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Why JoSoTL and Why Now?

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Ten years ago Ernest Boyer and the Carnegie Foundation for the Advancement of Teaching released the book *Scholarship Reconsidered: Priorities of the Professoriate* (1990). A small book of less than a hundred pages, it was a manuscript with very big ideas that would begin what some would see as a revolutionary change in how those in the academy would view the role of the professoriate. In campuses across the country, from Level I research universities to community colleges, colleagues began to discuss the Boyer model and its implications for their scholarly endeavors, their teaching, and their professional lives. For the first time in fifty years our profession began to reflect seriously on the potential for new roles and rewards within the institutions.

The academic revolution of the 1940's and 1950's (Jencks and Riesman, 1968) which had established a climate based on research as legal tender was now being challenged by a new revolution which suggested a broadened view of the professorate. For a generation of academics who had been raised on the centrality of discovery research the possibilities of a broadened view of scholarship raised questions and sparked debate. On some campuses this was a civil intellectual exchange welcomed by many in the academic community: these discussions often led to changes in the climate of the college or university. Other campuses experienced greater resistance and, perhaps, less civility in the discussion. But in the past decade few campuses in America have escaped the impact of the Boyer model.

A brief history of the Scholarship of Teaching and Learning and JoSoTL

Ernest Boyer and his colleague Gene Rice started the fire and kept it going at the national level. Others at the Carnegie Foundation for the Advancement of Teaching (http://www.carnegiefoundation.org/) and the American Association of Higher Education (http://www.aahe.org/) expanded the conversation with publications, conferences, and new initiatives. Gene Rice's work at AAHE with Faculty Roles and Rewards and his working paper "The New American Scholar" framed the agenda for faculty and administrators in higher education. As the conversation proceeded questions were raised about the legitimacy of teaching in terms of scholarship: what criteria should be used to assess valid scholarship? Scholarship Assessed (Glassick, Huber, and Maeroff, 1997) helped answer these concerns by offering six criteria for evaluating all types of scholarship.

In 1997 Lee Shulman became president of the Carnegie Foundation and in 1998 the Carnegie Academy for the Scholarship of Teaching and Learning (CASTL) was launched. CASTL is a project which focuses on the development and encouragement of programs in the scholarship of teaching and learning in institutions of higher education and K-12 programs. The goals of the program are to:

1. Foster significant, long-lasting learning for all students
2. Enhance the practice and profession of teaching
3. Bring to faculty members' work as teachers the recognition and reward afforded to other forms of scholarly work

To meet these objectives CASTL has launched three programs designed to: recognize and foster the work of outstanding faculty who are involved in the scholarship of teaching and learning; work with the scholarly and professional societies to advance the scholarship of teaching within the professional disciplines; and support campus initiatives in the scholarship of teaching and learning.

The "Pew National Fellowship Program for Carnegie Scholars" selects and brings together outstanding faculty to create a community of scholars in teaching and learning. The purpose of the Pew Scholars program is to support, foster, and deepen the profession of teaching and the learning of students.

The "Work with Scholarly and Professional Societies" program is designed to provide networking opportunities for scholarly and professional organizations to support teaching and learning. CASTL will also afford these organizations grants to share findings in the scholarship of teaching and learning, encourage extensive peer review, and support graduate programs to be more responsive to the scholarship of teaching and learning.

The "Teaching Academy Campus Program" was the first CASTL initiative and also the impetus to create the ***Journal of Scholarship of Teaching and Learning*** (JoSoTL). In the fall of 1998 the Carnegie Foundation and the American Association for Higher Education invited institutions of all types from higher education to join in a discussion on the scholarship of teaching. The first step, **Level I: Campus Conversation**, invited any interested campus to draft a definition of the scholarship of teaching and identify supports for and barriers to the scholarship of teaching and learning. **Level II: Going Public** asked campuses to widen their circle by sharing their work including peer review and collaboration. Level II initiatives include seed grants to help campuses communicate their outcomes; this level of the program will continue through December 2001. In 2002 the Campus Program will

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begin **Level III: National Teaching Academy** by inviting selected campuses to become initial members of the national Teaching Academy.

The ***Journal of Scholarship of Teaching and Learning*** started as an idea spawned at a conference for the Faculty Colloquium on Excellence in Teaching (FACET) (http://www.iusb.edu/~facet/). A number of colleagues from Indiana University South Bend were discussing how our campus could make the scholarship of teaching and learning more public on our campus. Before long the discussants became more ambitious and faculty suggested that we widen our scope to communicate our findings to our FACET colleagues from across the state. A number of faculty in the discussion had web pages and when Gary Kern, a management information systems professor, suggested we could put a journal on the web, **JoSoTL** was conceived. The birthing process has taken a little more time and effort.

The initial issue of **JoSoTL** has been created in the past six months out of an interest in creating a forum that would encourage faculty to share their knowledge and inquiry into the teaching - learning process. When we first began this endeavor our focus was the faculty on the eight campuses of Indiana University. We quickly learned the world wide web offered us the opportunity to reach out beyond Indiana University and our state to include colleagues from around the world. As soon as **JoSoTL** was put on the web (before any articles were included) inquiries arrived from across the nation and around the world. I like to think the creative touch of our web-master (Gary Kern) inspired colleagues to contact us but the overwhelming response rate is also indicative of the widespread interest in the scholarship of teaching and learning. Clearly, a vehicle is needed to allow scholars of teaching and learning to share their work in a public forum to build a knowledge base for a growing scholarly community.

The revolution that began ten years ago with *Scholarship Reconsidered* has already had a dramatic impact on higher education. However, there is still a great deal of confusion and misperception surrounding what is meant by the scholarship of teaching and learning. Some colleagues have argued excellent teaching qualifies as the scholarship of teaching. Others claim any professor who is an expert in the pedagogy of their discipline is really demonstrating the scholarship of teaching. While there is still much to be learned about the scholarship of teaching and learning we at the **JoSoTL** believe we should offer a general definition of the scholarship of teaching and learning to begin the discussion. This is not intended to thwart a discussion of definitions, or other debates, about SoTL but rather as a starting point and we invite colleagues to send us an essay or challenge us on our threaded discussion page. To begin the discussion we turn to Lee Shulman for a definition.

Defining the Scholarship of Teaching and Learning and Making it Public

As we begin the new century we have an opportunity to promote the scholarship of teaching and learning in an environment which is more receptive to the significant contributions of the study of effective instruction, student learning, and the expertise of the pedagogues of the disciplines. To take advantage of the opportunity to define the role of the scholarship of teaching and learning it is critical to start with a general definition of scholarship.

Lee Shulman, the president of the Carnegie Foundation, describes scholarship as disciplined inquiry and invention that has clear characteristics whether the scholarship be discovery, integration, application, or teaching (1998):

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> *For an activity to be designated as scholarship, it should manifest at least three key characteristics: It should be public, susceptible to critical review and evaluation, and accessible for exchange and use by other members of one's scholarly community. We thus observe, with respect to all forms of scholarship, that they are acts of mind or spirit that have been made public in some manner, have been subjected to peer review by members of one's intellectual or professional community, and can be cited, refuted, built upon, and shared among members of that community. Scholarship properly communicated and critiqued serves as the building blocks for knowledge growth in a field.* (p. 5)

In the last analysis, however, the scholarship of teaching is best defined through actual practice. The purpose of the ***Journal of Scholarship of Teaching and Learning*** is to serve the professional community by giving individuals within our professional community an opportunity to make their own work public, open to critical review and evaluation, and accessible to a wide spectrum of colleagues from many disciplines. As we discussed the creation of **JoSoTL** we realized the technology of the electronic journal could make a unique contribution to further the development of the scholarship of teaching and learning. Paper journals invariably lead to a time lag of months, if not years; an electronic journal allows knowledge to be disseminated almost immediately. Paper journals are extremely costly and tend to be discipline specific; an electronic journal is practically free and is accessible by anyone. Paper journals advance the knowledge base through the dissemination of information but do little to directly facilitate communications between colleagues; while electronic journal allows colleagues from distant settings and diverse fields to have real time communications in an open forum.

Thus, the goal of the ***Journal of Scholarship of Teaching and Learning*** is to create a forum without boundaries for colleagues from any discipline to join the discussion of the teaching-learning process. We believe it is extremely important to invite *all* of our colleagues to join the discussion. This would include teachers from any discipline; there is much to learn across disciplines. We have noted an increasing number of colleagues have begun serious discussion on effective teaching within their own disciplines and they have much to teach those of us outside their field of study.

We also believe it is critical to invite colleagues from all levels of "expertise" into the discussion. Teaching has always been viewed as a private activity that is seldom discussed in an open forum. This has created an army of experts who, ironically enough, seldom share their teaching knowledge and may not realize the value of their own private learning. We need to invite these "silent" experts to share what they have learned about the teaching-learning process. Even if this knowledge is more intuitive than empirical it can be instructive as part of the larger collegial exchange.

Our goal is to create a forum that invites colleagues to share their work through their writing but also share their expertise and experience through their critique of, and commentary on, other's work. As information on the world wide web expands it is important for the academic community to carefully evaluate and screen information for rigor as we have always done through the peer review process. The advantages of the electronic medium (speed and availability) must not be undermined by the potential weaknesses (flood of data without peer review.)

Because we at **JoSoTL** believe it is extremely important to uphold the standards of scholarship, we use double-blind reviews for all the articles we publish. At the same time, we also want to take advantage of the strengths of speed and availability which an electron journal affords by including our readers in the peer review process. The technology of the web allows for interactions to be held on-line through

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a threaded discussion that invites comments and questions from any reader. These critiques will add a new dimension to the peer review process.

We believe the scholarship of teaching and learning can have an enormous impact on our understanding of the teaching-learning process, how we deliver instruction, and the learning which occurs within and outside our classes. We also believe the electronic format of the ***Journal of Scholarship of Teaching and Learning*** can facilitate this impact by creating a wider circle of SoTL. We thus extend an invitation to you, as readers of this inaugural issue, to discuss these papers, to share your own ideas about and critiques of the findings, and to consider submitting your own contributions to this challenging ongoing conversation.

Journal of Scholarship of Teaching and Learning: Our Initial Public Offering

In the first chapter of *Scholarship Reconsidered* Boyer describes the changes which occurred in the United States over the past two centuries which brought about the modern university. One of the most dramatic changes was the "conviction that knowledge was most attainable through research and experimentation." (1990, p. 9) As we enter the 21st century the problems that need to be addressed are clearly different. In the late 1800's outreach became the mission of many universities through applied research in areas such as agriculture. In the mid-1900's universities served a nation at war and through scientific collaboration changed a country and the workforce. As we enter a new millennium the most pressing challenges to our universities may be occurring on our own campuses: How can we better serve the country by increasing the learning of our students? Knowledge is still the focus of our studies but it is time to focus our research and experimentation on the teaching and learning which occurs within the university.

The purpose of **JoSoTL** is to advance the scholarship of teaching and learning by creating a vehicle for colleagues to make their studies of teaching and learning *public*, facilitating *critical review and evaluation*, and helping to build a knowledge base for *exchange and use* by members of a diverse scholarly community. In our first issue we have three papers to begin the discussion. Each paper is from a different discipline and each raises a different question but all demonstrate an important reason why the scholarship of teaching is so important. Scholarly teachers are reflective practitioners who have many questions they wish to answer about the practice of teaching. Sometimes our questions are brought to the fore by outsiders (e.g., accrediting agencies); some questions arise out of institutional needs (e.g., student retention); other questions originate in our own curiosity or feelings of professional need (e.g., need to adapt new instructional strategies.) Each of these questions can be addressed by the scholarship or teaching and learning although there are a variety of strategies which can be used to begin to answer the questions. The articles by Kern and Osborne we have described as research reports and the article by Milner-Bolotin and Svinicki we are describing as classroom action research. As you read these articles consider the questions the article raises, including questions from your own teaching. And remember that **JoSoTL** is very different from paper journals in that you can "talk" with the author and other colleagues who have read the article. We like to think of **JoSoTL** as a cross between a paper journal and a conference. You don't have to rush to front table to get a copy of the paper: just "click" on **Print the Paper** for your own copy from Adobe Acrobat Reader. You can also get involved in a discussion with the author and other readers: just "click" the **Discuss the Paper** and you can read the remarks of other readers and post you own comments. We hope you will take full advantage of the opportunities available with our web journal. As we tackle the difficult questions of higher education in the 21st century we need a venue to

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communicate. As Shulman says, “Scholarship properly communicated and critiqued serves as the building blocks for knowledge growth in a field.”

