International Journal for the Scholarship of Teaching and Learning

Volume 4 | Number 1 Article 10

1-2010

Active Learning in Introductory Economics: Do MyEconLab and Aplia Make Any Difference?

Trien T. Nguyen
University of Waterloo, nguyen@uwaterloo.ca

Angela Trimarchi
angetrim@sympatico.ca, angetrim@sympatico.ca

Recommended Citation

Nguyen, Trien T. and Trimarchi, Angela (2010) "Active Learning in Introductory Economics: Do MyEconLab and Aplia Make Any Difference?," *International Journal for the Scholarship of Teaching and Learning*: Vol. 4: No. 1, Article 10.
Available at: https://doi.org/10.20429/ijsotl.2010.040110

Active Learning in Introductory Economics: Do MyEconLab and Aplia Make Any Difference?

Abstract

This paper reports experiment results of teaching large classes of introductory economics with modern learning technology such as MyEconLab or Aplia. This new technology emerges partially in response to the enrollment pressure currently facing many institutions of higher education. Among other things, the technology provides an integrated online teaching and learning environment that allows active learning through student direct participation in the learning process as well as interaction with their instructor, peers, and the outside Internet. Our results showed that, for the classes in the experiment, modern learning technology could make a difference in helping students improve their class mark averages by a small but statistically significant amount of 2% regardless whether the technology was used as a required or optional course component. We noted that students responded more favorably when the technology component was given more weight in the marking scheme.

Keywords

Economic education, Active learning, Learning technology, MyEconLab, Aplia

Active Learning in Introductory Economics: Do MyEconLab and Aplia Make Any Difference?

Trien Nguyen University
of Waterloo Waterloo,
Ontario, Canada
nguyen@uwaterloo.ca

Angela Trimarchi
University of Waterloo
Waterloo, Ontario, Canada
angetrim@sympatico.ca

Abstract

This paper reports experiment results of teaching large classes of introductory economics with modern learning technology such as MyEconLab or Aplia. This new technology emerges partially in response to the enrollment pressure currently facing many institutions of higher education. Among other things, the technology provides an integrated online teaching and learning environment that allows active learning through student direct participation in the learning process as well as interaction with their instructor, peers, and the outside Internet. Our results showed that, for the classes in the experiment, modern learning technology could make a difference in helping students improve their class mark averages by a small but statistically significant amount of 2% regardless whether the technology was used as a required or optional course component. We noted that students responded more favorably when the technology component was given more weight in the marking scheme.

Keywords: Economic education; active learning; learning technology; MyEconLab; Aplia

Introduction

In the preface of the fifth edition of their well-known undergraduate micro economic theory work book, Bergstrom and Varian (1999) stressed the need for students to do exercises:

> Students often tell us "I read the textbook and I thought I understood it, but when I try to do the problems, I don't know where to start." Indeed it is a lot easier to passively "learn" a concept than to try to apply it. But the main reason for learning the tools of economic theory is so that you can apply them, and the best way we know to develop the skill of applying ideas is to do lots of problems. (p. vii)

Although Bergstrom and Varian did not explicitly use the term "active learning," they have made it clear to students that the skill of economic analysis had to be learned actively through exercises and problems.

It was not new that students were told of the importance of time management, study habits, exercises and problems in various disciplines (Ehrlich, 1961). For example, in "hard" subjects like mathematics, science, and engineering, they knew that active learning was a must for getting good marks as well as knowledge acquisition and retention. As early as middle schools, they learned that, with the exception of gifted students, it is impossible for

https://doi.org/10.20429/ijsotl.2010.040110

them to pass a math final exam without seriously getting involved in the course for the entire term (e.g., class attendance, interaction with teachers, keeping up with readings, doing homework, and learning from mistakes). That is, analytical skills of mathematical reasoning needed to be acquired through various forms of persistent active learning.

Along the same lines, students of modern economics have found that they too must endure the labor-intensive process of active learning in order to acquire the much needed skills of economic analysis and reasoning, be it mathematical or non-mathematical, for subsequent courses in their curriculum (Becker, 1998). Although mathematics is not used extensively in first-year introductory economics, students still must be able to follow the logical sequence of an economic argument in verbal or graphical forms (Cohen & Cohn, 1994).

This hurdle is further compounded by faculty shortages and enrollment increases. Recent surveys by Ontario faculty associations (OCUFA, 2008a, 2008b) showed that while many professors were reaching retirement age, only 11% of surveyed professors reported comparable replacement hire. Meanwhile, 60% of professors reported replacement hire at lower ranks, and 22% reported no replacement at all. In addition, 62% of professors faced larger classes than just three years ago. Some schools in the United States already had extremely large classes of up to 1,200 students (Pallack, 2009).

The situation made it more difficult for students to initiate and maintain student-instructor interaction in large classes. For example, given a typical large class of 250-500 students, the role of the instructor was practically reduced to giving mass lectures two or three times a week with very little student interaction beyond a few weekly office hours and sporadic review sessions before exams. Cochran (1989, p. 13) reported that, according to a Carnegie survey in the United States, the amount of time spent on teaching (e.g., class preparation and instruction, markings, office hours, advising, counseling) could be well over 70% of the instructor's total working time. It was worth noting that the survey was conducted at the time when large classes of 250 students were rare or unheard of.

As a result, students were left to fend for themselves from the beginning to the end for their first year of university education. Many were unable to manage their courses and failed. In the United States, Bosshardt (2004) reported that among students who failed their first-year introductory economic courses, only 16% remained at the university. Similarly, Finnie and Qiu (2009) estimated that the first-year dropout rate was about 15.1% at several universities in Atlantic Canada. Besides financial difficulties, the main reasons for dropouts included poor academic performance, poor study habits, and poor time management.

