Johnson & Wales University
ScholarsArchive@JWU

Humanities Department Faculty Publications & Research

College of Arts & Sciences

2013

Effectiveness of active learning in the arts and sciences

David Mello
Johnson & Wales University - Providence, dmello@jwu.edu

Colleen A. Less
Johnson & Wales University - Providence, colleen.less@jwu.edu

Follow this and additional works at: https://scholarsarchive.jwu.edu/humanities_fac

Part of the Cultural History Commons, History of Science, Technology, and Medicine Commons, Other History Commons, Political History Commons, Social History Commons, and the United States History Commons

Repository Citation

Effectiveness of active learning in the arts and sciences.

David Mello and Colleen A. Less

Department of Mathematics, and Department of Legal Studies, Johnson & Wales University, Providence, Rhode Island, U.S.A.

Background: The overall effectiveness of active learning techniques in the college classroom has been the subject of much research over the past several years. The vast majority of these studies have confined themselves to measuring the effectiveness of active learning techniques in specific academic courses or disciplines. An important question, however, is whether the effectiveness of active learning techniques carries over to a broad range of academic courses; those typically taught as part of a traditional Arts and Sciences curriculum.
Purpose: The aim of this study was to quantify the effectiveness of active learning techniques, when compared to traditional lecture model, over a broad range of academic courses in the Arts and Sciences.
Sample: A total of 817 students participated in this study. 384 students formed the control group (lecture-only), and 433 students comprised the treatment group (active learning).
Design and methods: Within each of the academic disciplines participating in the study, students in both groups were given the same pretest, and the same post-test. The test instruments were standardized within each academic discipline. The mean gain in overall test scores, and the standard deviations of those mean gains were calculated for each academic discipline, and on an aggregate basis.
Results: The average gain in the standardized test scores of active learners were significantly higher than traditional learners. Also, active learners exhibited less variability in their gains in academic performance than traditional learners.

Keywords: active learning; effectiveness; arts and sciences; achievement; benefits; outcomes

Introduction

"Active learning" as a pedagogical approach is by no means a novel concept. Colleges and universities throughout the country began exploring a more involved approach to instruction after having criticism of more passive teaching methods leveled at those institutions during the nineteen eighties. (Meyers and Jones, 1993). Responding to the criticism, educators began to hearken back to the days of Socrates, when education actually involved the student in the learning process. (Meyers and Jones, 1993).

So, what is active learning? While a single, generally agreed upon, definition of active learning does not exist, it is safe to say that active learning is characterized by a marked departure from the traditional lecture format, where students passively receive information, towards an approach which induces specific student engagement and activity in learning (Prince, 2004). An examination of the literature reveals that *active learning* is usually defined as a set of specific instructional methods that promote greater student involvement and responsibility for learning than traditional instructional approaches (Bonwell and Eison, 1991). The key ingredient to active learning is some structured activity that significantly increases the level of student engagement in the learning process. Ideally, a concomitant benefit of active learning is a shift in the role of the typical instructor as a "knowledge provider" to that of a guide, gently directing the student's attention to key landmarks along his intellectual journey. In other words, active learning is the antithesis of the classroom lecture, where educators talk and students listen. (Meyers and Jones, 1993)

Most active learning strategies fall into one or more of three general categories: collaborative learning, cooperative learning, and problem-based learning. Collaborative learning and cooperative learning are similar. Both focus upon the importance of interactions between students who are members of small groups. The goal of collaborative and cooperative learning is to shift learning from a solitary activity

performed by students in isolation to students engaged in a group activity. Typically, members of such groups collaborate or cooperate in an effort to complete a specific instructor-assigned task or goal (Cusea, 1992). These instructional strategies share the key characteristic of promoting a relatively high level of student interaction. In cooperative learning, however, less emphasis is placed upon student competition, and more emphasis is afforded to the achievement of the cooperative group as a whole.

On the other hand, problem-based learning is an instructional strategy where the material to be learned is first couched as a problem at the outset of the instructional process, ostensibly to provide motivation and context for subsequent instruction (Prince, 2004).

Over the past several years, a significant amount of research has been conducted in order to measure the effectiveness of active learning techniques in a host of academic disciplines   Needless to say, these studies have led to mixed results for a variety of reasons. Firstly, the methods of measuring purported gains due to active learning vary from study to study. For example, many studies attempt to determine whether reported gains due to the implementation of active learning techniques are statistically significant via the calculation of *effect sizes*. Here, one calculates the difference in the means of the test group and the control group, and then divides this result by the pooled standard deviation of these two populations.