The research article by Beth Kern, “Using role play simulation and hands-on models to enhance students’ learning fundamental accounting concepts”, is a controlled examination of a pedagogical approach to addressing a specific classroom challenge. Building on the work of colleagues who have studied active learning strategies in higher education, Dr. Kern explores the effectiveness of active learning and the specific learning outcomes in her accounting class. Many in the academic community are asked to make curricular changes in response to accreditation agencies and many programs make the “required” changes simply to meet the agency demand. Dr. Kern has taken the Accounting Education Change Commission’s call for active learning strategies in the accounting curriculum as an opportunity to study how active learning affects specific types of learning in her introductory students. She reports both significant and non-significant learning results which may assist instructors in choosing when to use active learning or more traditional approaches.

The research article by Randall Osborne, “A model for student success: Critical thinking and ‘at-risk’ students” addresses a growing institutional problem. As universities open their doors to students with less academic preparation they also invite increasing student failure in introductory classes which demand higher order thinking skills. Professors often express displeasure at the number of students who are unable to think critically and it is not uncommon for faculty to believe these skills cannot be taught. Universities who are concerned with student retention, as well as faculty who are troubled by high drop-out and failure rates, will be encouraged to read Dr. Osborne’s study. In a study of short-term and long-term gains Dr. Osborne reports on a program teaching critical thinking to his introductory psychology student.

In their classroom action research study, “Teaching physics of everyday life: Project-based instruction and collaborative work in undergraduate course for nonscience majors”, Milner-Bolotin and Svinicki explore a taxing problem for math and science teachers in higher education. They point out that scientific literacy and critical thinking is a requirement for every educated citizen in the 21st century but students who do not believe they can learn science and do not see the need to learn science make motivation a serious challenge in science classes for nonscience majors. Their detailed account of how they implemented a Project Based Instruction (PBI) into their physic class for nonscience majors is a pilot for future research with qualitative outcome measures and reflective commentary. Their article is also a gateway to many web sites on innovative approaches to the teaching of science and mathematics.

We at the ***Journal of Scholarship of Teaching and Learning*** are excited to begin the adventure. We know there are university teachers from every possible discipline, with various levels of expertise in teaching and research, who are interested in adding to and learning from the growing knowledge base of the scholarship of teaching and learning. We hope each of you will get involved on some level. As you read the articles in our first edition please consider the questions each article raises and post them on our threaded discussion. Whether you are doing traditional research on teaching and learning or classroom action research please feel free to send your work to us for review. If you have ideas you would like to share about the scholarship of teaching and learning put them into an essay and send them in for review. And please feel free to contact us with your feedback about our electronic journal.

At the American Association for Higher Education conference this winter on “Scholarship Reconsidered Reconsidered” the theme for Lee Shulman’s keynote address, “Teaching Among the

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Scholarships" was - **Pass It On.** This is also the guiding principle of JoSoTL. We are here to help facilitate the discussion and we hope you will join us in passing on what you have learned, and are learning, about teaching and learning in higher education.

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Using Role Play Simulation and Hands-on Models to Enhance Students' Learning Fundamental Accounting Concepts

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ABSTRACT

This paper both documents and assesses the use of a role play simulation exercise that can easily be incorporated into the first week of the first course in accounting. The exercise actively involves students by having them assume roles and simulate transactions to start a business. In addition, the students also perform a record-keeping role. Both the medium of exchange and record-keeping are accomplished by using white, red and blue poker chips. A primary focus of the exercise is to learn how transactions affect the fundamental accounting equation (assets=liabilities+owners' equity). In addition, several other fundamental accounting concepts are introduced. To assess if the exercise enhances student learning, other sections of the same accounting course learned identical subject matter with a lecture format. An assessment instrument was administered to both student groups. The results indicate that role play simulation enhances students' transfer problem solving, but there is no evidence that it enhances conceptual recall beyond that which can be attained via a traditional lecture. In addition, there is evidence that the role play simulation exercise helps student better retain problem solving learning over a four week period.

Introduction

In its call for accounting curricular reform, the Accounting Education Change Commission (AECC 1992, p. 250) states that "teachers of the first course in accounting should put a priority on their interaction with students and on interaction among students." This paper documents and evaluates an in-class exercise using role play simulation along with hands-on learning materials to enhance student interaction while learning fundamental accounting concepts. Assessment of this in-class exercise indicates that it does enhance students' transfer problem solving[1] capabilities, but there is no evidence that it enhances conceptual recall beyond that which can be attained via a traditional lecture oriented learning environment.

Role playing typically involves unstructured situations in which students improvise behavior according to their assigned roles (McKeachie 1994, p. 167). Simulations are usually defined more precisely with guiding principles, rules and structured relationships (Bonwell and Eison 1991, p. 47). Role play simulation entails assigning students to unique roles within a group as the group addresses a series of issues (DeNeve and Heppner 1997, p. 234). Role play simulations can accomplish multiple objectives. These are: "(a) to arouse student interest for a particular field of study, (b) to help students apply material learned in class, (c) to help students develop insight into the group dynamics of problem solving situations, (d) to give students a chance to develop leadership skills, and (e) to provide students with a working grasp of the scientific method" (DeNeve and Heppner 1997, p. 234). While role play simulation can accomplish a number of objectives, the focus of this study is assessment of enhanced student learning.

Since the Accounting Education Change Commission's (AECC 1990, p. 309) call for active learning strategies in the accounting curriculum, a number of studies have documented their use. These include the use of cooperative learning (Ravenscroft, et. al. 1995; Peek et. al. 1995; Ciccotello et. al. 1996; Lindquist and Abraham 1996; Hite 1996), simulation (Knechel and Rand 1994; Albrecht 1995), and writing (Scofield and Combes 1993). While there has been a notable increase documenting the use of active learning strategies, much work remains in terms of assessing the conditions under which they are effective in the accounting curriculum. To fully understand the advantages of active learning strategies, one must assess the conditions under which these strategies are effective. Their effectiveness is dependent upon at least four characteristics: (1) the subject matter, (2) the educational setting, (3) the specific learning materials, (4) the desired learning outcomes (DeNeve and Heppner 1997, p. 130).

First, with regard to using role play simulations or role plays in an accounting context, several studies have either advocated their use or provided specific examples. Tomassini (1974) examines the use of role play simulation in accounting. More recent studies document using role play simulation with Monopoly™ (Albrecht 1995; Knechel and Rand 1994). With regard to role plays (rather than role play simulations), Craig and Amernic (1994) examine their use in the context of using accounting information in labor disputes. Haskins and Crum (1985) document the use of role play in a cost allocations setting. Assessment of these methods is relatively sparse, however. One exception is Craig and Amernic who assess role play by examining student opinions. This study extends upon prior work by not only documenting the use of role play simulation, but by also providing an assessment of student learning.

[1] Transfer problem solving is the ability to transfer what one has learned to solve new problems.

Second, students can learn under a variety of learning settings. These range from passive lectures to more active strategies such as role play simulation or cooperative learning. This study differs the learning environment by presenting the same fact scenario with a lecture versus using a role play simulation.

Third, the learning materials that students use can vary from abstract characterizations to having more realistic hands-on materials (Ferguson and Hegarty 1995). In this study, students who participate in the lecture learning environment are able to observe a problem being worked on a blackboard. The students who participate in the role play simulation also are able to observe the same material on the blackboard, but are also able to manipulate poker chips as reinforcement. Thus, this study *jointly* assesses the impact of using a more active learning environment along with hands-on learning materials on students' learning.

Fourth, it is possible for some learning strategies to affect some learning outcomes and not others. Learning outcomes are the knowledge students gain as a result of the learning experience. This study focuses on students' learning and understanding fundamental relationships in accounting systems. Mayer (1989) has performed extensive analysis of ways to enhance students' learning scientific and computer systems. His research focuses on the usefulness of providing students models as aids to help them understand systems. These models can be explained with words or diagrams. He has found that students who are given model instruction about scientific systems demonstrate enhanced transfer problem solving and conceptual recall. They are less likely, however, to be able to recall verbatim information such as a list of details. In the AECC's call for improving accounting education, it posits that "the focus should be on developing analytical and conceptual thinking, not on memorizing professional standards" (AECC 1990, p. 308). A focus on helping students form mental models may be an avenue to accomplish the focus on accounting knowledge acquisition for which the AECC calls. In addition, Mayer (1989, p. 44) notes that novice students, such as those in the first accounting course, are more likely to benefit from instruction which fosters model building since they are less likely to already possess sophisticated conceptual models which may conflict which those presented during instruction.

Both instructional settings in the experiment (traditional lecture and role play simulation) attempt to help students form mental models of the fundamental accounting equation (assets=liabilities+owners' equity). The focus of the study to determine if the more active learning environment along with the hands-on learning material enhances students' ability to understand the model and thereby perform better in terms of problem solving and conceptual recall.

Description Of Role Play Simulation

This in-class exercise assigns students to perform roles within a set of pre-specified transactions forming a simulation of the formation of a new business. It can easily be incorporated in the first week of the first course in accounting and facilitates a high level of interaction among students who often do not know each other prior to attending the course.

Most of the students in the class are divided into groups of three that form a business. The students in the firm-groups all perform a record keeping and/or transaction engaging role in the role play simulation. One member of each business group is given a cupful of red chips; another is given a cupful of blue chips. The students who are not assigned to roles within a firm are assigned to banker,

supplier, landlord, customer and business owner roles. Each of these "volunteers" is given a cupful of white poker chips. They are told that these chips represent resources. One student is assigned to the banker, supplier, landlord and customer roles. The number of owner roles is equal to the number of firm-groups. Thus, each member of the class has a role. To facilitate formation, usually the firm-group roles are assigned after students volunteer for the banker, supplier, customer, landlord and owner roles. Each member of the class is then given a handout which lists a series of twelve transactions in which the business will engage. These twelve transactions are provided in Appendix 1.

Each business is beginning its operations. The students are asked what resources the business has at this time. It is obvious that each firm has none. They are then asked to look about the classroom. All the potential resources that a firm needs to begin a business are external to the firm; the firm must engage in transactions with these parties in order to procure the resources necessary to start a business.[2]

The record-keeping function is then introduced. The student in each business group who does not have any poker chips is assigned the task of keeping track of the resources as they are procured and disbursed. The concept that there must be a source for every resource is discussed. The importance of keeping track of the sources of resources, liabilities and owners' equity, is addressed. Finally, the fundamental relationship between assets, liabilities and owners' equity is discussed with the fundamental accounting equation (assets=liabilities+owners' equity) written across the top of the blackboard.

The students then engage in transactions using the poker chips as the medium of exchange and to perform the record keeping function. For example, the first transaction has the owner contributing $10,000 to the business and receiving stock in return. Each owner gives each business ten white poker chips representing $10,000 in cash.[3] The student in charge of assets stacks the assets on a common area designated for keeping track of assets, liabilities and owners' equity. The student responsible for the blue chips also stacks ten blue poker chips indicating that owners' equity increased. After each transaction, the students are asked to verify that the accounting equation remains in balance by stacking their liabilities (red chips) on top of their owners' equity (blue chips) and noting that the stack is the same height as the firm's assets (white chips).[4]

Several accounting concepts are introduced with the twelve transactions in the exercise. These include, but are not limited to: the accounting entity concept, revenue recognition, the matching principle, operating activities, investing activities and financing activities. A complete description of the concepts illustrated and discussed with each transaction is provided in Appendix 1.