This paper reported our experience of two learning technology and course management systems, namely, MyEconLab and Aplia, to help students achieve their learning objectives in spite of the class size increases. Specifically, our results showed that modern online learning technology could make a difference in helping students improve their class mark averages by a small, but statistically significant, amount of 2% regardless whether the technology was used as a required or optional course component (see Tables 1, 2).

We experimented with MyEconLab and Aplia in several classes of introductory micro and macro economics. Students got online access to these course systems at affordable costs. After login, they were able to follow guided learning modules related to the lectures and to interact online with the instructor as well as classmates. As students progressed through the course materials at their own speed, the instructor acted as the "answerer of the last resort" in case of difficulties. In this system, classroom interaction became multi-dimensional with four groups of participants, namely, instructor, students, peers, and learning technology.

Modern technology allowed students to have online contacts with their instructor and peers regardless of the size of the physical classrooms. Kumar (1992) compared classroom interaction data from English classes of different sizes (25–45) and found that the opportunities for students to interact in class depended more on the nature of classroom activities and the instructor's role and attitude, than on class size per se. On the other hand, Iaria and Hubball (2008) compared two medical classes with a wider range in size (17–150) and found that the ratio of students participating in classroom discussion dropped substantially from 15/17 in the small class to only 3/150 in the large class, even though both classes were given the same opportunities to be involved in active discussion, and in an identical manner. Their findings suggested that students in large classes were less willing to engage in classroom interaction than in small classes.

Educators (Gilbert, 1995, p.4; Lowman, 1995, p. 212) recommended that instructors of large classes provide more opportunities for student to make individual contacts as a way to compensate for the negative aspects of large classes. The advice highlighted the point that modern technology can help encourage students of the net generation to engage in class interaction using the digital technology which they have been comfortably growing up with (Tapscott, 2009). Although the online teaching environment provided by technology was still far from the vanishing traditional one-on-one dialogue between students and instructor, given a large class of 250–500 students that many instructors had to deal with, our reported results of 2% average mark increases suggested that technology could offer some hope for a second-best solution in the presence of limited teaching resources.

The structure of the remaining of the paper was as follows: we briefly reviewed the notion of active learning in general as well as within the discipline of economics. We described the two popular learning technology and course management systems, namely, MyEconLab and Aplia. We then presented results from our experiments. Based on the previous parts of the paper, we showed that these learning technology and course systems, to some certain degree, could help students achieve their learning objectives as seen through improved mark performance and positive survey responses. We concluded the paper with discussions about broad lessons learned and directions for future research.

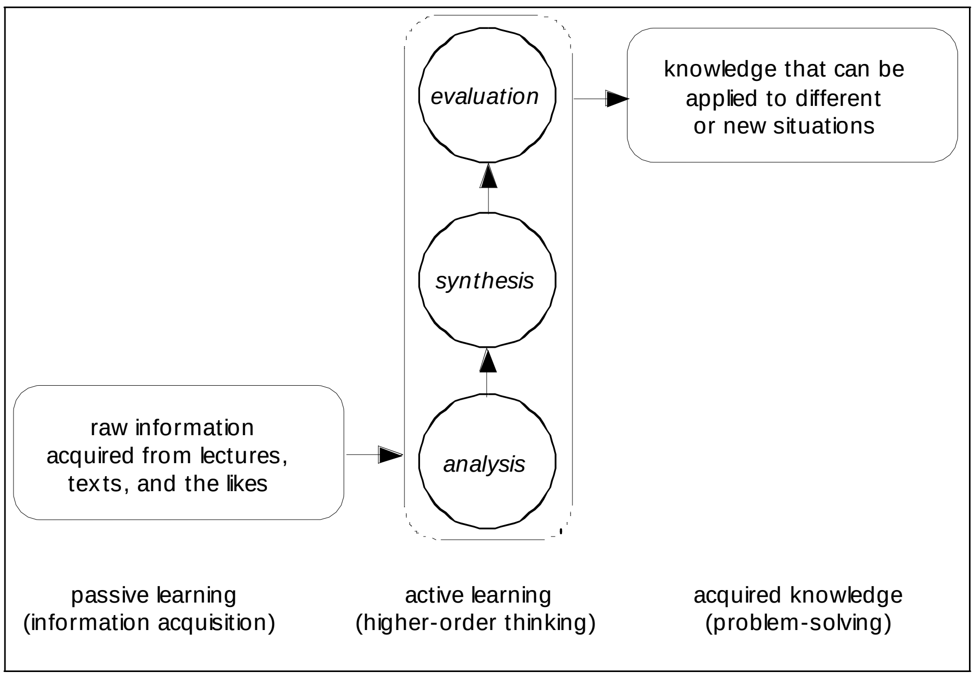
Active Learning

While a precise definition of active learning remains to be worked out among psychologists, educators, and researchers in the scholarship of teaching and learning (SoTL), we probably can say that active learning requires students to go beyond the first phase of acquisition of raw information (e.g., lectures and texts) and engage in higher-order thinking tasks such as analysis, synthesis, and evaluation (see Figure 1).

In practical terms, this means that students must do more than just attend lectures, take verbatim notes, read assigned texts, and work on suggested sample questions. Still, these are only the first steps which are necessary but not sufficient. Their goal is to be able to transform the raw information from course materials into a coherent body of acquired knowledge that can be used in new or different situations (e.g., work, subsequent courses, and experience outside the classroom). To do so, they need to communicate and interact with their instructors and peers for progress evaluation, assessment, consolidation and reflection. This learning process calls for a shift from the class-by-class focus to a long-term overview (i.e., a prerequisite means having the required knowledge and skill set rather than just a mark on transcripts). This fundamental attitude change is perhaps the most difficult for students who juggle classes on a short-term, last-minute, need-to-know basis.

A common misconception about active learning is that it is only needed in certain disciplines such as mathematics, science, and engineering. On the contrary, active learning is applicable to any discipline or field that calls for critical skill training, be it professional trade skill (e.g., truck driving, woodworking, sushi making) or creative arts and music (e.g., painting, singing, playing music instruments). Students in humanities and social sciences require critical thinking skills as much as, or perhaps even more than, mathematical and physical sciences, because they often face situations with no definite cut-and-dry answers and the quest for knowledge and truth is much more elusive.

