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Effectiveness of Blended Instruction utilizing On-Line Lectures and Split Classes in delivering an Applied Exercise Physiology Course

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Abstract

Background: To align with shifting institutional priorities, and to establish more time in the laboratory pursuing scholarly research, numbers of students in classes were doubled but courses were taught less frequently. While having less impact on lecture-based courses, this affected laboratory-based classes to a significant extent from a logistical standpoint. Therefore, the purpose of this investigation was to assess a large blended learning environment course compared to a smaller face-to-face class.

Hypothesis: It was hypothesized that a large blended learning class in Applied Exercise Physiology would be just as effective as a smaller traditional face-to-face course.

Methods: Data was collected from two Applied Exercise Physiology courses, one employing traditional face-to-face instruction, and the other blending on-line lectures with split laboratory experiences. Laboratory write-ups, examinations, and a group project were converted to standard z-scores and compared between classes. Significance was accepted at the $P \leq 0.05$ alpha level.

Results: Classes were statistically similar in terms of write-up assignments ($P = 0.60$), examinations ($P = 0.72$), and final group projects ($P = 0.99$).

Conclusions: Despite students not attending roughly half of the face-to-face classes compared to the traditional instructional method, the students in the blended learning environment performed just as well on laboratory write-ups, examinations, and the Applied Exercise Physiology final project. Based on these findings, blended instruction can be an effective mode for disseminating course information in a large laboratory-based class.

Abbreviations used: EXS – Exercise Science; **N** – number of students

The Exercise Science program in the Kinesiology, Recreation, and Sport Department at Western Kentucky University recently underwent a paradigm shift regarding course loads and teaching equivalencies. Previous to 2009, class sizes were capped at 30 students and courses within the major were taught frequently (usually each semester, and during winter or summer sessions at times). As the university wishes to shift from a regional comprehensive institution to one with a national / international presence, the role of scholarly research has been emphasized. Therefore, to align itself with the direction of the university, and to carve out more time in the laboratory pursuing scholarly research, the Exercise Science faculty opted to teach courses with double the student number (60) but less frequently (only once per year, in a set Fall / Spring rotation).

The Applied Exercise Physiology class is by nature a laboratory-intensive course. Students complete six specific laboratory experiences [1] during the beginning two-thirds of the semester including:

- anaerobic exercise (Wingate anaerobic cycle test, maximal vertical displacement, maximal horizontal displacement)
- submaximal aerobic activity (Åstrand cycle test, Forestry step test, aerobic run/walk test)
- maximal oxygen consumption (Bruce treadmill protocol and open spirometry)
- lung volume and ventilation (determination of Ventilatory Threshold via modified V-slope, ventilatory equivalent, and excess carbon dioxide methods)
- range of motion (lower body flexibility via traditional sit-and-reach box, YMCA sit-and-reach test, V-sit sit-and-reach test, and wall sit-and-reach tests)
- body composition (skinfolds, girth measurements, and Body Mass Index)

Throughout the semester, laboratories are incorporated to teach components of an effective scientific write-up (i.e. Introduction, Methods, Results, and Discussion sections). During the last third of the semester, students complete a mini-study using the laboratory techniques gained through the course, and culminate with a simulated research conference in which their work is presented to their peers in both poster and oral format.

To overcome the logistical complications of having approximately sixty students in the laboratory all trying to complete experiences, this past year we utilized on-line video lectures to relay information such as laboratory protocols, computations, and to demonstrate procedures. Because this instruction was delivered through a web-based format, it allowed us to effectively split the class, where half of the students attended lab on the first day and the remaining students completed the laboratory experience on the second day. Thus, we utilized a “blended learning” model with in-class and on-line components [2]. The purpose of this investigation was to assess a large blended learning environment course with both on-line and in-class components compared to a smaller face-to-face class in which students received all instruction in class and attended laboratory experiences each day.