[2]For schools who have adopted a contracting perspective for their accounting curriculum, this exercise provides an excellent illustration of these concepts.

[3]Each poker chip represents $1,000.

[4]The poker chips are reintroduced later in the course to illustrate the relationship between the income statement and the balance sheet by recording the portion of transactions relating to the income statement with blue chips on one side of the classroom with the balance sheet portion on the other. When the income statement poker chips return to the balance sheet via retained earnings, the balance sheet balances. (This is illustrated by verifying that assets (white chips) are equal to liabilities (red chips) and owners' equity (blue chips).

ASSESSMENT

Experimental Design

Six sections of an introductory accounting course at a medium-sized Midwest public university participated in an experiment over three semesters to assess the effectiveness of using role play simulation to teach fundamental accounting concepts. Some of the students participated in the role play simulation exercise as described above; the remainder discussed the identical twelve transactions in a lecture-oriented format. The concepts and material presented in the classroom experience in the lecture-oriented format were identical in content to those of the role play simulation. The instructor had notes for each transaction which specified what items needed to be addressed in each class. Similar to the role play simulation experience, the fundamental accounting equation (assets=liabilities + owners' equity) was written across the blackboard in the classroom, and the students participated in figuring out how each transaction affected the accounting equation. These classes, however, did not have poker chips and did not have students actively assuming roles.

Immediately following the classroom activity, each student was asked to answer several questions using the assessment instrument in Appendix 2. The students were not told that they would be answering questions based on their classroom experience until after it was completed. To increase the assessment's salience, the students were told that their score on these questions would replace their lowest homework grade if their score was better than the lowest homework. All sections participating in the experiment had the same instructor, assessment instrument and performance incentives. Both the lecture-oriented exercise and role-play simulation consumed approximately one hour of class time. The remaining 15 minutes of the 75 minute class were used for assessment and classroom housekeeping. The effect of alternative classroom environments on retained learning was also assessed. Approximately four weeks after the classroom presentation, the students answered a question on their first exam in the course that built upon the material.[5] All six sections had the same intervening classroom material with all using the same teaching methods from the day after the experiment to the day before the first exam.

Analysis

Assessment Instrument Results

The assessment instrument administered immediately following each classroom presentation has two types of questions. The first five questions assess transfer problem solving involving the fundamental accounting equation. The second five questions assess conceptual recall.

Table 1 displays the mean number of correct student responses for each classroom presentation by the type of assessment question. In all cases, the mean number of correct responses is higher for the students who were able to participate in the role play simulation class than for those that experienced a more lecture-oriented format. Statistical analysis reveals that the students participating in the role

[5]This assessment was conducted over three semesters. To mitigate the effects of subsequent sections learning from prior exams, the exam question was altered in terms of order and the specific assets, liabilities, owners' equity, revenues and expenses that were affected by each transaction. In addition, both the lecture-oriented and simulation formats were spread over the three semesters. Empirical assessment indicates that there is no reason to believe that the carryover effect from one exam to the next is greater for students in one classroom presentation over another.

play simulation exercise answered significantly more questions correctly than those that participated in a more lecture-oriented format. When the questions are disaggregated into those that focus on problem solving versus those that focus on conceptual recall, however, only the problem solving questions show a statistically significant higher number of correct responses.

Students' retention is also assessed with an exam four weeks after the material was presented. The retention instrument (see Appendix 3) focuses on problem solving since that is the only learning outcome that showed significant differences in learning outcomes initially. The mean score is

Table 1

Differences in Mean Performance Between Students Who Participated in a Role Play Simulation Exercise Versus Those Who Participated in a More Lecture-Oriented Classroom Presentation

	Mean Number of Correct Responses		
Performance Measure	**Simulation**	**Lecture-Oriented**	**t-statistic**
All Questions (Maximum Correct =10)	8.05 (91)	7.46 (59)	2.08**
Problem Solving Questions (Maximum Correct = 5)	4.25 (91)	3.76 (59)	2.44**
Conceptual Recall Questions (Maximum Correct = 5)	3.81 (91)	3.69 (59)	.73
Retention Assessment (Maximum Points = 25)	20.09 (80)	19.27 (55)	1.67*

The values in the parentheses are the number of students in each group. Four students dropped the course before the first exam in the lecture-oriented group during the experiment. In the simulation environment, two students did not take the first exam; nine dropped the course.

**Difference in the means is significant at less than the .05 level with a two-tailed t-test.
*Difference in the means is significant at less than the .10 level with a two-tailed t-test.

higher for the role play simulation learning environment at a mildly statistically significant level.

Further analyses were conducted to mitigate the potential confounding factor that students in the simulation sections perhaps by chance have a higher aptitude for accounting. To control for this possibility, analysis of covariance (ANCOVA) is performed with the number of questions answered correctly as the dependent variable. The independent factor is the classroom learning environment (role play simulation v. lecture). The covariate is the student's aggregate number of points for the course excluding the points for the exam question pertinent to the subject material in the experiment. Use of overall performance in the course not only helps mitigate the effects of differing levels of accounting aptitude across the two classroom environments, but it also subsumes other factors which may influence student performance.[6] For example, Wooten (1998) finds differences in traditional and nontraditional students. Mutchler et. al. (1987) find that gender may be related to student performance. Lipe (1989) finds that interaction between the gender of the instructor and that of the student affects student test scores. Buckless et. al. (1991), however, find no evidence of a gender effect once they controlled for academic aptitude. Thus, use of a measure of course performance may help mitigate the multiple factors which can vary across groups of students that may influence student performance.[7]

The results displayed in Table 2 are similar to those shown in Table 1. The learning environment (role play simulation v. lecture) is statistically significant even after controlling for overall accounting aptitude. This is predominately true for the problem solving questions administered using an assessment immediately following the classroom experience; there remains no evidence of enhanced conceptual recall. These results mirror those found without attempting to control for overall student aptitude. The results for assessing retention show a statistically significant learning environment effect after controlling for overall student aptitude. The simulation learning environment was able to help students of similar accounting aptitude retain the information in a way that allowed them to perform better on an exam administered four weeks later.

[6]GPA and SAT scores were also used as covariates with no material impact on the results. If the role-play simulation led to better overall classroom performance (and therefore better test scores) for the rest of the material in the course, that would tend to bias the results toward not finding significance. The test scores, however, may be a better measure of accounting aptitude with the caveat that they may be biasing the results away from significance.

[7]Additional factors such as gender and traditional v. non-traditional students were also added to the model to assess if there was an effect over and above what was captured by the covariate. These factors were consistently not significant echoing the conclusions reached in Buckless et. al. (1991).

Table 2

Analysis of Covariance Assessing the Efficacy of Role Play Simulation with Hands-on Learning Material Versus Traditional Lecture

Panel A: Dependent Variable is All Questions

Effects	*SS*	*Degrees of Freedom*	*F-statistic*	*p-value*
Within Group	266.47	114		
Covariate (Course Score)[a]	27.16	1	11.62	.001
Learning Environment[b]	6.64	1	2.84	.095

Panel B: Dependent Variable is Transfer Problem Solving Questions

Effects	*SS*	*Degrees of Freedom*	*F-statistic*	*p-value*
Within Group	130.28	114		
Covariate (Course Score)[a]	5.85	1	5.12	.027
Learning Environment[b]	5.92	1	5.18	.025

Panel C: Dependent Variable is Conceptual Recall Questions

Effects	*SS*	*Degrees of Freedom*	*F-statistic*	*p-value*
Within Group	97.43	114		
Covariate (Course Score)[a]	7.80	1	9.13	.003
Learning Environment[b]	.02	1	.02	.877

Panel D: Dependent Variable is Problem Solving Exam Question After Four Weeks

Effects	*SS*	*Degrees of Freedom*	*F-statistic*	*p-value*
Within Group	624.33	114		
Covariate (Course Score)[a]	111.35	1	20.33	.000
Learning Environment[b]	17.62	1	3.22	.076

[a]The covariate is the student's aggregate grade excluding the points allocable to the exam question pertaining to this material. (The maximum number of points is 435).

[b]Learning environment was one of two classroom experiences: (1) learning the material through role playing simulation or (2) learning identical material via a more lecture-oriented format.

Student Self-Assessment

Students were asked if they perceived either the problem solving or conceptual questions on the assessment instrument to be more difficult. Results from chi-square tests are displayed in Table 3. They indicate that the students perceived that the conceptual questions were more difficult. Further partitioning of the sample by classroom learning environment (role play simulation v. lecture), gender, and traditional v. non-traditional students does not reveal evidence that this perception varies across these factors. In addition, their perceptions reflect their actual performance on the assessment instrument in that they answered 81.08% of the problem solving questions correctly in comparison to answering 75.26% of the conceptual questions correctly. The difference is statistically significant at less than the .01 level.

Concluding Remarks

This study indicates that an active learning environment using role play simulation along with hands-on student learning materials can enhance students' transfer problem solving using fundamental accounting concepts. Students' learning was assessed both immediately after the classroom learning experience and several weeks following introduction of fundamental concepts. Assessment indicates that the active learning environment in which students simulated performing transactions helped them understand the material better than when the same material was presented in a lecture-oriented environment. In addition, when one controls for student accounting aptitude, the students who participated in role play simulation performed better on an exam four weeks following the class than those who learned the material with a lecture-oriented format. These results do not, however, extend to questions that assess conceptual recall.

Much more work remains to understand the circumstances under which more active learning environments lead to enhanced student learning. In this setting, evidence indicates that the role play simulation along with hands-on learning materials enhanced students' transfer problem solving learning. Further research is needed to assess if this result holds for other topics in the first accounting course. Additional research is needed to assess if more advanced accounting students can benefit from the use of active learning environments to enhance their problem solving abilities.

The results do not show evidence that the more active learning environment enhanced conceptual recall. The students performed more poorly on the conceptual recall questions than the problem solving questions for both environments. It may be that role play simulations offer little advantage over lecture-oriented environments which stress the key components of and relationships between accounting concepts. Alternatively, another learning environment may be superior to either of those explored in this study to enhance conceptual recall. Further work exploring the classroom environments and methods that would enhance this type of knowledge is needed.

Table 3

Student Perceptions of Whether Problem Solving or
Conceptual Recall Assessment Questions are More Difficult

Panel A: Tabulation of Student Perceptions: Entire Sample

	Perception of Which is More Difficult	
	Problem Solving	Conceptual Recall
Perception of Which is More Difficult	36	111

P^2: 38.27 (p=.000)

Panel B: Tabulation of Student Perceptions: By Classroom Learning Environment

	Perception of Which is More Difficult	
	Problem Solving	Conceptual Recall
Learning Environment		
Role Play Simulation	23	66
Lecture-Oriented	13	45

Pearson P^2: .22 (p=.698)

Panel D: Tabulation of Student Perceptions: By Gender

	Perception of Which is More Difficult	
	Problem Solving	Conceptual Recall
Gender		
Female	15	54
Male	21	57

Pearson P^2: .53 (p=.565

Panel c: Tabulation of Student Perceptions: By Traditional v. Non-Traditional Students

	Perception of Which is More Difficult	
	Problem Solving	Conceptual Recall
Student Type[a]		
Traditional	28	70
Non-Traditional	8	41

Pearson P^2: 2.65 (p=.154)

[a]Non-traditional students are those who are age 25 or older. This definition is used by the university in the experiment and also by Wooten (1998).

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Appendix 1

Classroom Material Used As a Basis for Simulation RolePlay Exercise

Starting a Business:
Business Transactions

Ima Hoosier is starting a new consulting business. The following events occurred when she started her new business:

Before the exercise begins, students volunteer to assume the roles of banker, supplier, customer, landlord and owners. One student is assigned to each role with the exception of owners. The number of students assigned as owners is equal to the number of firms. Each one of these parties receives a cupful of white poker chips. Each white chip represents $1,000 of assets. The remaining students are divided into groups of three. One is assigned the task of record-keeping. The other two are given either red or blue poker chips. Red poker chips represent liabilities; blue chips represent owners' equity. Before engaging in transactions, the groups are asked to indicate what resources each business has. Since the firms are beginning operations, no firm has any resources. They are then asked to look about the classroom to locate potential resources. All resources (white chips) at this point are held by parties external to the firm. The students are then told that they will engage in transactions which will allow them to acquire and/or use their firm's resources. The fundamental accounting equation is introduced. The words, assets, liabilities and owners' equity are written across the top of a blackboard. The concept that every resource has a source and that source can originate from two potential places is introduced. The fundamental accounting equation (assets=liabilities+owners' equity) is introduced. The effect of each transaction on assets, liabilities and owners' equity is written under the headings for each transaction.