Figure 1. Active Learning Goes Beyond Passive Learning



The notion of active learning can be traced back as far as ancient times in famous quotes of Socrates "The unexamined life is not worth living" (Plato's Apology), Plutarch "The mind is not a vessel to be filled, but a fire to be kindled," and Confucius "I hear and I forget, I see and I remember, I do and I understand."

Kolb (1983) developed his seminal theory of experiential learning to extend research work in education, philosophy, psychology, and physiology (e.g., Dewey, 1910, 1938; Lewin, 1951; Piaget, 1970). The term "experiential" was used to emphasize the key role of experience in the learning process, and to distinguish his approach from other theories of learning.

In brief, the experiential learning approach had two basic underlying assumptions, namely, people learn from concrete experience as well as from concepts and books, and people learn differently according to their preferred learning styles (Smith & Kolb, 1985, p. 11). The learning process comprised four basic building blocks: concrete experience, observations and reflections on that experience, formation of abstract concepts and generalizations, and finally testing implications of concepts in new situations. The building blocks were presented schematically as four stages following each other on a circular flow diagram known as the experiential learning cycle (Kolb & Fry, 1975). The approach had relevant implications for not only active learning in higher education but also for adult education and lifelong learning (Jarvis, 2004).

Using the experiential learning model, Kolb (Kolb, 1983, pp. 77-78; Smith & Kolb, 1985, pp. 13–17) constructed four basic learning styles from different combinations of dominant learning abilities as follows: (a) converger (abstract conceptualization and active experimentation) with strength in focused problem solving and decision making; (b) diverger (concrete experience and reflective observation) with strength in handling generation of alternative ideas and implications; (c) assimilator (abstract conceptualization and reflective observation) with strength in inductive reasoning, handling theoretical abstraction; and (d) accommodator (best on concrete experience and active experimentation) with strength in intuitive problem-solving through trial-and-error. These learning styles provided useful information about characteristics of learners. For example, students in economics, mathematics were assimilators while business majors tended to be accommodators (Kolb, 1983, p. 85).

SoTL in economics received a welcome boost from Rendigs Fels (1969) in his presidential address at the Southern Economic Association meeting in Washington DC. After reviewing the scarce literature on the subject at the time, Fels called for economic education as a new research field that uses economic methodology and quantitative methods to address issues of interest to the teaching and learning of economics.

Economists have gone beyond their own discipline to look for lessons from the literature in educational psychology (e.g., Kolb, 1983; Kolb & Kolb, 2009a, 2009b). Saunders (1998) reviewed learning styles (Smith & Kolb, 1986) and discussed the importance of student prior experience (learning set), motivation, visual aids, and active learning with special references to economics. Karns, Burton, and Martin (1994) examined six introductory economics textbooks in terms of educational objectives (Bloom, 1956).

Cameron (1998, 1999) suggested several classroom strategies for active and cooperative learning (e.g., one-minute quiz, question box, controlled class discussion, role playing, and group assignments) that can be applied to teaching economics. Chizmar and Ostrosky (1998) reported econometric evidence supporting the use of one-minute quizzes (Ruhl, Hughes & Schloss, 1987) to improve student performance. Truscott, Rustogi, and Young (2000) provided examples of the experiential learning techniques in teaching economic trade negotiations. Yamarik (2007) experimented with cooperative learning in small classes (22–35) of intermediate macroeconomics and found significant improvement in five measures of learning outcomes, namely, interest, preparation, participation, attendance, and mark performance.

However, changes were slow. In their comprehensive surveys of economics departments in the United States, Becker and Watts (1996, 2001) reported that 83% of class time were still conducted using the traditional “chalk-and-talk” lecture format with very little use (zero median response) of the pause procedure (one-minute quiz) for student self-assessment. Group assignments, computer games/simulations, and other cooperative learning techniques were rare. Economics instructors reported spending more time on teaching (60% on teaching in 2000 versus 50% in 1995) and less time on research (20% on research in 2000 versus 30% in 1995).

In addition, as modern economic theory had become highly technical, there was a need to prepare students with sufficient quantitative skills needed for their advanced curriculum or graduate school career. Although the focus was to teach quantitative economic reasoning rather than mathematical skills per se, economics instructors could still benefit from the highly successful Moore method of teaching mathematics (Chalice, 1995; Cohen, 1982; Whyburn, 1970; Zitarelli, 2004).

Conceived by Robert Lee Moore, a young graduate student in mathematics at the University of Chicago (1903-1905), this labor-intensive teaching method was a precursor of the active learning approach. A Moore class typically comprised average students, not exceptionally gifted ones. They did not have textbooks (or were even not allowed to read textbooks). Instead, they were given a list of theorems and results that they were expected to know from the course curriculum.

Under the watchful eye of the instructor, the class struggled through the course to actually “do mathematics” and reproduced these results by themselves, rather than getting them from textbooks. This labor-intensive teaching method thus introduced students to not only a higher form of active learning but also provided them with a first-hand training in doing original research at an early age. Students were not told that they were learning to do research. Instead, they were simply told to learn the “enjoyment of doing mathematics” and “class participation.” Many graduates of Moore classes later became excellent researchers. This active learning technique perhaps could be modified to suit the focus and ability of students in economics as well.

Recently, the Good Questions project (http://www.math.cornell.edu/~GoodQuestions/) at Cornell University aimed at promoting a more active learning environment in teaching first-year calculus. The point of the project was to craft “good” questions that required no mechanical computation and yet could relate to student experiences, stimulated interest and curiosity in mathematics, led to lively classroom discussions with opportunities to make conjectures and argue about their validity, and provided instructors with timely assessments of what the class was learning. The project was successful with eye-opening experiences for both students and instructors about active learning.

