructivism and Ms. White clearly oriented more toward directed learning, with the remaining three in between. However, some caution is needed; the differentiations are useful for elucidation, but all five teachers clearly engaged in cooperative learning activities, and utilized a problem-based approach to some degree.

Paragon Learning Style Inventory

The Paragon Learning Style Inventory (PLSI) is a 48 item self-administered/self-scored survey that provides a very reliable indication of learning style and cognitive preference based on Myers-Briggs Type Indicator (MBTI). The result presents in four Jungian dimensions (introversion/extroversion, intuition/sensation, thinking/feeling, and judging/perceiving). Reliability is reportedly approximately 70% at that grade level (Shindler, 2000).

Dependent Variables

Sense of Community

The Sense of Classroom Community Inventory (SCCI), (Rovai, 2002) was used to assess the degree to which students feel part of their learning community. The instrument has 20 likert-type items which return three scores: (a) an overall Classroom Community Score, which is a total of two subscales, (b) connectedness and (c) learning. The instrument was slightly modified with the assistance of a language expert to match the reading level of fourth-grade students. Cronbach's Alpha for the overall SCCI was .93, indicating excellent reliability. With regard to internal consistency estimates, Cronbach's Alpha for the connectedness subscale was .92 and for the learning subscale was .87, indicating good reliability (Rovai, 2002).

Achievement

We believed that a carefully constructed achievement instrument that followed a cognitive hierarchy would enable us to compare levels of learning across different situations. The original intent was to align assessment with Merrill's hierarchy that categorizes learning into three+ levels: Remember (verbatim and paraphrase), use, and find but utilizing only the remember and use stages. A content area expert was enlisted to develop a quiz, based on the social studies standards of learning that had recently been covered by the cooperating teachers. At their request, the consultant did not work directly with the teachers because the teachers themselves wanted "SoL-type" questions that would test their students' knowledge without a

bias toward what had actually happened in the classroom. To meet their request, multiple-choice questions were developed. These questions were mostly low-level knowledge questions to which students needed to "recognize" the answer from the multiple choices provided. Additional questions that required students to "remember" the answers via fill-in-the-blank and short answer were devised, as were questions that required students to "use" knowledge to solve problems. After its development, the quiz was reviewed by the cooperating teachers, which resulted in minor wording changes. In the end, for the purpose of this study, the cognitive levels were limited to recognize (multiple-choice and true-false questions), remember (fill-in-the-blank and short answer questions) and use (use prior knowledge to complete closely related tasks). The pilot quiz allowed us to determine which students, and what *types* of students have reached what *cognitive* levels on the assessment.

Analysis and Results

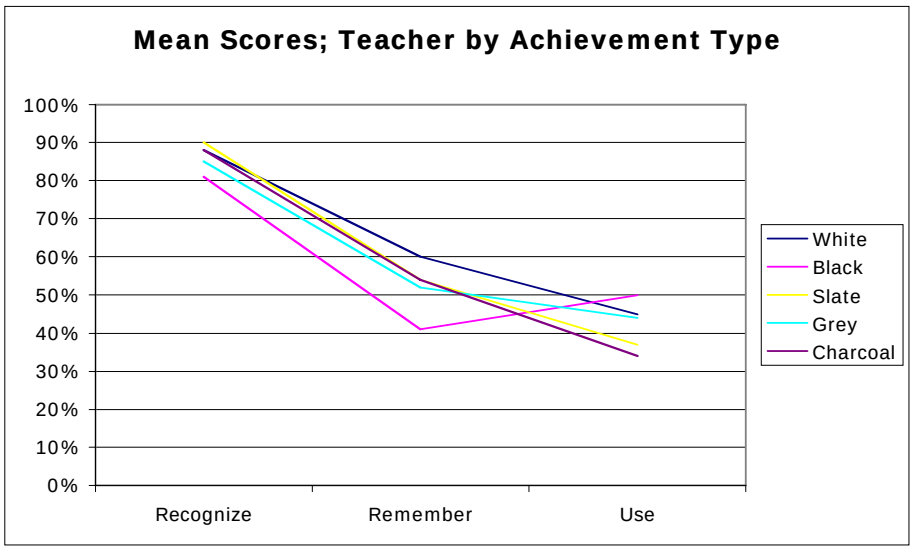
To answer the first research question, **What effect does a problem-based instructional environment have on student achievement measured hierarchically?,** the first analysis followed the "typical" approach to measuring achievement first—comparing the total quiz scores for each of the five classes. There were no significant differences. While this may not seem interesting, we believed that such a result had the potential to illustrate how differences in learning can be lost through averaging. We then compared the achievement of *all* the students as a single group in terms of the three levels of cognitive engagement designed into the quiz questions—(a) recognize, (b) remember, and (c) use levels, and found significant differences at the .001 level (See Table 1). The students scored highest on recognize (M=.87), followed by Remember (M= .53) and the lowest on Use (M=.41).