1) She contributed $10,000 cash to the business and the corporation distributed stock worth $10,000 to the owner.

   In addition to being the first example of how transactions affect the accounting equation, the entity concept is introduced and highlighted with this transaction. The owner's personal assets not invested in the firm remain with each owner. It is noted that some owners have more resources (white chips) than others. This does not affect the amount of resources that are allocated to the firm because of the entity concept.

2) The firm bought $3,000 of supplies with cash.

   Students realize upon visiting the supplier that they are merely exchanging one asset for another. There is no net change in assets. Liabilities and owners' equity remains unaffected.

3) The firm borrowed $5,000 cash from the bank.

   The concept of liabilities is further refined.

4) The firm bought a truck for $4,000 paying for it with cash.

   After the students engage in this transaction, the similarities between (4) and (2) are discussed.

5) The business realized it did not need as much cash as she thought she would, so it paid off $2,000 of the bank debt.

   This transaction highlights the effect of paying liabilities has on the firm's overall resources.

At this point, the following question is posed. If the firm were to cease being a business, how much in resources would the owner receive? The students realize that the owner would only receive her original investment back. The concept of owners having a residual interest is introduced. The students are asked if owners would be satisfied over the long-run if they were only to receive their original investment. The notion that the owners are bearing risk to engage in this business is discussed. In return for bearing the risk, the owners are hoping to achieve a higher return for their investment than would be attainable through other investment vehicles. Then, the students are asked how businesses generate returns for their owners. The notion of profit is introduced and that a business must perform a service or sell a

product to generate profits. The concepts of operating, investing and financing activities are also introduced. It is noted that up to this point the firm has only engaged in financing and investing activities. To earn a return for its owners, the firm must engage in operating activities.

6) The firm performed services for customers and received $5,000 cash.

Students have difficulty deciding how balance the accounting equation. They are asked who would receive the $5,000 if the firm were to liquidate. The concept that owners' equity can be divided into two components, contributed capital and retained earnings, is introduced. Revenues are introduced.

7) The firm paid $1,000 rent in cash.

The concept of expenses is introduced.

8) The firm performed $3,000 of services for customers and billed them for them.

Revenue recognition and the difference between cash and accrual basis is introduced.

9) The firm collected $2,000 of the amounts owed from its customers.

The class discusses why the collection from a customer is not a revenue. The impact of this transaction on the accounting equation is emphasized.

10) The firm used $1,000 of the supplies.

Expenses and the matching principle are discussed.

11) The firm purchased a $4,000 computer on credit.

Liabilities are reinforced. The term, accounts payable, is introduced.

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12) The firm paid Ima a $2,000 dividend.

There is a discussion focusing on why dividends are not considered expenses. The notion that a firm has no legal obligation to pay dividends is introduced. In addition, the students are asked how investors are able to achieve a return on a stock investment. Dividends and stock appreciation are discussed. Growth stocks are also discussed at this point.

Note: The italicized descriptions below each transaction indicate what concepts were discussed in class for each transaction.

Appendix 2

Assessment Instrument

1. Red Company borrowed $10,000 from a bank.

   A. Assets decreased by $10,000 and liabilities decreased by $10,000.
   B. Assets increased by $10,000 and liabilities increased by $10,000.
   C. Assets increase by $10,000 and owners' equity increased by $10,000.
   D. There was no net change in total assets.
   E. None of the above.

2. Red Company bought a computer for $5,000 in cash.

   A. Assets increased by $5,000 and liabilities decreased by $5,000.
   B. Assets increased by $5,000 and liabilities increased by $5,000.
   C. Assets increased by $5,000 and owners' equity increased by $5,000.
   D. There was no net change in total assets.
   E. None of the above.

3. Red Company performed services for customers and received $6,000 in cash.

   A. Assets increased by $6,000 and liabilities increased by $6,000.
   B. Assets increased by $6,000 and owners' equity increased by $6,000.
   C. There was no net change in total assets.
   D. Assets decreased by $6,000 and liabilities decreased by $6,000.
   E. None of the above.

4. Red Company performed $10,000 of services for a Joe Blue and billed him for it. Payment is expected in a few weeks.

   A. This transaction is not recorded.
   B. Assets increased by $10,000 and liabilities increased by $10,000.
   C. Assets increased by $10,000 and owners' equity increased by $10,000.
   D. There was no net changed in total assets.
   E. None of the above.

5. Red Company received $10,000 from Joe Blue for the services that they had performed for him in Number 4.

   A. Assets increased by $10,000 and owners' equity increased by $10,000.
   B. Assets increased by $10,000 and liabilities increased by $10,000.
   C. There was no net change in total assets.
   D. This transaction is not recorded.
   E. None of the above.

6. Expenses are recognized:

   A. When they are paid in cash.
   B. When management cares to do so.
   C. In the time period in which the costs are used up.
   D. None of the above.

7. Revenues are recognized:

   A. When the cash is received.
   B. When management cares to do so.
   C. When the service is performed or the product is sold.
   D. None of the above.

8. The entity concept in accounting:

   A. Ensures that an owner's personal assets and liabilities will be recorded separately from a firm's assets and liabilities.
   B. Requires that transactions that involve an exchange of value be kept separately from those that do not.
   C. Requires that tax records be kept separately from accounting records.
   D. None of the above.

9. Transactions are recorded in an accounting system:

   A. When there is an exchange between the firm and an outside party.
   B. When management feels it is appropriate to do so.
   C. Only when it will cause a net change in either assets, liabilities or owners' equity.
   D. None of the above.

10. With regard to owners' rights:

   A. A corporation has a legal obligation to pay them a dividend every year.
   B. They have a residual claim to the assets of the business.
   C. Should the firm go bankrupt, the owners' initial investment in the firm is paid prior to that of the creditors.
   D. None of the above.

11. Which questions do you feel were easier to answer?

   A. 1-5.
   B. 6-10.

12. Have you taken an accounting class before?

   A. No.
   B. Yes, in high school only.
   C. Yes, I tried once before in college.

13. How old are you?
   A. 25 or older.
   B. Less than 25.

Appendix 3

Instrument Assessing Concept Retention

For each of the transactions given below, indicate the effect on assets, liabilities, stockholders' equity, revenues, expenses, and net income by entering a plus (+) for increase, a minus (-) for decrease, and a blank for no effect.

	Transactions	**Assets**	**Liabilities**	**Stockholders' Equity**	**Revenues**	**Expenses**	**Net Income**
A	Issued capital stock for cash.						
B	Performed services for a customer who will pay us later.						
C	Received a telephone bill for telephone service for this month.						
D	Received cash from the customer in (B)						
E	Purchased truck on credit						
F	Paid the telephone bill mentioned in (C).						
G	Recognized the depreciation on equipment						
H	Declared and paid cash dividends.						
I	Paid next year's insurance in advance.						

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Teaching physics of everyday life: Project-based instruction and collaborative work in undergraduate physics course for nonscience majors

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Abstract

In the current paper, we describe a project-based physical science course for nonscience majors designed and implemented at the University of Texas at Austin during the fall semester of 1999. We focus on practical implications of project-based instruction[1] in motivating nonscience majors in science study, as well as the challenges the students and the instructors encountered during the course. Cognitive, attitudinal and social outcomes of the project-based physical science course as reported by the students throughout the semester are also discussed.

Keywords:

Project-based instruction (PBI), physical science, motivation, collaborative learning

[1] For more information on project-based instruction see: http://ouray.cudenver.edu/~nflejeun/lcstrategies.htm and http://forum.swarthmore.edu/~sarah/Discussion.Sessions/Blumenfeld.html.

When people turn away from science in a world that is increasingly dependent on technology, it is time to take a look at the way science and technology are taught in our schools…

Robert N. Little (Little 1971).

Introduction

Most of us will agree that minimal scientific literacy is required from every educated citizen. Not surprisingly, the issue of physics teaching to nonscience majors has become one of the hottest issues in contemporary science education[2]. Thousands of college students, regardless of their majors, are required to enroll in and pass a physical science course. The reason for this requirement is the hope that a physical science course will (a) improve student scientific literacy and critical thinking skills, and (b) serve as a conceptual base for subsequent courses taken (Dickinson and Flick 1998). However, there is ample evidence that the traditional introductory physical science course too often fails to fulfill any of these goals (McDermott 1991; Hake 1998). Two major factors may account for this failure (Tobias 1990; Tobias 1992). On the one hand a majority of nonscience majors exhibit very low self-efficacy toward science and mathematics. On the other hand, the students put little personal value in learning physical science (Maehr and Midgley 1991; Pajares 1996; Dickinson and Flick 1998). These factors substantially contribute to the lack of motivation for science study demonstrated by the students (Forsyth and McMillan 1991).

Our research thus focuses on designing and exploring the learning environment that promotes student motivation and supports meaningful science learning. In this paper, we describe an attempt to address the challenges described above through the incorporation of the project-based instruction (PBI) into a traditional undergraduate physical science course for nonscience majors.

The goals of the current study are to explore effective ways of implementing PBI in the undergraduate physical science hands-on laboratory course for nonscience majors;

1. to gather and categorize information about possible student outcomes of the PBI;
2. to analyze student perceptions of PBI as teaching and learning environment;
3. to outline interesting directions for the future study.

Why project-based instruction?

Education should be viewed "as a social enterprise in which all individuals have an opportunity to contribute and to which all feel a responsibility".

John Dewey

[2] For more information see Physical Science Resource Center (PSRC) developed by the American Association of Physics Teachers (AAPT): http://www.psrc-online.org/

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As we pointed out earlier, the majority of nonscience majors coming to the physical science class have rather negative expectations from the course. The students rarely see how the course contributes to their future beyond being an "additional obstacle in their college career".

Keeping this in mind, our first goal in redesigning the course was making it relevant and useful to the students. However, convincing them that understanding the basic concepts of physical science will be helpful in the future is not an easy task, unless we can show that this knowledge can make a difference in students' lives. Therefore, we decided to focus on the role of science and technology in everyday life. We asked the students to investigate (a) How do the appliances we use in everyday life work? (b) What are the physical principles they are based upon? and (c) What are the most important parameters of these appliances we have to know about in order to be wise consumers on the modern market? By asking these questions, we hoped to raise student awareness and curiosity about science.

Today it is widely accepted that students do not come to the science classrooms as blank slates. They bring a wide array of common sense knowledge and beliefs that too often "successfully" interfere with the formal science instruction (Shipstone, Rhoeneck et al. 1988; Saxena 1992; Smith, diSessa et al. 1993; Wandersee, Mintzes et al. 1994). These preconceptions are very resilient to change and the strategy of a gradual replacement of student "misconceptions" with the "acceptable scientific conceptions" proposed during the 1980's was in general proven unsuccessful (Webb 1992; Chambers and Andre 1997). As it was pointed out by Andrea diSessa (diSessa 1988, p.49) "the transition to scientific understanding involves a major structural change toward systematicity, rather than simply a shift in content".

Therefore, our second goal in redesigning the course was building an environment that supports student "structural change toward systematicity". We tried to achieve it by:

1. Helping the students to become aware of their learning process as well as of the informal science knowledge, they brought to the physical science classroom (Milner-Bolotin 1999).
2. Emphasizing the relations between the theoretical concepts studied during the traditional classroom activities and their applications explored during the PBI.