Some researchers, such as Albanese (Albanese, 2000) and Cohen (Cohen, 1977) support the use of effect sizes to measure the significance of reported gains due to active learning. In fact, Cohen set forth a classification- scheme where he characterized effect sizes of 0.2, 0.5, and 0.8 respectively, as small, medium, and large gains in learning. Other researchers, such as Colliver (Colliver, 2000), have argued that effect sizes only greater than or equal to 0.8 should be considered as significant.

Secondly, the vast majority of previous studies have attempted to measure the effectiveness of *specific* active-learning activities; these activities have encompassed a broad spectrum of specific learning activities that may be viewed as falling under the headings of cooperative learning, collaborative learning, and problem-based learning previously discussed. In some cases, the purported gains or lack of gains may have had more to do with measuring the *appropriateness* of the active-learning strategies employed in the context of academic learning task at hand, rather than measuring the effectiveness of active learning itself.

Finally, the inherent complexity of the learning process makes it difficult to truly assess the overall benefits associated with active learning. As Prince (Prince, 2004) has correctly pointed out, the institution of any given method of instruction may affect a host of learning outcomes such as student retention, student attitudes towards the course material, the acquisition of specific skills connected with the learning tasks at hand, and retention of knowledge. Consequently, it is safe to say that what may be reported as a significant gain in connection with one learning outcome may also be accompanied by insignificant gains in other, concomitant outcomes associated with the same study.

Method

Over the course of two years, a total of 817 students, enrolled in courses in the John Hazen White School of Arts & Sciences, participated in this study. The participants attended courses offered by faculty from a diverse group of academic departments that included   Economics, English, English as a Second Language, Humanities, Mathematics, Social Sciences, and Science. The average class size was about 30 students. From the total number of 817 student participants, 384 formed the control group (lecture-only), and 433 students comprised the treatment group (active learning).

The primary goal of the study was to measure whether the level of student involvement and responsibility for learning had a significant effect on learning outcomes. Consequently, a great deal of freedom was intentionally given to each instructor relative to the choice of active-learning activity they employed. Each instructor was given a menu of standard active-learning activities and was asked to employ the active-learning activity he or she deemed most appropriate in the teaching of a single learning module. Each learning module was an integral part of the standard course outline for the course being taught.

The chief requirement of instructors participating in the study was that the active-learning method selected by each instructor must significantly increase the level of student involvement in the learning process—placing more responsibility for learning on the student, rather than upon the instructor. During each 55 minute class meeting, the active-learning activity was to consume a minimum of about 40 minutes..

In order to measure the effect of active learning within each academic discipline, students in both the control groups and the treated groups were given the same pretest and the same post-test. Each pretest and post-test were multiple-choice exams, consisting of no less than ten questions. The mean gains in overall test scores, and the standard deviations of those mean gains were calculated for each academic discipline, and on an aggregate basis. This information appears Table-1 and Table-2, below.

Table-1. Sample sizes, mean gains, and standard deviations for students in the control groups.

Discipline	Sample Size	Mean Gain	Standard Deviation
Economics	136	31.82	22.76
English	39	15.69	24.66
ESL	64	19.11	23.13
Humanities	14	35.00	15.57
Mathematics	61	12.46	19.03
Social Sciences	31	14.84	18.95
Science	39	23.46	21.54
Totals:	384	22.89	23.11

Table-2. Sample sizes, mean gains, and standard deviations for students in the treated groups.

Discipline	Sample Size	Mean Gain	Standard Deviation
Economics	192	30.67	22.88
English	42	20.71	24.66
ESL	30	50.77	29.68
Humanities	20	31.50	29.79
Mathematics	66	39.17	24.55
Social Sciences	36	26.39	20.02
Science	47	28.09	15.44
Totals:	433	31.79	24.21

Results

The reader will first note that when the data is analyzed by academic discipline there is considerable variability in the mean gains of both the treated and control groups. With the exception of economics and humanities courses, the mean gains of students in the treated groups (active learning) were higher than those in the corresponding control groups (lecture-only).

Based upon the above information, the effect sizes corresponding to each academic discipline were calculated and appear in Table 3. Employing the language of Cohen (Cohen, 1977), we found "small" gains in the areas of English and Science, a "medium" gain in the Social Sciences, and "large" gains in the areas of ESL and Mathematics.

The combined effect size of 0.38 (when all disciplines are considered at the same time) indicates that a gain in learning was prevalent, falling somewhere between Cohen's "small" and "medium" gains. The overall effect was somewhat in line with the level of effect attributed to previous studies that examined problem-based learning (Colliver, J., 2000).