Learning Technology

The changing landscape at many universities and colleges in North America can thus be summarized by a few key factors: faculty shortage, high enrollment, online technology, and the arrival of the Net generation of tech-savvy students. Seeing this market opportunity, publishers positioned themselves as instructional media content providers in addition to the traditional paper-based publishing house image. They offered instructional products aiming at instructors teaching large classes mostly at introductory levels. In this paper, we focused on two popular learning technology systems, namely, MyEconLab and Aplia. There was also Lyryx (http://www.lyryx.com) from McGraw-Hill Ryerson which came to our attention too late to be included in the study.

Online learning technology was a recent addition and hence, was not included in the earlier comprehensive surveys by Becker and Watts (1996, 2001). There was a small but growing literature on learning technology in economic education. For example, Pozo and Stull (2006) used Aplia in introductory economics (for math skill reviews only) and found a statistically significant gain of 2 percentage points in marks. The gain was most noticeable for students at the lower end of the mark distribution. The implication was that weaker students could benefit the most from technology provided they were willing to do the work required.

Structure of Learning Technology

The traditional computer-aided instructional (CAI) software was designed to help students learn course materials (e.g., simple graphs, numerical exercises, model simulation). The software ran on old computers with command-line or crude graphical interfaces. Besides being crude and simple, its most serious drawback was that students generally studied in an isolated environment with little or no contacts with instructors, peers or the outside world.

The situation changed with the arrival of the new generation of learning technology and course management systems. These systems were built for modern computer hardware and could run much faster with extensive graphical capabilities (e.g., videos and complex diagrams), enhanced user inputs (e.g., mathematical symbols and equations), and fast connection to the Internet.

The key feature that set this modern learning technology apart from CAI software was its *ability to service both students and instructors within an integrated environment*, and hence, tended to the needs of both the learning and teaching sides of the classroom at the same time.

The learning side had the following modules to help students set up a learning environment suitable to their tastes or learning styles:

(a) the learning modules provided supplementary expositions of course materials on topics taken from the curriculum or a pre-adopted textbook;

(b) the review modules provided a self-testing facility in which students could assess their own progress as often as they needed; in addition, the redo option had an advantage over the traditional classroom by the fact that individual attention and timely feedback to students did not have to be constrained by instructor time or availability;

(c) the communication modules provided interaction with peers and instructors as well as the Internet (see Figure 2).

Similarly, the teaching side had the following modules to help instructors set up a teaching environment suitable not only to their tastes and teaching styles but also to the academic ability of their students:

(a) the editing modules provided editing tools to create and revise learning modules;

(b) the assessment modules provided testing tools to build exams with canned questions or custom-made questions of their own; in addition, exam questions could be randomized in different ways including structural and numerical changes;

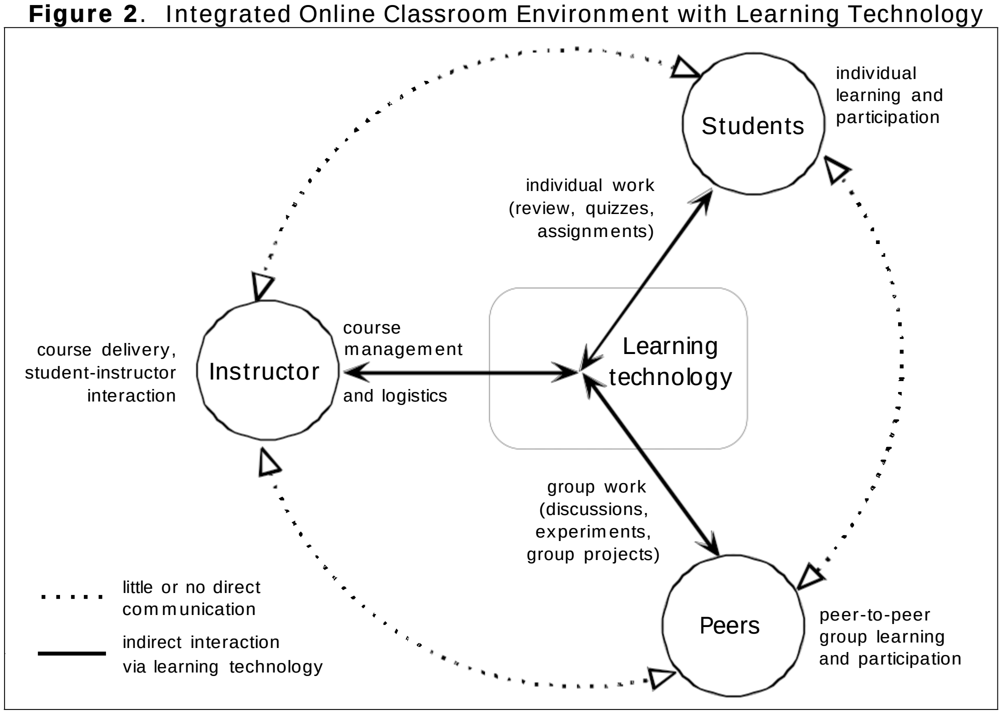
(c) the communication modules provided interactions with the entire class or individual students, e.g., class announcements, questions and answers, or private concerns (see Figure 2);

(d) the course management systems automated the processing of exams, markings, and various administrative tasks of class management.

Background on MyEconLab
MyEconLab (http://www.myeconlab.com) is the economics portion of the My…Lab series of learning technology products marketed by Pearson Education. Students get online access to the software when they buy adopted textbooks in introductory economics (Abel, Bernanke & Croushore, 2008; Lipsey, Ragan & Storer, 2008; Parkin, 2008). Learning technology for courses beyond introductory level (e.g., introductory statistics, intermediate economic theory, and international economics) begin to appear as well.