We also put a special emphasize on student learning outcomes, as expressed in the development of student cognitive as well as metacognitive skills. The most important of them, from our point of view, are learning how to:

1. ask meaningful questions related to science and to approach the investigation;
2. gather appropriate data and analyze it;
3. evaluate the reliability and the validity of the information, and
4. communicate about science effectively.

The PBI offered a promising framework for the goals we chose. As it was outlined by Blumenfeld et al.:

> *Project-based learning is a comprehensive perspective focused on teaching by engaging students in investigation. Within this framework, students pursue solutions to nontrivial problems by asking and refining questions, debating ideas, making predictions, designing*

plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and finding to others, asking new questions and creating artifacts.

(Blumenfeld, Soloway et al. 1991, p. 371)

However, designing projects that will be relevant and interesting for the students and giving them an opportunity to become independent learners are not the only arguments in favor of PBI incorporation into science teaching to nonscience majors. We will mention here two additional reasons supporting our choice. The first one relates to the population of students participating in the physical science classes. The term "nonscience majors" refers to a very heterogeneous group of students. In addition to majoring in different fields, and being freshmen, sophomores or juniors, these students have various science and mathematics backgrounds. Teaching such a heterogeneous class is a challenging task. However, if every one of these students is given an opportunity to make a unique contribution to the project in the field of his or her expertise, the class can benefit from such diversity. This opportunity might have an invaluable impact on students' content knowledge, as well as on their self-confidence and self-efficacy toward sciences (Barron 1998).

The second reason relates to the learning environment in the project-based classes. PBI is based on the ideas of social constructivism, emphasizing the role of social environment in teaching and learning (Boaler 2000). It promotes mutual respect, support and understanding, making an impact on student-student and student-instructor relationships. The role of these relationships in the science class for nonscience majors can not be overemphasized. As it was pointed by Walsh and Maffei:

There are a variety of theoretical grounds for suspecting that a more positive student-professor relationships will lead to increased learning. Insofar as motivation plays a critical role in learning by initiating, channeling, and sustaining student efforts to learn, theoretical linkage between the quality of the student-professor relationship and motivation to learn is very important in accounting for the relevance of the student-professor relationship to learning.

(Walsh and Maffei 1998, p.1)

Therefore, by incorporating PBI into a physical science course we expected to affect student affective as well as cognitive outcomes.

Our next task was to make PBI work in our classroom. In the following sections, we will describe the physical science course and the organization of the project the students were engaged in during the semester.

Introductory guided discovery laboratory course in physical science

In order to understand the organization of the project a brief description of the particular physical science course will be helpful.

Physical Science PS-304 class is a small-section (up to 22 students) introductory guided discovery laboratory course for nonscience majors. The course is usually taught by a graduate student and covers the topics of electricity, magnetism, sound and optics. It is a three-hour course: the second in the six-hour sequence of two physical science courses for non-science majors. The course consists of eight hands-on guided activities aiming to "discover" basic physical principles using very unsophisticated equipment. The students follow the lab manual written about three decades ago and

almost unchanged since then. The manual mostly focuses on confirmation of known laws and principles, containing detailed prescriptions of what the students are supposed to do, leaving little room to student open-ended discovery (Little 1973). Although, the course does not incorporate any technology or computers, it includes a few interesting classical experiments. The textbook of the course is Paul Hewitt's "Conceptual Physics" (Hewitt 1997).

Population

Current study included two sections of the physical science course (N=42). Gender and ethnic representation of the students, participating in the study, as well as student college history are given in the Table 1. Out of 42 students nine (21%) were majoring in elementary education, one student was majoring in computer sciences and all the rest were liberal arts or communication majors (77%). Each of the 42 students in the study successfully completed the PS-304 course.

Total enrollment: N = 42	**Gender representation**		**Ethnic representation**				**Year at college**			
	Male	Female	African American	Asian	Hispanic	Caucasian	Freshmen	Sophomores	Juniors	Seniors
Number of students	13	29	1	3	3	35	3	26	7	6
Percentage	30%	70%	2%	7%	7%	84%	7%	62%	17%	14%

Table 1. Gender ethnic and college history representation of the PS-304 students, participated in the study.

The organization of the project "How things work"

> *In many ways, education is a process of learning to indicate to ourselves things we hadn't seen.*
>
> Julia T. Wood

The organization of the project "How things work" is schematically described in Fig.1. There were five main work-stages in the project: (I) Organization of the learning environment; (II) Question generation; (III) Project development; (IV) Artifact production; (V) Project presentation. Research shows that successful project required a lot of peer and instructor feedback and at least a few iterations (Barron 1998; Krajcik, Blumenfeld et al. 1998). Therefore, the order of the stages (Fig. 1) was important only for the first round of the instruction. As it often happens, the more students proceeded with the project, the more interrelated and interconnected the stages became. For example, while working on artifact production, stage III, students could decide that the questions they posed during stage II could be more specified, clarified or some new interesting questions could arise.

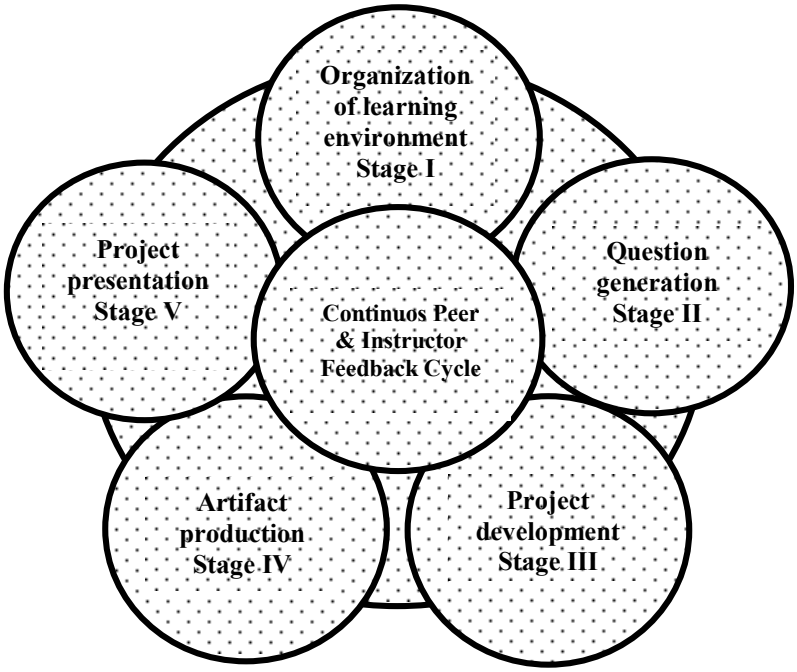

Figure 1. Schematic organization of the five stages of the project "How things work". In the following subsections, we will outline each one of the project stages mentioned above[3].

Stage I: Organization of learning environment

Although, PBI does not necessarily imply collaborative work of a small group of students, contemporary research supports the claim that small group instruction makes PBI more powerful (Blumenfeld, Soloway et al. 1991; Cooper and Robinson 1998; Cooper and Robinson 1998; Krajcik, Blumenfeld et al. 1998). Therefore, during the first month of the semester, we invested much effort into organization of a collaborative classroom environment. During that period, the students were working on standard classroom activities and labs, but most of the time they were encouraged to work in small groups, share responsibilities, help and support each other. We tried to help students experience different possibilities of effective collaborative work (Millis and Cottell 1998), providing them with various opportunities for small group discussions, problem solving and hands-on activities. We also encouraged them to work together on the homework assignments. Another important aspect was establishing after class communication. An electronic discussion board was useful for this purpose.

The first few weeks of the semester were found especially critical in creating an effective learning environment and investing effort in doing so at the beginning returns twofold later[4].

[3] For more information about the organization of the PS-304 course and the project "How things work" see the course web site: http://www.ph.utexas.edu/~ps304.
[4] For more information about classroom activities, we found helpful for this purpose look in PS-304 web site: http://www.ph.utexas.edu/~ps304.

Stage II: Question generation

As was pointed out by Blumenfeld et al. (Blumenfeld, Soloway et al. 1991), the main feature distinguishing the PBI from any other inquiry-based activity is the presence of a driving question that guides classroom activities:
Projects are decidedly different from conventional activities that are designed to help students learn information in the absence of a driving question. Such conventional activities might relate to each other and help students learn curricular content, but without the presence of a driving question, they do not hold the same promise that learning will occur as do activities orchestrated in the service of an important intellectual purpose (Blumenfeld, Soloway et al. 1991, p. 372).

Therefore, the next step in the organization of the PBI was helping the students to formulate questions that they would be interested to pursue in the future.

A general driving question of the project was to investigate and to report in the classroom how one of the appliances we use in everyday life works. The students were given freedom to choose any appliance they wished. The only restriction on their choice was that the appliance had to use physical principles we were dealing with in the classroom.

As simple as it might look, it is not trivial to choose an appliance that is relevant for the students' lives; is simple enough to be explained using the basic physical principles; and
students are interested to work with.

Moreover, working on the project in small groups of four or five students, the students had to reach a group agreement on the appliance choice. Taking all this into account, we gave them up to four weeks to discuss what appliance they would like to investigate and what interesting questions they would like to ask. We also tried to put students' attention on different applications of the principles they have been learning. The course textbook (Hewitt 1997) and on-line resources about "How things work"[5] were good starting points for students' research. In order to get continuous feedback on student progress we established very close e-mail communication.

After choosing a particular appliance, each group prepared a tentative proposal of the research, including the research questions, possible information sources etc. Originally, the students came up with rather broad questions. Every group met with the instructor during the office hours to translate these broad questions into small subproblems that (a) could be solved more easily and (b) would lead the students to the solution of the original question. During this meeting, the instructor also emphasized what labs and hands-on activities might be especially helpful for answering the questions the students posed. This meeting gave an impetus for the process of students making connections between the concepts learned in the classroom and the driving question they wanted to answer. For example, one of the groups decided to investigate how the toaster works. After thinking about this project for a few weeks, the students became interested in understanding how it happens that the toast pops up before it gets burned. This group put special attention on the hands-on activities related to electric current and to the thermal properties of metals. The students were very surprised when

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[5] For example, see http://www.howstuffworks.com/microwave.htm.

they realized that the timer device they wanted to find inside the toaster was a simple bimetallic strip they had been working with in the lab.

Another group decided to build binoculars, using simple laboratory equipment. This group became so engaged in the project that they decided to investigate a few additional devices: a kaleidoscope, a telescope and even night vision binoculars.

Stage III: Project development

The development stage was the central stage of the project. In addition to student-instructor classroom communication, every group had to e-mail on biweekly basis a progress report as well as to describe the problems they encountered. The students got a prompt constructive feedback from the instructor. Sometimes, the electronic communication was not sufficient and then the instructor met with the students during the office hours and discussed possible solution to the existing problems. Moreover, in order to provide every student with an opportunity to express his or her opinion without a fear of "being punished for it", we incorporated the classroom assessment technique called a minute paper (Angelo and Cross 1993, p. 149). It consisted of asking the students to provide anonymous three-sentence response on the following questions: (a) What were the best/worst things about the project they encountered during the last week? (b) What is the most important thing related to the project they learned during the last week? (c) What important questions still remain unanswered?"

This simple but very effective technique gave us the opportunity to adjust and improve the group work as well as to help the students to formulate and answer their research questions.

Stage IV: Artifact production

Although we included artifact production in a separate stage, the students started creating, recording and gathering artifacts from the very beginning of the project. By "artifacts" we mean all the products the students created, found and analyzed during the project.

Creating interesting and effective artifacts requires critical thinking abilities as well as observational skills. Writing component played an important role during the project, since in addition to gathering and analyzing the information, necessary to answer the research question, the students were asked to reflect on their project. During this stage, the students focused on learning (a) How to report their findings to other students; (b) How to incorporate technology in their research (Power Point, video, etc.); (c) How to communicate information effectively.

Learning these important skills is necessary for contemporary undergraduate students. However, only a few students in the physical science course felt confident about them.