In order to determine whether the mean gain in test scores was statistically significant, a confidence-interval calculation and hypothesis test were performed on the combined data. Due to the high variability of the mean gains (or losses) within individual academic disciplines, similar calculations (on the departmental level) shed little light on the data, and hence, they were not reported.

Table 3. Effect sizes corresponding to each academic discipline.

Discipline	Effect Size
Economics	-0.04
English	0.16
ESL	1.26
Humanities	-0.14
Mathematics	1.37
Social Sciences	0.60
Science	0.25
All Disciplines Combined:	0.38

Relative to the confidence interval calculation for the *combined data*, it was determined that with a probability of 95%, the mean gain in test scores was between 5.65 and 12.15 points higher for active learners than for their counterparts in the control group. Stated differently, the mean gain in test scores was somewhere between one-half a letter-grade to slightly more than one full letter-grade.

A one-tailed hypothesis test was performed for the combined data. The particular type of test employed was a standard z-test for comparing means from two independent populations (Bluman, 2012). The results of this test were quite encouraging, and gave a calculated test-statistic (z = 5.36) which fell well into the rejection region. We concluded that the null hypothesis could be safely rejected, and that the average gain in test scores associated with active learning are *significantly higher* than those associated with the traditional lecture format.

In terms of the *variability* of the mean gains in test scores, a simple calculation reveals that the coefficient of variation for traditional learners was 100.96%, while that for active learners was only 76.16%. Thus, there was less variability (or more consistency) in the gains to academic performance for active learners than for traditional learners.

We now turn the reader's attention to Figure-1 and Figure-2, where relative frequency histograms depict the distribution of the mean gains in test scores for active learners and traditional learners. Observe that the resulting relative frequency distribution for traditional learners is highly skewed to the right, while that for active learners is almost normally distributed. It is also interesting to note that while 12.01% of the active learners did not improve their test scores, more than twice as many (24.22%) of the traditional learners failed to do so.

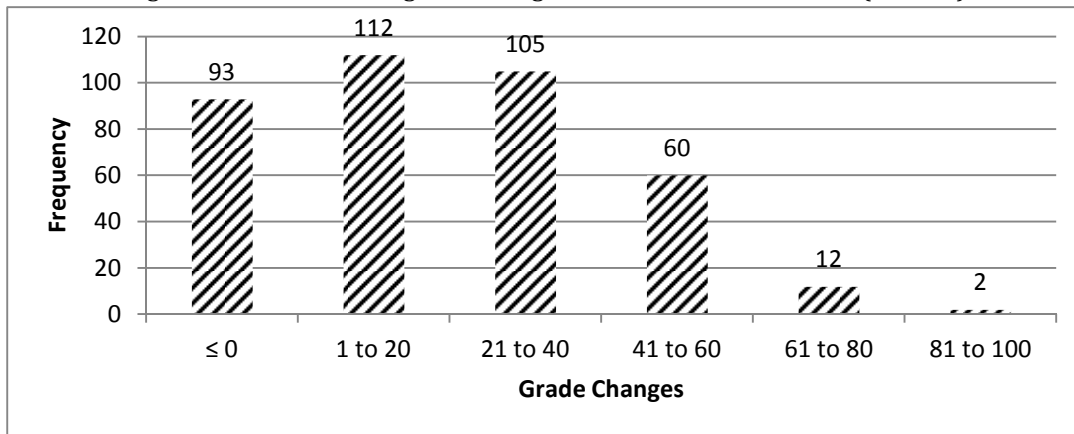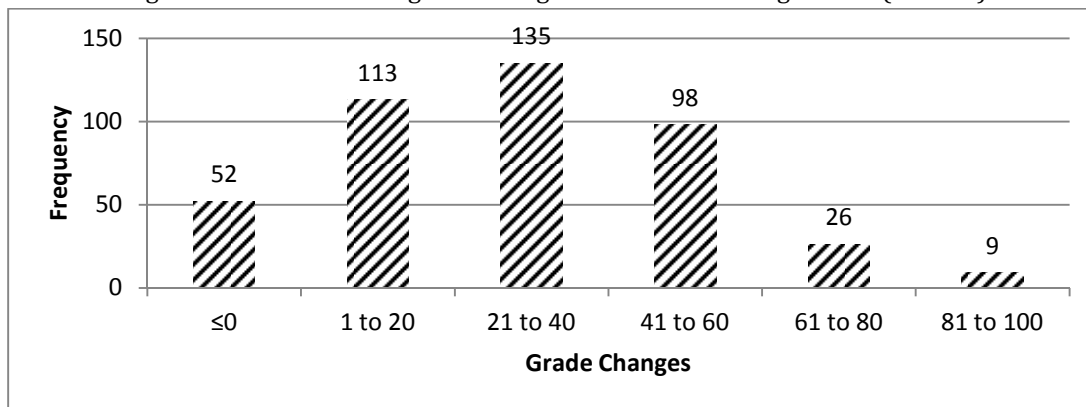Figure 1. Distribution of grade-changes for lecture-based classes (n = 384).