Methods: Data was collected from two Applied Exercise Physiology courses (EXS 325) taught at Western Kentucky University and approved by the Institutional Review board (IRB 12-130). The first class (N=31 students) was offered during 2009 and the traditional method of face-to-face instruction was provided, with students responsible for attending class each day. This class met twice per week throughout a 14 week semester, for a total of 2240 contact minutes (see *Table 1,* *page 4*). For the laboratory experiences, these students had 560 minutes of hands-on learning (*Table 1*). The second class (N=58 students) was offered during 2010 utilizing on-line Tegrity lectures for delivering instruction and split laboratory experiences (i.e. 29 students attended lab on Tuesday, and the remaining 29 students completed the same laboratory experience on Thursday). Tegrity (Mc-Graw-Hill Higher Education, Santa Clara, CA, USA) is a lecture-capture software system that can be integrated into and delivered via the Blackboard course management system (Blackboard Inc., Washington, D.C., USA). Given this, students met face-to-face with the instructor once a week through the 14 week semester for 1360 contact minutes, and had 560 minutes of hands-on learning dedicated to laboratory experiences (refer to *Table 1*). Students were expected to have watched the on-line video lectures and completed assigned homework available through the Blackboard delivery portal prior to their scheduled laboratory day (i.e. on the day in which they were not in class). Each individual was assigned into a laboratory group (with 5-6 students per group), and six groups attended on their assigned lab day. To further alleviate logistical concerns, two graduate assistants were responsible for the facilitation of three laboratory groups each and assisted students through a rotation of laboratory experiences. For example, a student completing the anaerobic capacity laboratory would collect data for the 40-yard dash, then rotate to the vertical jump, and finish the rotation with the Wingate anaerobic cycle test (while being instructed to utilize downtime between stations to complete power output calculations).

For comparison, similar assessment elements from each class were evaluated. Specifically, four laboratory write-ups (representing an Introduction, Methods, Results, and Discussion), two examinations, and the final group project were included in our data analysis. The actual course content was the same between both semesters, the grading rubrics for assessment were the same each semester, and the same instructor graded the laboratory write-ups, evaluated the group projects, and scored the exams. As points for exams differed between classes, we chose to convert raw scores for each student into a standardized z-score, similar to the investigation on blended learning by Ginns [3]. The z-score was calculated as follows: [the raw student score minus the mean score for the class] divided by the standard deviation. The combination of the four individual write-up z-scores was summed so that a single value represented the variable (i.e. a write-up standard score), the combination of two individual examination z-scores was added to denote the score for exams, and these were both added to the z-score representing the final project to give an overall class standardized score (write-up + exam + final project = overall).

Statistical analysis: Differences between classes in the four areas (write-up, exams, final project, and overall) were determined using independent samples t-tests assuming equal variance. Significance was accepted at the $P \leq 0.05$ alpha level.