Stage V: Project presentation

Toward the end of the semester, each group wrote a report, based on their investigations, including all the artifacts they created during the semester. After discussing their findings with the instructor, the students presented them to the classmates. The goal of the presentation was to communicate science via teaching other students what they had learned during the project. Students were encouraged to bring the appliances they were researching to their presentation. The presentations were evaluated by the instructor and by their classmates, using the criteria developed together with the students. After the presentation every group met with the instructor in order to reflect on the presentation and on the group work. Seven out of nine student teams' presentations were videotaped and analyzed. Three groups out of seven asked to watch the video in order to reflect on their presentations.

VI. Student cognitive, affective and social outcomes

> *While learning has many ends, teaching has only one: to enable or cause learning.*
>
> K. Patricia Cross

Data collection procedures

In order to evaluate the project "How things work" and to find out what were the outcomes of the PBI we continuously gathered and analyzed course information throughout the semester. Trying to uncover students' understanding of basic physics concepts, we conducted, videotaped and analyzed multiple interviews focused on student understanding of electricity and waves (Milner-Bolotin 1999; Milner-Bolotin, Lane et al. 1999). Minute papers, student reflections and e-mail communication also served us an invaluable source of information about the project. Moreover, every test included at least one open-ended question about the science applications in everyday life. In addition to that, at the end of the semester we asked the students to reflect on their project experience, writing a three-page essay. We asked them to answer four questions: (a/b) What did/didn't you like about the project? (c) What did you learn from participating in the project? (d) How the project can be improved? We did not ask specific questions about different cognitive or affective outcomes, since we did not want to influence student responses.

All the outcomes described in this section were reported independently by a large number of students. The outcomes mentioned by the students and caused, in their opinion, by the PBI fall into three interrelated categories: cognitive/metacognitive, affective and social outcomes. In the next paragraphs, we will describe them, illustrating each one with students' quotes.

a) Cognitive and metacognitive outcomes:

> *The majority of the students mentioned how much they learned while participating in the project, not only learning the content of the course, but also making connections between different course related activities. Not surprisingly, the students emphasized that the project helped them to relate scientific concepts learned in the classroom to everyday life:*
>
> *The things I learned in this physical science class came into play when doing research on the toaster.*
>
> L.C.

The students also pointed out that teaching the ideas they had learned to other students helped them to deepen their understanding. Science teaching experience was very unusual for the majority of the students.

The part I liked most about the project was presenting the material we had learned, and being able to teach it to others. I also thoroughly enjoyed watching everyone else's final product being presented to the class.

A.W.

Another student wrote:

This project was much more interesting than the labs. I felt like we had discovered something unique instead of given the labs easy format. I liked that we had to find information. However, because we had all worked together before, it was easy to work together on this project.

K.M.

More than 50% of the students mentioned that the project helped them to learn how to learn and become more responsible for their learning. Taking responsibility for the group learning was a difficult step for the students. However, a lot of them emphasized that it was a very positive learning experience. More than 25% of the students mentioned that working on the project helped them to learn how to read popular science articles and books and be critical about what they have read. A few students mentioned how surprised and sometimes disappointed they were to find out that not all the information published on the web is trustworthy and they should not believe every written word. A few of them pointed out that working in small groups on a systematic basis helped them to become more critical of their own learning habits. Some of the students acknowledged that they learned to monitor their learning and to manage their time.

b) Affective outcomes:

Affective outcomes were the most frequently mentioned outcomes in students' reflections. The majority of the students emphasized that the project helped them to look at science and at themselves doing science in a different way. More than 70% of the students emphasized gaining an appreciation of science. This outcome relates to the gain in self-confidence and self-efficacy toward science, as mentioned by more than 60% of the students. A lot of students reflected that they were surprised to find they could do science and even teach other people science concepts they understand.

I also liked the project because we got to apply physical science to our everyday life. That aspect is not common in most classes. I think it helped me respect physical science more, because I realize how crucial it is to all of our lives.

M.R.

I think that as far as physics goes, this project made me look around and think more carefully about the way things work instead of just taking them for granted. I don't know why I had never contemplated how a toaster worked, for example, but I hadn't, so this gave me the opportunity to see things in a different light.

E.H.

c) Social outcomes:

More than 50% of the students pointed out that during the project they learned some social skills. They acknowledged that learning to compromise, to listen to other people, to work collaboratively, to respect other students and the instructor were very important.

> *I learned much about the telescope and new scientific terms, but this project also taught me how to compromise and to work better with other people.*
>
> A.W.

> *There were many things that I thoroughly enjoyed about our group project, but one thing stands above all of the others. At the university level, many professors have forgotten the importance of the group work. Working well with others is a vital skill necessary for success in today's society; and this idea is often lost in institutions of higher learning. Group members attempt to combine their skills for attaining a common goal. Compatibility is uncertain and groups do not always agree. Even though dissention often teachers a better lesson when working with others, I was fortunate to be a part of a work-efficient foursome, whose skills combined for a phenomenal project.*
>
> D.F.

A few students mentioned that making friends was one of the very important personal outcomes of the course.

> *What I liked most about the group project was the group efforts. I feel that I became much closer to my group and may even have some lasting friendships after the class is over. We worked well together, and taught each other the things that we were researching. We had good discussions over the subject matter that helped to give me a better understanding of the course content at that time.*
>
> V.B.

VII. Addressing the challenges of the PBI

In this section, we will outline possible strategies that might be useful in overcoming the common challenges to successful implementation of the PBI, based on our observations.

These challenges can be roughly divided into three groups: (a) conceptual challenges, (b) challenges related to project management, (c) communication challenges related to student difficulties in communicating project findings.

a) Conceptual challenges

Conceptual or cognitive challenges relate to choosing a topic of the investigation, gathering data or analyzing the information. Sometimes students insist on a topic that is much more complex than it seems. For example, one group decided to investigate how the cellular phone works. With the background they had it was a great challenge to pursue this question in depth. Too often, the students do not have enough knowledge and experience to comprehend the complexity of the issue. They need good advice from the instructor to help them decide if it is feasible to investigate the topic in the

available time. Frequent student feedback and formative assessment are necessary components of the successful PBI. In our case, the minute papers mentioned above, personal meetings and e-mail communication were very useful in solving this problem.

There is one more reason why continuous student feedback is so important in PBI. Too often students find some on-line information and without testing its reliability base all their work on it. Sometimes the students find different contradictory sources and they don't know "which one to believe". By establishing close student-instructor communication the instructor can help the students to become critical consumers of on-line information. This very important skill will save the students a lot of time and might be very helpful in the future.

Very often the interaction with the instructor and getting immediate feedback are crucial (Walsh and Maffei 1998). Obviously, not all problems can be solved immediately using an electronic mail or any other type of communication software. However, the students have to know that the instructor is available for them and they can rely on his/her help and support. The worst situation occurs when students have problems and do not ask for help. In order to avoid this a variety of various formative assessment techniques might be useful[6].

In another case, the instructor might not be an expert in the topic the students want to pursue. PBI opens doors for learning for the students as well as for the instructors. Moreover, in the ideal case, the students will become experts in the chosen field and then they will know the specific topic in more depth than may be the instructor does. Therefore, it might be useful to connect students with other experts in the field of their interest. For example, in our case, the students who were interested in building a telescope found it very helpful and exciting to use the solar telescope of the Department of Astronomy at the University of TX at Austin[7].

b) Project management

The second type of difficulty relates to project management. PBI requires students to work outside of the classroom and to take responsibility for their learning. Helping students to organize their meetings and to find out other ways of communicating is a part of this challenge. As we mentioned earlier, electronic communication amongst the students and between the students and the instructor might be very helpful in solving this problem. Students also have to be given time to discuss these issues during the class time. A clear outline of deadlines of different stages of the project will also help the students and the instructor to manage their time more effectively. Dr. JoyLynn Reed's (Reed 2000) idea to organize students' groups around their schedules might be another way to solve this problem.

Another important issue in project work management is helping the students to find the information more effectively. Providing students with hints about the library or on-line web search and some useful references might be very important and can save them a lot of time and unnecessary frustrations. For example, one group of students wanted to investigate how the microwave oven works. However, the results of their on-line search, using the key-words "microwave oven" were not helpful, since they

[6] The book "Classroom Assessment Techniques" by Thomas A. Angelo and K. Patricia Cross can serve as a very helpful reference on the ways of incorporating formative assessment into classroom practice (Angelo and Cross 1993).

[7] Our thanks to Prof. Bob Robbins and the Department of Astronomy staff member Lara Eakins for supporting the students and helping them to operate the solar telescope.

were getting a lot of sales information and obviously not what they wanted. One of the group members e-mailed the instructor and got a prompt response to use a search using a different combination of key words: "How stuff works" (Brain 2000).

The organization of effective collaborative work can also be very challenging. This problem relates to the time management, but it is even more complex. Barbara Millis and Philip Cottell in their book "Cooperative Learning for Higher Education Faculty" (Millis and Cottell 1998) addressed a few important issues in cooperative group management. The key-issue is being flexible and responsive to students' feedback helping them to organize their work more effectively.

c) Communication of project findings

The third type of challenge relates to teaching students to communicate their findings. We found that the majority of the freshmen and many sophomores had never given a twenty-minute presentation, especially communicating scientific findings. Therefore modeling a good presentation, emphasizing important points and supporting the students was necessary to help them in preparation of a successful presentation.

In order to reduce student presentation anxiety we modeled the final presentation during the semester, by assigning students to make a five-minute report about one of the topics or experiments discussed in the classroom. We also spent some times discussing the criteria of a good presentation and preparing an outline of the criteria students had to keep in mind while preparing to the presentation.

A few groups also consulted the instructor regarding the visual aides they could use in order to make a presentation more attractive to the audience. It is important to mention that during the presentation stage students majoring in communication, theater, photography and other related fields were especially helpful to their classmates and made invaluable contributions to the group project.

Project evaluation and conclusions

The project-based physical science course described above was our first, and we hope a successful, attempt to incorporate the PBI into a traditional physical science course for nonscience majors. We have no doubts that the design can be and should be improved, and we are currently working on incorporating student reflections and suggestions into a new version of the project (Milner-Bolotin 2000). In order to be able to make some statistical inferences and generalizations about the population of nonscience majors we are also planning to incorporate rigorous experimental design in the future study.

However, this pilot study made it clear for us that nonscience majors are capable of science learning and can be very motivated, productive and creative. The key-issue is letting the students ask questions they want to answer supporting their endeavor through meaningful science learning.

The current study also posed a few important questions for further investigation: What are the other key-issues in the PBI that are responsible for cognitive and attitudinal outcomes of the nonscience majors? What effect does PBI have on student conceptual understanding of physical science? Does PBI have an impact on student "misconceptions" about physical science? What are the long-term outcomes of the PBI? What is the impact of PBI on student metacognitive skills? How does PBI

impact student problem-solving abilities? What is the impact of PBI on instructor's attitudes toward teaching nonscience majors?

In conclusion, we believe that the field of teaching sciences to non-science majors will experience an extensive growth during the next decade, and PBI will have a special place in this process.

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A Model for Student Success: Critical Thinking and "At Risk" Students

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Abstract

There appears to be a significant gap between faculty expectations for incoming college students and these same students perceptions of their abilities. Incoming college students are not very confident of their critical thinking abilities, yet faculty expect students to enter college already being able to critically evaluate information and to reach conclusions based on a critical analysis of the data. The current study challenges the preconception that critical thinking cannot be taught and delineates a model for critical thinking that can be employed regardless of one's discipline. Outcome data strongly suggests critical thinking can lead to both proximal and distal increases in student success.

Introduction

In a recent poll of campus faculty, Osborne (1998) noted a large discrepancy between faculty expectations for incoming students and incoming students' perceptions of their own abilities. In particular, faculty expect college students to: (1) critically think, (2) manage their time, (3) monitor their own stress levels, (4) solve problems, (5) clearly articulate what they do and do not know, and (6) prioritize tasks so more important tasks are afforded more time. In this same poll, however, first year students cited the following areas of weakness in their own preparation for college: (1) poor time management skills, (2) ineffective methods for coping with stress, (3) frustration with communication abilities, and (4) poorly developed critical thinking skills.