The MyEconLab web site has separate work areas for students and instructors. For students, there are learning modules to explain course materials with computer graphics, multimedia content, and numerical calculations. There are also planning and review modules (calendar, study plan, homework, quizzes and tests) to coach students into the habit of active learning mode with regular practice exercises for tryouts as well as real quizzes and tests for marks. In particular, the result module provides instant feedback on student progress which is much faster than the traditional manual marking by instructors or teaching assistants.

Figure 2. Integrated Online Classroom Environment with Learning Technology



For instructors, MyEconLab provides an integrated course management system with various administrative modules (course manager, homework manager, quiz and test manager, grade book, announcement manager and resources). Thus, MyEconLab functions both as a multimedia online teaching framework and a computerized course management system (e.g., WebCT, Angel). In addition, there are tools for instructors to survey questionnaires for student evaluations.

Instructors reported favorable experiences with MyEconLab not only in first-year economics but also for MBA students needing a crash course in introductory economics (Kayahan, 2008; Ryan, 2008; Speckler, 2007). Their satisfaction with MyEconLab came from the help they get in dealing with the constraint of limited instructor time and increased class sizes.

Background on Aplia

Aplia (http://www.aplia.com) was founded by Stanford economist Paul Romer as an educational technology firm with a special interest in promoting student learning and engagement. Similar to Pearson Education, Aplia has extended its product line beyond economics to cover a wider range of subjects (e.g., accounting, business communication, finance, and statistics). Since the focus of this paper is on economics, we will refer to "Aplia for Economics" simply as Aplia.

Other than specific details on the user interface, Aplia is generally similar to MyEconLab in its dual functionality for learning and teaching. Students have active learning modules (live economic experiments, animated math tutorials and exercises, news analysis exercises, and student blog) for course work while instructors have their teaching modules (My courses, assignment library, course outline, course materials, announcements, administration) for course management and administration. An additional product differentiation feature of Aplia is that instructors have a built-in discussion group (professor discussion) to exchange ideas with other instructors (including Paul Romer, the creator of Aplia).

Like MyEconLab, responses from adopted instructors have been favorable (Kennelly & Duffy, 2007; O'Dea & Ring, 2008; Talley, 2005). For example, in a first-year economics class of 700 students at Galway, Ireland, 89% responded that Aplia assignments had a positive effect on their overall understanding of the course (Kennelly & Duffy, 2007).

Teaching Environment

We briefly describe the teaching environment in which our experiments with learning technology were conducted. The school was in the mid-size range with about 25,000 undergraduates and 4,000 graduate students studying arts, engineering, environment, mathematics, and sciences.

The department of economics offered first-year principles courses to economics majors as well as non-majors. Class sizes were recently capped at 250 students per section (up from 100) based on enrollment forecasts, space capacity, and room allocation. Courses were offered in 3 terms all year round with 5–7 sections per term. In total, each year there were about 6,000 students taking both macro and micro, including about 800 students taking online courses instead of the traditional "brick and chairs" classrooms on campus.

Both regular faculty and sessional lecturers shared the job of teaching first-year courses. They made their own decisions on course organization (e.g., text selection, teaching styles, lectures, and exam formats). Most adopted Canadian versions of popular texts used in the United States (Parkin & Bade, 2006a, 2006b; Mankiw et al., 2008) with or without the accompanied study guides. Some had their own texts or did not use texts at all. Because of the large number of students, all exams were in multiple-choice format and processed by scanners and computers.

Instructional supports from the department included teaching assistants and office services (e.g., printing exams and course materials). Most instructors used teaching assistants for proctoring exams, especially in large classes, but handled the teaching by themselves. Instructional supports from the university came from a teaching resource center which offered library resources, training seminars, distinguished guest lectures, teaching grant programs, and an annual best teacher award.

Teaching Experiment with MyEconLab

There were 12 introductory micro classes of 2,629 students in two consecutive years 2007-2008. In order to be as close to a controlled experiment as possible, we arranged to have the same instructor with the same textbook (Parkin & Bade, 2006b), course structure, marking scheme, exam format, class room and schedule. The main difference was that four classes used MyEconLab as optional with no marks assigned (to avoid introducing incentive effects) while the other eight classes did not use MyEconLab. The experimental unit was chosen to be a class, rather than an individual student.

In comparison, classes with MyEconLab (even on an optional basis) had a boost of 2.12 percentage points (72.67% versus 70.55%) in class averages over those without it (see Table 1). The median marks were also higher with MyEconLab (74% versus 72%). The differences in means were statistically significant at 5% level for the two groups.

Table 1. Mark Performance With and Without MyEconLab

Introductory Micro	With MyEconLab	Without MyEconLab	Difference
Average class sizes	236	211	25
Average marks	72.67%	70.55%	2.12%
Median marks	74.00%	72.00%	2.00%
Standard deviations	12.90%	13.43%	-0.53%

Although it is difficult to pinpoint the contributing sources of the 2.12% statistically significant mark increase, the result suggested that MyEconLab could have some positive effect on student mark performance.

In addition, since MyEconLab was used as an optional component of the course, it was likely that the better students are more willing to use it to get the extra benefit of their additional learning effort. Even if this was what actually has happened, there was still a case for using learning technology like MyEconLab to encourage students to study more and improve their mark performance. The opportunities to learn more were exactly what were missing in the over-crowded traditional classroom environment that modern learning technology was trying to offer to fill the gap.

Teaching Experiments with Aplia

In this experiment, there were six introductory macro classes of 1,392 students in three consecutive years 2006-2008. Again, all classes had the same textbook (Mankiw et al., 2006), course structure, exam format, class room and schedule. The difference this time was that two classes used Aplia as required (worth 10% in the marking scheme) while the other four classes did not use Aplia at all.

In comparison, the classes with Aplia showed a statistically significant boost of 1.81% percentage points (73.93% versus 72.12%) in class averages over those without it (see Table 2). The median marks were higher as well (76% versus 73%). The differences in means were again statistically significant at 5% level for the two groups.