Figure 2. Distribution of grade-changes for active-learning classes (n = 433)

Along the same line, it was found that 55% of those students who engaged in traditional learning achieved a passing grade when post-tested, while a corresponding 85% of active learners received a passing grade when post-tested. In order to determine whether this apparent difference was significant, we performed a standard hypothesis test or the difference between two proportions. The results of the test indicated that at that at a significance level of $\alpha = .01$, the percentage of active learners who achieved a passing grade on the post-test was significantly higher than that percentage corresponding to the control group.

Conclusions and Recommendations for Future Work

In summary, we can conclude that while the results within individual academic disciplines were quite variable, the combined data supports the hypothesis that the academic gains due to active learning (as simply defined by increased student involvement) are *statistically significant*, and there is more consistency in the *overall performance* of active learners than for traditional learners.

The variability of results at the departmental level may be largely due to individual instructor differences, individual differences in the amount of time devoted to active-learning exercises, differences in the difficulty of the course material taught, and differences in the active learning techniques that were employed.

In order to reduce this inherent variability, and to fix concepts for future work, we would like to make several recommendations. First, any future work should confine its scope of analysis to only one

academic discipline and to only one academic course. For example, a sufficient number of sections of one course, such as a mathematics course, should be examined.

Finally, instructors teaching the chosen course should – wherever possible – employ the same set of active learning techniques, and the amount of time devoted to active learning techniques should be closely monitored and documented. This will enable a linear regression analysis of the mean gains in test scores and the time on task.

References

Albanese, M., 2000. Problem-based learning: Why curricula are likely to show little effect on knowledge and clinical skills, *Medical Education*, Vol. 34, No. 9.

Bluman, A.G., 2012. Elementary Statistics: A Step by Step Approach, McGraw-Hill, New York, N.Y.

Bonwell, C.C., and J.A. Eison, 1991. Active learning: creating excitement in the classroom, *ASHEERIC Higher Education,* Report No. 1, George Washington University, Washington, D.C.

Braxton, J. M., Milem, J. F., and Sullivan, A. S., 2000. The influence of active learning on the college student departure process. *Journal of Higher Education*, 71(5), 569-590.

Cohen, J., 1977. Statistical Power Analysis for the Behavioral Sciences,(revised edition), Englewood Cliffs, New Jersey: Erlbaum.

Colliver, J., 2000. Effectiveness of problem-based learning curricula, *Academic Medicine*, Vol. 75, p. 259.

Cusea, J., 1992. Collaborative and cooperative learning in Higher Education: a proposed taxonomy *, Cooperative Learning and College Teaching*, Vol. 2, No. 2.

DeNeve, K. M., & Heppner, M. J., 1997. Role play simulations: The assessment of an active learning technique and comparisons with traditional lectures. *Innovative Higher Education* 21, 231-246.

Faust, J. L., & Paulson, D. R. 1998. Active learning in the college classroom. *Journal of Excellence in College Teaching*, 9(2), 3-24.

Foyle, H.C., (Ed.). 1995. *Interactive learning in the higher education classroom: Cooperative, collaborative, and active learning strategies.* Washington DC: National Education Association.

Hatfield, S.R., (Ed.). 1995. The seven principles in action: Improving undergraduate education. Bolton, MA: Anker Publishing Company.

Iran-Nejad, A., and Chissom, B. S. 1992. Contributions of active and dynamic self-regulation to learning. *Innovative Higher Education*, 17(2), 125-136.

Jensen, E., and Davidson, N. 1997. 12 step recovery program for lecture-holics (based on 12 steps of Alcoholics Anonymous). *College Teaching*, 45, 102-103.

Meyers, C., and Jones, T. B. 1993. *Promoting active learning: Strategies for the college classroom.* San Francisco: Jossey-Bass.

Myers, L. L. 1988. Teachers as models of active learning. *College Teaching*, 36, 43-45.

Prince, M., 2004. Does active learning work? A review of the research, *Journal of Engineering Education*, 93(3).

Rubin, L., & Hebert, C. 1998. Model for active learning: Collaborative peer teaching. *College Teaching*, 46(1), 26-30.

Simpson, M. L., 1995. Talk throughs: A strategy for encouraging active learning across the content areas. *Journal of Readings*, 38(4), 296-304.