Table 1. Whole group achievement scores at three cognitive levels.

	SS	df	MS	F	p
Between groups	10.989	2	5.495	189.463	.001
Within Groups	8.352	288	.029		

The next step was to further break the sample into potentially different learning environments created by the individual teachers' pedagogy which ranged from a focus more on directed instruction to a focus on generative learning/problem solving. To answer the question, **What effects do varied learning environments have on elementary students' academic achievement measured hierarchically?,** a 3 X 5 ANOVA was conducted with Teacher and Achievement types as the independent variables and quiz scores as the dependent variable. A significant main effect was found for Question type ($F(2,4) = 178.634$, $p < .001$), which reflects the results of the prior analyses. However, an interaction was also found ($F(2,3) = 2.610$, $p < .1$). Subsequently, three 1 X 5 ANOVAs were conducted—1 for each cognitive achievement level. No significant differences were found at the Recognize level but were found at the Remember and Use levels. At the Remember level, Ms. White's students scored the highest ($M = .60$), which was significantly higher than Ms. Black's students ($M = .41$), whose students scored the lowest with the remaining teachers in between. The achievement pattern is consistent and clear but only the two extremes reached statistical significance (see Figure 2). Interestingly, at the Use level, Ms. Black's students' scores jumped to the highest level ($M = .50$) and Ms. Charcoal's students scored the lowest ($M = .30$) with the other teachers in between. Although not statistically significantly, Ms. White's students dropped to second highest at the use level, which kept her students performing the highest, overall, although not significantly so.

Figure 2.



Our third question: **What is the relationship between elementary student's learning styles and achievement in a constructivist environment of varied fidelity?,** was intended to look at how student personality differences might affect their learning in various learning environments. The Paragon Learning Styles Inventory was used to categorize students across four dichotomous dimensions: (a) extrovert-introvert, (b) sensate-intuitive, (c) feeler-thinker, and (d) judger-perceiver. The categories are similar to the Jungian categories identified by the Myers-Briggs Type Indicator and therefore would result in 16 possible personality profiles based on the various combinations of the four dimensions. However, our sample was too small to block students into 16 cells, so we examined each of the domains individually in order to discover whether or not any of the dimensions might be related to achievement. A series of t-tests were conducted on each type of learning grouped by the PLSI dimension dichotomies.

The only significant difference was found in the second dimension, Sensate-Intuitive, at the Use achievement level; the sensate students score significantly higher than the intuitive students ($M = .45$ vs. $M = .26$) ($t(53) = 2.959$, $p<.01$). The students were very unevenly distributed with 48 sensate students and only seven intuitive students.