Table 2. Mark Performance With and Without Aplia

Introductory Macro	With Aplia	Without Aplia	Difference
Average class sizes	239	229	10
Average marks	73.93%	72.12%	1.81%
Median marks	76.00%	73.00%	3.00%
Standard deviations	11.35%	10.90%	0.45%

In summary, the experiments showed that learning technology, such as MyEconLab and Aplia, contributed a small, but statistically significant, increase of 2% mark averages. The results were about the same regardless whether the technology was used as required or optional course components, or whether the course subject was micro or macro economics.

Student Responses

Our surveys of two introductory macro economics classes during the Spring term of 2008 revealed some interesting facts about student responses to the use of learning technology. Although the surveyed classes happened to use Aplia at the time, we believed that the student responses reflect a general attitude towards learning technology rather than any specific software, be it Aplia or MyEconLab.

It is worth noting that in these surveys, Aplia was used as a required component of the course with two different weights in marks: 10% of the total course mark for Aplia use in one class (light-use) versus 25% of the total course mark in the other class (heavy-use). It was interesting to see that students reacted differently towards these different rewards for using the technology.

Table 3 presented general information about student characteristics and backgrounds. We saw that female students represented a significant proportion of the class (between 42.5% and 61%) and the proportion of visa students could be as high as one-third of the class (between 17% and 33%). More than half of the classes had studied economics before (perhaps the introductory micro course or high school economics). The last three pieces of information:

- only half of the classes or less were first-year students;
- the classes were dominated by students from mathematics, engineering and science;
- more than half of the classes had a heavy load of five courses

confirmed that there were upper-year co-op students in technical programs returning to school after a work term in the winter. These were hard-working, highly-motivated, and more mature students.

Table 3. Student Backgrounds

	Aplia 10%	Aplia 25%
Sample size	80	41
Female students	42.50%	60.98%
Visa students	32.91%	17.07%
Had introductory economics before	56.25%	51.22%
First-year students	50.00%	39.02%
From math/engineering/science	96.25%	68.30%
Heavy course loads (5 courses)	53.75%	58.54%

Table 4 revealed interesting information about study habits of the students. They attended classes regularly and hence, read textbooks only when needed for assignments, quizzes or exams. In addition, they preferred to study independently and alone, rather in groups. This was consistent with the learning styles of convergers (engineering) and assimilators (mathematics, science) that were less interested in people and more concerned with abstraction (Smith & Kolb, 1985, p. 16).

Table 4. Study Habits

	Aplia 10%	**Aplia 25%**
Attend classes regularly	74.68%	60.98%
Prefer to study alone	75.95%	78.05%
Read textbooks only when needed	60.76%	56.10%
Find the review questions helpful	59.40%	39.02%

Table 5 showed that Aplia was new to almost all students in the classes. It was worth noting that students responded differently according to the weights assigned to Aplia in the marking scheme. For example, if more marks were assigned to Aplia (25% versus 10%), more students would think that Aplia helps them get better marks in assignments, quizzes, midterms as well as in final exams. In addition, twice the number of students (70% versus 33%) felt that Aplia was worth the extra cost in the heavy-use class (Aplia 25%) compared to the light-use class (Aplia 10%). This was not surprising as marks were often considered the currency in the classroom.

Table 5. Experience with Learning Technology

	Aplia 10%	**Aplia 25%**
Never used Aplia before	96.15%	82.93%
Help getting better marks in assignments/quizzes/midterms	50.60%	70.00%
Help getting better marks in final exams	45.45%	60.00%
Worth the extra cost	32.89%	70.00%

Table 6 gave a glimpse of how students spent time with the learning technology for their classes. For example, the pattern of time usage of Aplia was about the same between “one hour per week” (33.33%–26.83%) and “only when needed for assignments, quizzes, or exams” (38.46%–34.15%). A small number of dedicated students (5.13%–7.32%) used the software as often as 3 hours per week or more.

Table 6. Time Usage

	Aplia 10%	Aplia 25%
Use Aplia 1 hour per week	33.33%	26.83%
Use Aplia 2 hours per week	23.08%	31.71%
Use Aplia 3 hours per week	5.13%	7.32%
Use Aplia only when needed for assignments/quizzes/exams	38.46%	34.15%

Table 7 probed into the types of questions that students found most helpful in Aplia. The surveys showed that the questions students found most helpful to them were those about theory (39.47%–31.71%) and assignments (38.16%–31.71%). Both types of questions ranked at the top of the list. This underlined the importance of knowing the theory before or while attempting problem-solving tasks required by the assignments. In other words, the students thus followed the loop between acquisition of information and production of assignment along McDowell's (2008, p. 426) pathways to assignments.

Table 7. Most Helpful Questions

	Aplia 10%	Aplia 25%
Questions about theory	39.47%	31.71%
Questions about definitions	11.84%	4.88%
Questions about graphs	10.53%	31.71%
Questions about assignments	38.16%	31.71%

This interesting result brought us back to the point made by Bergstrom and Varian (1989) about the need for students in economics to do more problems and exercises (see the quote at the beginning of the Introduction section). Active learning required students not only understand the theory and concepts but also be able to apply them in new or different situations (e.g., homework assignments). The significant ratings of both questions about theory and assignments as most helpful meant that they were working on the link between theory and applications. Modern learning technology thus had given them the opportunities to practice active learning and problem-solving skills which otherwise would not be available in the current over-crowded traditional classroom settings.

Summary and Conclusion

In summary, this paper attempted to address the important issue of active learning in teaching introductory economics given the current high enrollment environment. Our results suggested that modern learning technology, such as MyEconLab and Aplia, could made a difference in helping students improve their class mark averages by a small but statistically significant amount of 2% regardless whether the technology was used a required or optional course component, and whether the course subject is macro or micro economics.