Many students, in fact, suggest critical thinking is not only under-appreciated in high school but also actually punished. One student said it best when he recalled a comment a high school teacher made on an essay exam of his. In response to this student's effort to speculate on the causes of the issue being addressed, the teacher wrote in the margin, "Do not tell me what you think, tell me what I told you to know."

Although we do want students to know what we believe it is important for them to know, should we actively discourage their efforts to place their knowledge within a context? Research suggests, in fact, that first year students are significantly less likely to be successful in making the transition to college level work when they take introductory courses that do not require written work (e.g., Boice, 1990; Rickabaugh, 1993). Additional research shows that emphasizing study skills, as many "first year experience" or "transition to college" programs do, actually does little to promote student success unless metacognitive skills are taught as well (e.g., Flavell, 1979; Gardner & Boix-Mansilla, 1994).

Yet, when discussing critical thinking as a method for assisting a first year student's transition into college, it is not uncommon to hear faculty suggest critical thinking cannot be taught. Indeed, even students appear to enter the college environment believing you either have what it takes or you do not (e.g., Sydow & Sandel, 1996).

In an effort to increase the retention of first year students, a pilot program was developed pairing an introductory psychology course with a course on critical thinking (Browne & Osborne, 1998). Over a five-year period, students completing this pairing of courses were tracked and both proximal and distal student success measures were gathered. The focus in this article is two-fold. First, information will be provided to challenge the prevailing attitude that students cannot be taught to critically think or the perception that, at the very best, if students can be taught to do so it cannot be accomplished within one semester. Second, longitudinal data from this pairing of courses will be provided to delineate the long-term benefits of promoting critical thinking skills in "at risk" students.

In a longitudinal study of "at risk" students, Browne and Osborne (1998) established the link between the development of critical thinking abilities and long-term measures of student success. Students enrolled in randomly selected sections of an introductory psychology course also participated in a two credit-hour critical thinking laboratory. Activities in the lab were linked to the weekly content of the introductory psychology course. Students were placed in these special paired courses based on college entrance assessment scores, low high school ranking, and/or having already been placed on academic probation.

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The challenge became one of delineating the process of critical thinking. Surprisingly, the literature is very sparse in terms of information about what critical thinking is or how it can be taught. Although there are a few well known exceptions (e.g., Chaffee, 1994, Halonen, 1995 & Smith, 1995), critical thinking is ill-defined and even more difficult to incorporate into the general education of first year students. Rather than adopt one of the discipline specific approaches to critical thinking (e.g., Halonen, 1995) Browne and Osborne (1998) chose to use applications from the the education literature. Benjamin Bloom (1956) articulated six cognitive levels for student learning. These levels, then, became the building blocks upon which Browne and Osborne built their "critical thinking as process" approach.

Bloom's cognitive levels include: (1) knowledge – facts, (2) comprehension – an understanding of those facts, (3) application – an ability to utilize an understanding of that information for addressing a problem, (4) analysis – an assessment of what aspects of that knowledge are meaningful, (5) synthesis – a reintegration of those pieces into a more meaningful whole, and (6) evaluation – an assessment of the learning that has taken place and a comparison of what is now known versus what was initially known. Exams and other classroom assessment methods that require recitation of facts only require students to demonstrate the first level of understanding in Bloom's taxonomy. Browne and Osborne, therefore, developed in-class activities, demonstrations, and assessment rubrics requiring students to demonstrate an ever-increasing ability to go beyond what is simply known.

An Example

Before proceeding with a discussion of the outcome data, it would be useful to provide an example of an activity that encourages students to move up the cognitive levels of Bloom's taxonomy. A technique employed during the first week of the course was called, The Costs and Benefits of Critical Thinking (see Osborne, Laws & Weadick, 1999 for a detailed description of this activity). This activity was designed to illustrate the relationship between the effort associated with critical thinking and the benefits gained.

Students were placed in five-person working groups. Each group was given $240 of play money, some sketchy information about a sniper killing incident, and the opportunity to purchase additional information to assist them with the task of answering the question, "Why did Rick kill those people?" Three categories of information were available for purchase, (1) $25.00, (2) $40.00, and (3) $75.00. The more expensive information was said to be more critically important for answering the question.

Student groups then spent time deciding how to spend their money (the analogy was made to this paralleling and "investment" in their critical thinking), purchasing information and preparing an in-class presentation as to why Rick killed people. Students were given 30 minutes to purchase their information and develop their response to the question. Groups could earn points in two ways. First, they would earn points for having money left over. If there were six groups, for example, the group with the most money left over would earn six points, the next highest amount of money left over would earn five points, and so on. Additionally, groups could earn points based on the total critical thinking score assigned to their presentations by the judges.

Judges were given Bloom's taxonomy and instructed to utilize it in assessing the critical thinking demonstrated within each presentation. The group receiving the highest critical thinking score would earn six points, the next highest group score would earn five points, and so on. Data from the groups was then plotted to show the relationship between the costs of critical thinking (the spending of the

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money) and the benefits of critical thinking (the critical thinking score). Each time this technique was employed, the data showed almost a perfect inverse relationship. The more money the groups spent, the higher their critical thinking scores tended to be.

It is important to note that the information students employed in reaching their conclusions about why Rick killed people, is less important than how that information is employed. As an example, one group purchased a $25.00 piece of information revealing Rick drove a "beat up black Ford Pinto." A critical thinker would be expected to set this information aside and reach the reasonable conclusion that, at least in isolation, this information is not informative for answering the question as to why Rick did what he did. The group who purchased the information, however, proceeded to suggest that this was important because "the fact he chose to drive a black car indicates that he was depressed" (represented by the black color of the car), and "in this state of depression he decided to kill himself and take others with him."

Not surprisingly, this analysis of why Rick did what he did received a very low critical thinking score by the judges. Other groups showed a similar unwillingness to set aside information they had purchased and this became a focal point in the discussion that followed the activity. In a general sense, people may be unwilling to "give up" something they have invested a lot of time, effort and/or money on. This certainly could explain why some groups utilized apparently useless information at the expense of their own critical thinking scores.

In contrast, some groups received very high critical thinking scores despite the fact that most of their information did not "converge" on a clear answer. One group, for example, speculated that he may have had some form of brain damage (they had information stating that on the morning of the murders he suffered three blackouts). They went on to speculate that it could be a brain tumor of some kind that was affecting his perceptions of reality. Although they had very little information to build this case upon, their honesty in drawing their conclusions struck the judges as particularly indicative of critical thinkers. This group ended their presentation by stating that their analysis was entirely speculation and could only be corroborated with an autopsy. It is worth noting that a piece of information that might have been purchased stated that an autopsy after the killing spree revealed major damage to his amygdala (a brain structure responsible for a person's levels of aggression and fear).

This activity was then followed by an in-class discussion about why students should invest in critical thinking. The costs, of course, include: (1) critical thinking is time consuming, (2) it requires a great deal of intellectual effort, (3) it requires thinkers to be open and honest about what they do or do not know, and (4) it demands that one not go "beyond the data." The benefits discussed with students include: (1) an ability to understand, apply, and analyze what is known, (2) a clearer understanding of what is not known, and, ultimately, higher grades, (3) more confidence in one's knowledge, and (4) an enhanced ability to discern what information still needs to be discovered in order to be confident in drawing conclusions.

The following class period students were required to bring in syllabi for their courses for the semester. A content analysis of these syllabi showed a very clear expectation on the part of faculty that students would be able to demonstrate critical thinking. Such statements as, "students should be able to apply course principles to real world issues," and "students are expected to develop informed opinions and to separate opinion from fact" reinforce the point that faculty expect students to already be able to do the kind of thinking outlined by Bloom.

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Other course activities included assessing news programs, persuasive speeches, and newspaper/magazine articles on Bloom's levels. Students were required to read a magazine article, for example, and assess the degree to which the author had or had not, demonstrated critical thinking according to the six level model being used. As a final project in the course, groups were assigned chapters from the introductory psychology course textbook. It was their responsibility to learn the material, and prepare an in-class presentation of that material. These group presentations had specific criteria such as inclusion of at least three different visual aids, and a minimum of two handouts. Students in the course, then, utilized a scoring rubric based on Bloom's taxonomy to assess the critical thinking level demonstrated by the groups in their presentations. This assessment was a major component of the students' final grades in the critical thinking laboratory.

The Data

Proximal measures were gathered to assess the impact of this critical thinking course on students. These measures included: (1) grade point average in the paired introductory psychology course, (2) overall GPA for the semester, and (3) number of students in the paired courses receiving D, F, or withdrawal grades. These data were compared to a matched sample of students completing the introductory psychology course during the same semesters but not completing the critical thinking lab. The samples were matched for gender, high school rank, number of credits hours completed, declared major, and admission placement scores.

Proximal data showed clear effects of the critical thinking lab. Students completing the paired courses received higher grades in the introductory psychology course (3.0 versus 2.19 on a 4-point scale), received fewer D, F, or withdrawal grades (24% versus 46%) in the introductory psychology course, and had higher overall GPA's for the semester in which the introductory course was taken (2.7 versus 2.22 on a 4-point scale).

More important than these proximal indicators of success, however, were the distal or long-term changes that were tracked. Students completing the paired courses were significantly more likely to re-enroll the next semester (80% versus 56%), were significantly more likely to have graduated within the next five years (45% versus 33%), and were significantly more likely to declare majors within the behavioral and social sciences (14% versus 8%).

Discussion

The data from this study appear to support the contention that critical thinking is a process that can be taught. Additionally, the data strongly suggest that the process of critical thinking can be taught and modeled well enough in one semester to initiate some long-term change. One primary challenge to employing the process of critical thinking to promote student success, however, is convincing faculty and students alike that critical thinking can be taught. Even with a model for critical thinking in hand, however, student success is not guaranteed. Students need ongoing and frequent practice with applying the critical thinking model, and they need practice with applying the model in diverse ways. Discipline-specific applications on the process of critical thinking may be less effective in the long run than requiring students to implement critical thinking in ways that are relevant to their daily lives.

One student, for example, suggested that the critical thinking course destroyed her ability to get pleasure out of watching television because she felt most programs were insulting her intelligence.

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This student went on to lament television commercials and asked, "just how many dentists did they survey when they decided four out of five dentists surveyed recommended a particular gum?" Although the class found the comment to be comical, it also illustrates an ability on the part of this student to critically evaluate what others are asking her to believe.

Several faculty commented on the poll mentioned earlier that they want students to become informed consumers of information. It appears the aforementioned student, at least, has made progress on that goal. Critical thinking is a process that must be nurtured, encouraged, and rewarded. The costs are high. It is difficult for students not because they cannot do it but because they have not been encouraged to practice it. One student proclaimed after the first class period, "this kind of thinking makes my head hurt." From that day forward, a bottle of Ibuprofen sat on the front desk to remind the class that the outcome is worth the pain. In the end, this student graduated and recently sent a note to the author stating, "I just had to tell you that I got a big promotion at work. The boss said my ability to critically think was the primary reason he recommended me for the promotion. It really was worth the headaches."

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From Minsk To Pinsk: Why A Scholarship Of Teaching And Learning?[1]

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The Carnegie Foundation for the Advancement of Teaching[2]

Preamble

More than 25 years ago, I was serving as an American Psychological Association visiting scholar to the psychology departments of small liberal arts colleges. I spent two days at a lovely campus in southeastern Indiana, Hanover College. I particularly enjoyed the energy and intelligence of an undergraduate psychology major named Randy Isaacson. A short time later, he was admitted to the doctoral program in educational psychology at Michigan State University, where I had been teaching since 1963. When Randy completed his PhD at Michigan State, he returned to Indiana as a member of the faculty at Indiana University, South Bend.

What a pleasure it has been to reconnect with Randy so many years later around our mutual passion for the importance of a scholarship of teaching and learning. I deeply appreciate his role in the creation of this on-line journal. The Indiana University System is demonstrating significant national leadership in sponsoring this effort, as well as in its pioneering initiatives to recognize and reward scholarly contributions to teaching and learning among its faculty members.