The fourth question, **What effects do varied learning environments have on elementary student's sense of community?,** resulted from the current focus on cooperative learning, and the purported necessity of building a strong sense of community within the learning environment. ANOVAs were conducted with the Sense of community scores (Total, Connectedness, and Learning) as the dependent variables and the five classrooms as the independent variable. There were no significant results for the total score or for the Connectedness subscale. However, there was a significant difference for the Learning subscale with Ms. Black the highest and Ms. White the lowest ($M = 32.79$ vs. 26.38) indicating that Ms. Black's students felt they were learning more information as related to their perceived needs.
To answer the final question, ***What is the relationship between elementary student's learning style, sense of community and academic achievement?,*** multiple correlations were conducted for sense of community and achievement. A small but significant relationship existed between all three Sense of Community Scales (Total, Connectedness and Learning) and the three Achievement Levels (recognize, remember and use). (See Table 2)

Table 2. Correlations among the three CCS subscales and three achievement levels

	% Remember Verbatim	% Remember Paraphrase	% Use
CCS Connectedness	.25*	.21*	.20*
CCS Learning	.25*	.20*	.24*
CCS Sense of Community	.27*	.23*	.24*

* p < .05, (*N*=105)

Next, to identify any relationship between Sense of Community, Achievement, and the PLSI dimensions, four discriminant analyses (stepwise) were run to determine if the six variables (three Sense of Community scales and three Achievement Levels) could accurately discriminate the four categories in PLSI1, PLSI2, PLSI3, & PLSI4. Only two of the six variables were reliable as predictors—achievement in the Remember level and the Learning subscale of Sense of Community. (See Table 3.)

Table 3.

Step		Wilks' Lambda	df1	df2	df3	Exact F Statistic	df1	df2	Sig.
1	PERCE_RP	.861	1	2	73.0	5.905	2	73.0	.004
2	CCS Learning	.774	2	2	73.0	4.916	4	144.0	.001

At each step, the variable that minimizes the overall Wilkes' Lambda is entered.

a Maximum number of steps is 12.

b Minimum partial F to enter is 3.84.

c Maximum partial F to remove is 2.71.

d F level, tolerance, or VIN insufficient for further computation.

Table 3.1. Standardized Coefficients of Predicator Variables with the Two Discriminant Functions

	Standardized Coefficients for Discriminant functions	
	Function 1	Function 2
Remember	.70	-.73
CCS Learning	.62	.80

Next, the Judger-Perceiver variable was removed, leaving only the Sense of Community-learning, which remained significant with an overall accuracy of classification of 71.2 %. That is, of the 66 subjects, 48 were correctly classified as Judgers. However, caution must be exercised as the sample only included six perceivers, three of which were correctly classified for an accuracy of 50%, $p < .05$. Wilkes Lambda was used to determine that the significance of the discriminant analysis was .93, $p < .05$. No significant relationships were found for the first three dimensions of the PSLI. (See table 4.)

Table 4. Classification Results.

	Predicted Group Membership				
	Judger		Perceiver		
PLSI- JP	Count	%	Count	%	Total Count
Judger	48	72.7	14	28.3	62
Perceiver	3	50	3	50	6

Table 4 shows the classification results. The overall accuracy is good; however, an obvious weakness exists because of the small number of students classified as Perceivers (6 students). In other words, the classification accuracy for Judger (66 students) at 73% was reasonably high, but the classification accuracy for Perceiver was only 50% (only 3 of 6

students were correctly classified). In sum, these results are a bit interesting because they show that a measure of achievement (paraphrasing) and a measure of feelings about the degree to which educational goals are met are *both* needed to discriminate the categories of PLSI 4. With paraphrasing only, the correct overall classification was only 38.0% and with CCS Learning only the correct overall classification was 67.1%

Discussion

Student Achievement and Sense of Community

The lack of differences between the classes on total quiz scores clearly shows that a comparison of overall achievement across a variety of learning environments masks differences that might be attributable to student differences and pedagogy. In addition, student achievement at different cognitive levels may be masked. This line of inquiry is important because, although the state standards of learning are primarily interested in low, knowledge-level learning, professional educators are interested in teaching students to think, apply their knowledge to new situations, and pursue solutions to new problematic situations. These results show clearly that students achieved high scores on the multiple choice questions designed to reflect the state's standardized testing. Multiple-choice questions are lowest on the cognitive hierarchy because they require that the students only recognize the correct answer. The sample scored 87%, well above the 70% required for passing the Standards of Learning Test, is particularly notable because a consultant who was not familiar with the teachers or the students involved designed the quiz.