We found that students responded more favorably to learning technology especially when it was given more weights in the marking scheme. This response could have been applicable to any course component introduced by the instructor, not just learning technology alone. More importantly, learning technology offered a complex multi-lateral classroom structure involving four groups of interactive participants (student, instructor, peers, and technology) compared to the traditional one-on-one student-instructor relationship.

From our own experience, technical problems such as software bugs, program glitches, and implementation issues were unavoidable. For example, MyEconLab required plug-ins for key modules such as PowerPoint Viewer and Real Player. Students complained that the plug-ins took too long to install in Windows, and did not work on Mac machines. In addition, for security reasons, the plug-ins were removed as soon as they got off the university computer network, and the next time they logged in, they had to go through the installation process again. While Aplia did not have the problems of installing plug-ins on local machines, it had its own share of software headaches. For example, students complained that the diagrams did not load properly, and more importantly, assignments were out of synchronization with lectures (e.g., assignments were due even before associated lectures were made available). These problems have been resolved with recent updates by both MyEconLab and Aplia.

Although MyEconLab and Aplia could, in theory, be used with any third-party textbook, they usually worked best only with the textbooks that they were originally designed to support. As a result, textbooks became either MyEconLab-supported or Aplia-supported, but not both, and instructors faced the tough choice of textbooks or software, but not both. In some exceptional cases, the same textbooks, especially the highly popular ones (e.g., Bade & Parkin, 2007; Parkin, 2008) were supported by both MyEconLab and Aplia. This could open up the possibility of an interesting controlled experiment of two classes using the same textbook but different learning technology.

We were aware that we were only scratching the surface under which many interesting and important issues still remained to be explored. For example, although we have found that learning technology can make a difference in student performance, we must go deeper to investigate the effects of various contributing factors such as learning effort, characteristics, experience, and academic background. Furthermore, we also need to look further into the question of how the traditional labor-intensive teaching style can be used in conjunction with this new generation of learning technology. Only then can we direct limited teaching resources to areas that students need our help the most. This paper is a first step in this direction.

References

Abel, A. B., Bernanke, B. S., & Croushore, D. (2008). *Macroeconomics 2008-2009* (6th ed.). New York: Addison-Wesley.

Bade, R., & Parkin, M. (2007). *Foundations of Economics* (3rd ed.). New York: Addison-Wesley.

Becker, W. E. (1998). The use of mathematics and statistics in the teaching and learning of economics. In W. B. Walstad & P. Saunder (Eds.), *Teaching undergraduate economics: A handbook for instructors* (pp. 127–139). New York: McGraw-Hill.

Becker, W. E., & Watts, M. (1996). Chalk and talk: A national survey of teaching undergraduate economics. *American Economic Review*, 86(2), 448–453.

Becker, W. E., & Watts, M. (2001). Teaching methods in U.S. undergraduate economics courses. *Journal of Economic Education*, 32(3), 269–279.

Bergstrom, T. C, & Varian, H. R. (1999). *Workouts in intermediate microeconomics* (5th ed.). New York: W. W. Norton.

Bloom, B. S. (1956). *Taxonomy of educational objectives: The classification of educational goals* (B. S. Bloom, Ed.). New York: David McKay Co.

Bosshardt, W. (2004). Student drops and failure in principle courses. *Journal of Economic Education*, 35(2), 111–128.

Cameron, B. J. (1998). Active and cooperative learning strategies for the economics classroom. In W.B. Walstad & P. Saunder (Eds.), *Teaching undergraduate economics: A handbook for instructors* (pp. 245–256). New York: McGraw-Hill.

Cameron, B. J. (1999). *Active learning* (Green Guide No. 2). Halifax, NS: Society for Teaching and Learning in Higher Education.

Chalice, D. R. (1995). How to teach a class by the modified Moore method. *American Mathematical Monthly*, 102(4), 317–312.

Chizmar, J., & Ostrosky, A. (1998). The one-minute paper: Some empirical findings. *Journal of Economic Education,* 29(1), 3–10.

Cochran, L. H. (1989). *Administrative commitment to teaching*. Cape Girardeau, MO: Step Up, Inc.

Cohen, D. W. (1982). A modified Moore method for teaching undergraduate mathematics. *American Mathematical Monthly*, 89(7), 473–474, 487–490.

Cohen, E., & Cohn, S. (1994). Graphs and learning in principles of economics. *American Economic Review*, 84(2), 197–200.

Dewey, J. (1910). *How we think*. Boston: D. C. Heath.

Dewey, J. (1938). *Experience and education*. West Lafayette, IN: Kappa Delta Pi.

Ehrlich, E. H. (1961). *How to study better and get higher marks*. New York: Thomas Y. Crowell Company.

Fels, R. (1969). Hard research on a soft subject: hypothesis-testing in economic education. *Southern Economic Journal*, 36(1), 1–9.

Finnie, R., & Qiu, T. (2009). *Moving through, moving on: Persistence in post-secondary education in Atlantic Canada — Evidence from the PSIS*. Ottawa: Statistics Canada, Centre for Education Statistics.

Gilbert, S. (1995, April). *Quality education: Does class size matter?* AUCC Research File, 1(1). Ottawa: Association of Universities and Colleges of Canada. Retrieved November 12, 2009 from AUCC Web site: http://www.aucc.ca/_pdf/english/publications/researchfile/1995-96/vol1n1_e.pdf

Iaria, G., & Hubball, H. (2008). Assessing student engagement in small and large classes. *Transformation Dialogues: Teaching and Learning Journal*, 2(1), 1–8.

Jarvis, P. (2004). *Adult education and lifelong learning. Theory and practice* (3rd ed.). London: RoutledgeFalmer.

Karns, J. M. L., Burton, G. E., & Martin, G. D. (1983). Learning objectives and testing: An analysis of six principles of economics textbooks, using Bloom's taxonomy. *Journal of Economic Education*, 14(3), 16–20.