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[1] These remarks were originally prepared for a meeting of the Carnegie Academy for the Scholarship of Teaching and Learning (CASTL) campus affiliates hosted by the American Association for Higher Education (AAHE) at its 2000 annual meeting held in Anaheim, CA, March 29, 2000.

[2] Lee S. Shulman is President of the Carnegie Foundation and Professor of Education, Stanford University.

A Strange Journey

As more individual teacher/scholars and their institutions become engaged in the scholarship of teaching and learning, we often find ourselves discussing the history of the phenomenon, the precise definitions of "scholarship," "teaching," and "learning," and some of the methodological and technical standards for conducting such research in an excellent manner. Periodically, it is worthwhile to step back and ask: "*Why* are doing this? What are the reasons we are committed to the pursuit of such work?"

At such times I am reminded of the old Jewish story of the Russian itinerant who needed to travel from Minsk to Pinsk. He caught a ride with a wagon driver whose cart was drawn by a rather ancient horse. As they approached the first significant hill on the Minsk-Pinsk highway, the driver halted the cart, unhitched the horse, and asked the passenger to assist him in pushing the wagon to the top of the hill. At the top, he hitched up the horse again, and they proceeded on their way until the next small elevation, where they again repeated the previous procedure.

After the fifth such ritual, the now-exhausted passenger dropped to his knees at the side of the road and looked quizzically at the driver. "I know why I have to get to Pinsk. I suspect you have a reason for going there as well. Enlighten me please. Why are we bringing the horse?" As we strengthen both our resolve and our capacities for moving faculty in higher education from the Minsk of a restricted view of scholarship to the Pinsk of a more comprehensive and inclusive perspective, we had better step back and make sure we understand why we need the horse of a scholarship of teaching and learning.

Three P's

I'd like to suggest that there are three broad rationales for advocating a serious investment in the scholarship of teaching and learning: Professionalism, Pragmatism, and Policy. *Professionalism* refers to the inherent obligations and opportunities associated with becoming a professional scholar/educator, and especially with the responsibilities to one's discipline symbolized by the PhD. *Pragmatism* refers to the activities needed to ensure that one's work as an educator is constantly improving and meeting its objectives and its responsibilities to students. *Policy* refers to the capacity to respond to the legitimate questions of legislatures, boards and the increasingly robust demands of a developing market for higher education.

Professionalism. The most important reason for engaging in the scholarship of teaching is professional role and responsibility. Each of us in higher education is a member of at least two professions: that of our discipline, interdiscipline or professional field (e.g., history, women's studies, accounting) as well as our profession as educator. In both of these intersecting domains, we bear the responsibilities of scholars—to discover, to connect, to apply and to teach. As scholars, we take on the obligation to add to the core of understanding, skepticism, method and critique that defines our fields and their ever-changing borders. We also assume the responsibility for passing on what we learn to discern and act, through teaching, social action, and through exchanging our insights with fellow professionals. Indeed, the core values of professional communities revolve around the expectation that we do not keep secrets, whether of discovery or of grounded doubt. We are expected to share our knowledge by making it public, whether via publication, correspondence,

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presentations or pedagogy. The new technologies make such exchange even more widely possible than ever before.

I have emphasized the professional imperatives for a scholarship of teaching most seriously in other writings. In so doing, I have also emphasized the importance of distinguishing between two equally important and desirable activities—scholarly teaching and a scholarship *of* teaching. This is a distinction that Boyer chose not to make in ***Scholarship Reconsidered***. Scholarly teaching is teaching that is well grounded in the sources and resources appropriate to the field. It reflects a thoughtful selection and integration of ideas and examples, and well-designed strategies of course design, development, transmission, interaction and assessment. Scholarly teaching should also model the methods and values of a field, avoiding dogma and the mystification of evidence, argument and warrant.

We develop a scholarship of teaching when our work as teachers becomes public, peer-reviewed and critiqued, and exchanged with other members of our professional communities so they, in turn, can build on our work. These are the qualities of all scholarship.

Both scholarly teaching and a scholarship of teaching are deeply valued in the professional community. Scholarly teaching is like the clinical work of faculty members in a medical school's teaching hospital. I would never wish to be associated with a medical school that was not home to outstanding clinical faculty. That clinical work, however valued, does not become scholarship until it is subjected to systematic reflective analysis. Such reflection leads to its display or communication in ways that render it community property in the fullest sense—public, reviewed and exchanged.

The *professional* rationale for engaging in the scholarship of teaching is that affords all of us the opportunity to enact the functions of scholarship for which we were all prepared. We can treat our courses and classrooms as laboratories or field sites in the best sense of the term, and can contribute through our scholarship to the improvement and understanding of learning and teaching in our field. Thus, the professional imperative for a scholarship of teaching is both individual and communal. We fulfill our own obligations as members of the dual professions with which we identify, and we fulfill our responsibilities to our professional peers to "pass on" what we discover, discern and experience.

Pragmatism. The professional rationale is critical, but not sufficient. We also have a practical rationale for pursuing the scholarship of teaching and learning. Such work helps guide our efforts in the design and adaptation of teaching in the interests of student learning. By engaging in purposive reflection, documentation, assessment and analysis of teaching and learning, and doing so in a more public and accessible manner, we not only support the improvement of our own teaching. We raise the likelihood that our work is transparent to our colleagues who design and instruct many of the same students in the same or related programs. Active scholarship of teaching provides the teacher with a very different perspective on what he or she may have been doing for many years. I have recently had such an experience myself.

A Recent—and Personal—Example

During the past semester, I have been team-teaching (with my colleague Professor Linda Darling-Hammond) a course—*Principles of Learning for Teaching*--that I have taught at Stanford since 1983. For most of those years, I co-taught the class with a variety of colleagues. The team teaching alone fostered serious reflection about the teaching. I have written about my strategies of teaching in the

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course (e.g., Shulman, 1996)[3], but I never actively conducted research on the teaching and learning taking place in the course itself.

This year, for the first time, we agreed to conduct more systematic research on the teaching and learning processes. This commitment was in no small measure motivated by my experience in working with Carnegie Scholars on their own scholarship of teaching projects.

The course is offered to all (nearly 60) secondary teaching candidates at Stanford. They are preparing to teach mathematics, social studies, English, science or foreign languages in middle and high schools. All students already hold at least a BA or BS in their discipline and will receive an MA at the completion of their teacher preparation. During the academic year, each student is actively teaching in a secondary school for the first half of the day, returning to campus in the afternoon for formal classes, practicums and seminars.

At the core of the class is the case-writing assignment.[4] All students are expected to complete a case study of their own practice during the class. They begin with brief "case starts" in which they outline an extended episode that they believe will be "caseworthy." After feedback from the instructors and from their own colleagues, they prepare a first-draft case, which is presented in a small working case conference. Based on feedback, they then spend nearly a month revising and editing their case (often choosing to write an entirely new case) which is presented at a second case conference and then written in final form. During this period, they continue to read a variety of theoretical and research material on teaching and learning, as well as additional cases written by others. The final version of the case is written up after the second case conference, and is accompanied by two commentaries written by others, and a five-page reflective essay on the whole process.

We decided before the class was offered that we would conduct research on the processes of learning through case writing that constituted the central structure of the course. Our teaching colleague Dr. Karen Hammerness took on responsibility for documentation and data gathering. Karen systematically collected each draft of every case written, including the commentaries and the reflective essays. Extensive notes were taken of every class session. Selected sessions were videotaped, and selected case conferences were also videotaped. These data will now be organized and analyzed to answer a number of questions about the efficacy of case writing in promoting reflection, deep understanding and motivation among the students in the program.

We intend to do several things with these data. We will certainly meet to reflect on our findings and use those insights to redesign the course for the coming year. These meetings have already begun. We will also prepare more formal oral and written presentations on our experiences, methods, and findings. Hammerness is also taking leadership in developing a new web-site through which she will communicate our activities in the course, our insights into the learning that did (and did not) occur, and our analyses of the effort. We will also provide abundant examples of evolution of selected cases written during the term. Thus the web-site will also include examples of student work and their own reflections.

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[3] Shulman, Lee S. (1996). "Just in Case: Reflections on Learning from Experience" in J.A. Colbert, P. Desberg & K. Trimble (Eds.) ***The Case for Education: Contemporary Approaches to Using Case Methods***. Boston: Allyn and Bacon.

[4] The web page with the syllabus, instructions for writing cases and other materials for the course can be found at http://www.stanford.edu/class/ed269/.

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I offer this personal account as an example of how the pragmatics of engaging in a scholarship of teaching on a course I have taught for years has introduced far more intelligent design and analysis of my own work than I have ever done before. Moreover, it has brought me into collaboration with close colleagues in new ways. I fully expect that our efforts at rendering this work public, reviewable and available for exchange can serve as a valuable resource for colleagues both within Stanford and in the more general community of teacher educators. I also believe that these efforts will lead to significant improvements in the course itself and in the program of which it is a part.

Policy. We in higher education are also enmeshed in webs of national, state and local policy. Those who make policies and approve budgets for our institutions are increasingly asking for evidence that we are making measurable progress toward our educational goals. Accrediting agencies are insisting on educational "audits" in which we provide evidence that we are achieving our stated goals and missions. "Accountability" and "Assessment" have become the themes of the emerging movements toward reform in higher education.

These are not bad ideas. They only become problems when the wrong indicators are used to assess the quality of our efforts. They are only problematic if the metrics employed are chosen because of convenience or economy of use, rather than because they serve as authentic proxies for the learning and development we seek to foster. These indicators cannot be "one-size-fits-all" quick-and-dirty off-the-shelf instruments that purport to measure the outcomes of higher education. They should be the result of carefully conceptualized, designed and deployed studies of teaching and learning in each of our fields, conducted by scholars qualified to pursue them. This kind of work cries out for a vigorous scholarship of teaching and learning engaged by discipline and field-specific scholars of teaching.

The free market is also creating new challenges for higher education. For-profit providers, distance learning, and other new sources for higher education are creating a market wherein institutions must be prepared to document and display evidence that they are fostering learning, deep understanding, passionate commitments and civic virtues in the domains in which they educate. Once again, unless we can provide relevant evidence of the processes and products of our pedagogies, we will find ourselves making empty claims and offering degraded arguments.

I envisage a scholarship of teaching and learning offering the kinds of evidence that can be powerful in these policy and free market discussions. New forms of institutional research will be developed that are learning-focused, domain-specific, and oriented toward analyzing the educative experiences and outcomes that institutions support or fail to support.

So who needs the horse?

I began this essay with a story about making the journey from Minsk to Pinsk.[5] The protagonists seemed to understand why each of them needed to make the journey; it was unclear why they needed the horse. In this case, I believe it is clear why our professional, pragmatic and policy interests can be supported and enhanced by a scholarship of teaching and learning. It will not be an easy journey. At first, it may seem as if the horse is either useless, or an additional burden itself. Ultimately, however, we will need a sturdy horse to carry us on these journeys. We cannot do these

[5] By the way, Minsk and Pinsk are now cities in Belarus. Minsk is the national capitol. In the 18th and 19th centuries they were usually part of Russia, but at different periods one or the other was in Poland or Lithuania.

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things alone. We will need to develop networks of campus-based teaching academies to serve as centers, support systems and sanctuaries for these kind of scholarly efforts.[6]

Our interest in engaging in such work was summarized by three P's, our professional interest, our pragmatic responsibilities, and the pressures of policy. Scholarship of teaching and learning supports our individual and professional roles, our practical responsibilities to our students and our institutions, and our social and political obligations to those that support and take responsibility for higher education. We should be making all three journeys and we need a really good horse. This journal, its leaders, readers and contributors, are helping to make the journey possible.

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[6] I have written about a variety of visions for such academies in my essay "Visions of the Possible" reproduced at the Carnegie Foundation website: http://www.carnegiefoundation.org/OurWork/OurWork.htm

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