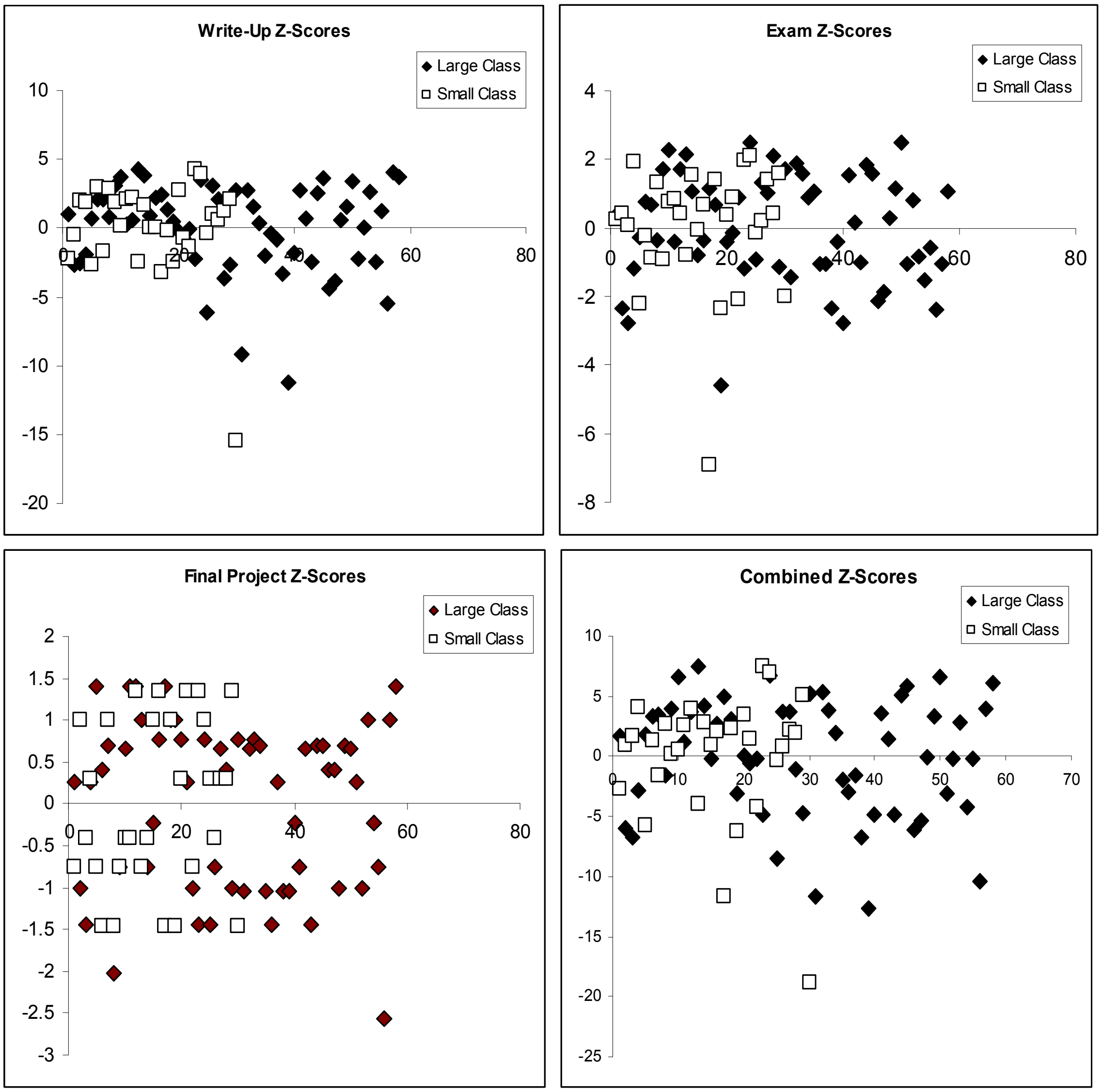
Results: No differences were observed in any of the areas assessed. Classes were statistically similar in terms of write-up assignments ($F = 0.28$, $P = 0.60$), examinations ($F = 0.13$, $P = 0.72$), final group projects ($F = 0.00$, $P = 0.99$), and an overall combination of these areas ($F = 0.25$, $P = 0.62$). Variations in standardized scores of individual students for each area are displayed in Figure 1 *(on Page 5).*

Table 1: Breakdown of time attributed to method of instruction (Face-to-Face, Blended), including course content and laboratory experiences.

	Content	Day 1 (min)	Day 2 (min)	Weekly Face-to-Face Time (min)	Accumulated Face-to-Face Time (min)
Week 1	Syllabus, Introduction to Applied Physiology	FtF: 80 BLA+BLB: 80	FtF: 80 BLA+BLB: 80	FtF = 160 BLA+BLB = 160	FtF = 160 BLA = 160 BLB = 160
Week 2	Laboratory Write-up Seminar	FtF: 80 BLA+BLB: 80	FtF: 80 BLA+BLB: 80	FtF = 160 BLA+BLB = 160	FtF = 320 BLA = 320 BLB = 320
Week 3	Body Composition	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 480, (L) = 80 BLA = 400, (L) = 80 BLB = 400, (L) = 80
Week 4	Anaerobic Capacity	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 640, (L) = 160 BLA = 480, (L) = 160 BLB = 480, (L) = 160
Week 5	Submaximal Aerobic Activity	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 800, (L) = 240 BLA = 560, (L) = 240 BLB = 560, (L) = 240
Week 6	Examination I/Open Lab	FtF: 80 BLA: 80 BLB: Open Lab	FtF: 80 BLA: Open Lab BLB: 80	FtF = 160 BLA = 80 BLB = 80	FtF = 960 BLA = 640 BLB = 640
Week 7	Maximal Oxygen Consumption	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 1120, (L) = 320 BLA = 720, (L) = 320 BLB = 720, (L) = 320
Week 8	Maximal Oxygen Consumption	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 1280, (L) = 400 BLA = 800, (L) = 400 BLB = 800, (L) = 400
Week 9	Ventilatory Threshold Determination	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 1440, (L) = 480 BLA = 880, (L) = 480 BLB = 880, (L) = 480
Week 10	Flexibility	FtF: 80 BLA: 80 (L) BLB: on-line	FtF: 80 (L) BLA: on-line BLB: 80 (L)	FtF: 160 BLA: 80 BLB: 80	FtF = 1660, (L) = 560 BLA = 960, (L) = 560 BLB = 960, (L) = 560
Week 11	Examination II/Open Lab	FtF: 80 BLA: 80 BLB: Open Lab	FtF: 80 BLA: Open Lab BLB: 80	FtF = 160 BLA = 80 BLB = 80	FtF = 1760 BLA = 1040 BLB = 1040
Week 12	Mini-Study Testing	FtF: 80 BLA: 80 BLB: Open Lab	FtF: 80 BLA: Open Lab BLB: 80	FtF = 160 BLA = 80 BLB = 80	FtF = 1920 BLA = 1120 BLB = 1120
Week 13	Mini-Study Testing	FtF: 80 BLA: 80 BLB: Open Lab	FtF: 80 BLA: Open Lab BLB: 80	FtF = 160 BLA = 80 BLB = 80	FtF = 2080 BLA = 1200 BLB = 1200
Week 14	Simulated Research Conference	FtF: 80 BLA+BLB: 80	FtF: 80 BLA + BLB: 80	FtF = 160 BLA+BLB = 160	FtF = 2240 BLA = 1360 BLB = 1360