Unfortunately, student achievement fell dramatically across the next two levels—Remember and Use. The Remember-Level Questions are also Knowledge-Level Questions but were fill-in, which requires a higher level of cognition than recognizing correct answers. The students were unable to "remember" facts at a passing level (M=.53), but there were differences among the classes. The most constructivist-oriented teacher's class performed the best at this level, although the score was below passing and was significantly higher than only the most directed-teaching class. The remaining three classes fell in-between. However, these findings suggest that the constructivist approach to teaching and learning may be more efficient. Also, at the pilot-level of this investigation, these findings suggest that more

dramatic results may be found with additional data collection. Interestingly, the results nearly reversed themselves at the Use level. The class that scored the lowest on the Remember Questions, scored the highest on the Use-Level Questions (See Figure 1).

Examining the results of the Sense of Community analyses may help to explain this interaction. To reiterate, Ms. White's students achieved the highest at the Remember Level and Ms. Black's student achieved the lowest. Ms. Black's students achieved the highest at the Use Level, with Ms. Charcoal's students the lowest, but Ms. White's were very close to Ms. Black's (M= .45 vs. .50). A logical interpretation is that Ms. Black's students, with their higher Sense of Learning, may have felt more comfortable answering the quiz questions from an outside source, while Ms. White's students, with their Lower Sense of Learning, may have questioned themselves to a higher degree and thus achieved slightly lower scores. This is supported by the notion of the Knowledge subscale of the Sense of Community Instrument: students who believe that their learning needs are met are more likely to achieve higher scores. Ms. Black's students are acclimated to having their knowledge level needs met while Ms. White's students are accustomed to proving the accuracy of their conclusions. While this difference might imply better learning in Ms. Black's class, we believe that Ms. White's students are learning metacognitive skills that, while perhaps impeding them at this juncture, will serve them better in the long run. Additional research will verify or discredit this conclusion.

Personality and Achievement

Our third research question was intended to find out if personality differences have an influence on learning. Based on these preliminary findings, only the Sensate-Intuitive dimension showed any indication of being important. That difference was found on the "use" achievement level which might imply the importance of this dimension on higher-level achievement, especially because of the limited number of intuitive students in this sample. The sensate students achieved significantly higher scores, (M = .45) than the Intuitive students (M = .26) indicating that while both scores are below passing level, the intuitive students were extremely low. However, a lot of caution must be exercised because of the sample included only six Intuitive students.

Personality Type, Sense of Community and Achievement

The findings of the discriminant analysis are interesting because they reinforce the preliminary findings that Sense of Community and the Judger-Perceiver Dimension of the PLSI may be important. They imply, at least on the Remember-Level of Achievement, that students' perception that their learning needs are being met may, in fact, contribute to higher levels of learning. This implication, combined with a consideration of students who are classified as Judgers, may result in predictably higher scores in the remember achievement domain. Therefore, students who have a Lower Sense of Learning Community, and who are classified as Perceivers, will likely need adjustments in the instructional design to achieve equivalent success.

Conclusions

This pilot study began a look at various instructional designs and student characteristics and their relationship with achievement at various cognitive levels. We believe we have met with success—albeit that the limited findings reported here will provide a basis for further, more intense study. The achievement data is limited to a single quiz designed by a content-area expert. While we are comfortable that the quiz provided a reasonable profile of student learning on various cognitive levels, within the confines of state standards of learning, we look forward to expanding the database of achievement data through further testing. In addition, further study of the teaching strategies of the involved teachers will shed more light on student achievement differences, which will lead to pedagogy designed to maximize learning.

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