Kayahan, C. B. (2008, June). Utilizing MyEconLab in the classroom. Paper presented at the Ahead of the Curve Workshop of Pearson Education Canada, Niagara-on-the-Lake, ON.

Kennelly, B., & Duffy, D. (2007, September). Using Aplia software to teach principles of economics. Paper presented at the 2007 Developments in Economics Education Conference, Cambridge, UK. Retrieved October 17, 2009 from DEE Web site: http://www.economicsnetwork.ac.uk/dee2007/presentations/kennelly_aplia.ppt.

Kolb, A., & Kolb, D. A. (2009a, June). *Experiential learning theory bibliography* (Vol. 1, 1971–2005). Retrieved November 14, 2009 from EBLS Web site: http://www.learningfromexperience.com/images/uploads/Bibliography_1971-2005.pdf.

Kolb, A., & Kolb, D. A. (2009b, June). *Experiential learning theory bibliography* (Vol. 2, 2006–2009). Retrieved November 14, 2009 from EBLS Web site: http://www.learningfromexperience.com/images/uploads/Bibliography_2006-2009.pdf.

Kolb, D. A. (1983). *Experiential learning: Experience as the source of learning and development*. Englewood, NJ: Prentice-Hall.

Kolb, D. A., & Fry, R. (1975). Towards an applied theory of experiential learning. In C. L. Cooper (Ed.), *Theories of group processes* (pp. 33–37). London: Wiley.

Kumar, K. (1992). Does class size really make a difference? Exploring classroom interaction in large and small classes. *RELC Journal*, 23(1), 29–47.

Lewin, K. (1951). *Field theory on social sciences*. New York: Harper & Row.

Lipsey, R. G., Ragan, C. T. S., & Storer, P. (2008). *Economics* (13th ed.). New York: Addison-Wesley.

Lowman, J. (1995). *Mastering the techniques of teaching* (2nd ed.). San Francisco: Jossey-Bass.

Mankiw, N. G., Kneebone, R. D., McKenzie, K. J., & Rowe, N. (2006). *Principles of Macroeconomics* (3rd ed.). Toronto: Nelson.

McDowell, L. (2008). Negotiating assignment pathways: Students and academic assignments. *Teaching in Higher Education*, 13(4), 423–435.

OCUFA (Ontario Confederation of University Faculty Associations). (2008a, October). *Enrolment increases* (Briefing Note). Retrieved October 17, 2009 from OCUFA Web site: http://www.ocufa.on.ca/OCUFA/docs/issues/bn_enrolment_oct08.pdf.

OCUFA (Ontario Confederation of University Faculty Associations). (2008b, October). *Faculty shortages* (Briefing Note). Retrieved October 17, 2009 from OCUFA Web site: http://www.ocufa.on.ca/OCUFA/docs/issues/bn_facultyshortage_oct08.pdf.

O'Dea, W. P., & Ring, D. W. (2008). *The impact of Aplia on student performance in intermediate microeconomics theory*. Paper presented at the American Economic Association Annual Meeting, New Orleans, LA.

Pallack, B. (2009, November 8). Teaching to the masses at UA. *Arizona Daily Star*. Retrieved November 10, 2009 from AzStarNet Web site: http://www.azstarnet.com/sn/printDS/316700.

Parkin, M. (2008). *Economics* (8th ed.). New York: Addison-Wesley.

Parkin, M., & Bade, R. (2006a). *Macroeconomics: Canada in the Global Environment* (6th ed.). Toronto: Addison-Wesley.

Parkin, M., & Bade, R. (2006b). *Microeconomics: Canada in the Global Environment* (6th ed.). Toronto: Addison-Wesley.

Piaget, J. (1970). *Genetic epistemology*. New York: Columbia University Press.

Pozo, S., & Stull, C. A. (2006). Requiring a math skill unit: Results of a randomized experiment. *American Economic Review,* 96(2), 437–441.

Ryan, M. J. (2008, June). *Observations on using MyEconLab in principles courses*. Paper presented at the Ahead of the Curve Workshop of Pearson Education Canada, Niagara-on-the-Lake, ON.

Ruhl, K. L., Hughes, C. A., & Schloss, P. J. (1987). Using the pause procedure to enhance lecture recall. *Teacher Education and Special Education*, 10(1), 14–18.

Saunders, P. (1998). Learning theory and instructional objectives. In W. B. Walstad & P. Saunder (Eds.), *Teaching undergraduate economics: A handbook for instructors* (pp. 85–108). New York: McGraw-Hill.

Smith, D. M., & Kolb, D. A. (1985). *User's guide for learning-style inventory: A manual for teachers and trainers*. Boston: McBer.

Speckler, M. D. (2007). *Ahead of the curve: A report on the success of MyEconLab*. Toronto: Pearson Education. Retrieved October 4, 2008 from MyEconLab Web site: http://www.myeconlab.com/success/ahead_of_the_curve.pdf.

Talley, D. A. (2005). *Teaching and technology: Learning in a high-tech environment revisited*. Paper presented at the American Economic Association Annual Meeting, Philadelphia, PA. Retrieved October 4, 2008 from DSU Web site: http://www.homepages.dsu.edu/talleyd/papers/TalleyTeachingandTechnology2.pdf.

Tapscott, D. (2009). *Grown up digital: How the net generation is changing your world*. New York: McGraw-Hill.

Truscott, M. H., Rustogi, H., & Young, C. B. (2000). Enhancing the macroeconomics course: An experiential learning approach. *Journal of Economic Education,* 31(1), 60–65.

Whyburn, L. S. (1970). Student oriented teaching: The Moore method. *American Mathematical Monthly,* 77(4), 351–359.

Yamarik, S. (2007). Does cooperative learning improve student learning outcomes? *Journal of Economic Education*, 38(3), 259-265,268-269,273,275-277.

Zitarelli, D. E. (2004). The origin and early impact of the Moore method. *American Mathematical Monthly*, 111(6), 465–486.