FtF = Face-to-Face, BLA = Blended Group A (meets Tuesday), BLB = Blended Group B (meets Thursday), BLA+BLB = Days when Blended Group A and Blended Group B meet together Face-to-Face, (L) = Laboratory experience. Shaded cells denote Weeks in which laboratory experiences were completed.

Figure 1: Plots displaying variations of standardized scores (on y-axis) for write-up, exam, final project, and combined measures between a large class in which on-line lectures and split labs were utilized, and a small class instructed through traditional means. X-axis indicates student number (31 for the small class and 58 for the large class).



Discussion:

The purpose of this investigation was to evaluate the impact of a blended learning arrangement utilizing on-line lectures to replace in-class instruction, and splitting class laboratory sessions in a large laboratory-focused course. Our findings show that students performed similarly in terms of laboratory write-ups, examinations, and during the completion of group culminating projects. No differences were observed, despite students not attending roughly half of the face-to-face classes compared to the traditional instructional method. This finding is similar to an investigation performed at Central Florida University, where student success rate increased despite face-to-face meeting time being reduced by 66% [4].

While so-called "blended learning" has generated much research [2, 3, 5-9], the broadness of the term has naturally led to some confusion regarding how this type of instruction is to be carried out. In fact, one author has argued against the term [10], proposing that instructors in higher education already employ a blended style of content instruction. In the context of the current investigation, blended learning included a mixture of on-line lectures focused on instructional content, and face-to-face meetings in which hands-on laboratory experiences were completed. Given that the didactical design of blended classes must be tailored toward the focus of each specific discipline [7], it is difficult to compare results from the scientific literature in this area. Nevertheless, Boyle et al. [5] found that a blended learning arrangement increased the pass rates of computer programming undergraduate (by 15-23%) and graduate students (12%). In the present investigation, while no differences were observed between any of the dependent variables measured (laboratory write-ups, examinations, and group projects), the failure rate for the blended learning class was 3.4%, and 6.5% for the traditional course.

While more investigation is necessary, subjective comments from selected students indicated that use of on-line modules allowed them to proceed through the material at their own pace, as well as the option to view the instruction multiple times if desired. The on-line materials were particularly useful to students reviewing for examinations, and as a resource leading up to the final group project. In addition to the noted benefits to students, utilizing the blended format and split classes offered advantages for this instructor of the class. The primary benefit was that the larger class counted double toward teaching load, thus clearing time to spend in the laboratory and research endeavors. In addition, having the pre-recorded Tegrity lectures allowed the instructor to reduce class teaching preparation time. Based on the preliminary data provided in this study, we propose that web-based only instruction and splitting laboratory time between groups in a blended learning environment can be an equally effective mode for disseminating course information in a large laboratory-based class compared to traditional face-to-face classes with smaller numbers that meet each period.

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References:

[1] Beam WC, Adams GM. Exercise Physiology Laboratory Manual. 6th Edition. New York: McGraw-Hill, 2011.

[2] Osguthorpe RT, Graham CR. Blended learning environments: definitions and directions. *Q Rev Distance Ed.* 2003; 4(3): 227-33.

[3] Ginns P, Ellis R. Quality in blended learning: Exploring the relationships between on-line and face-to-face teaching and learning. *Internet and Higher Ed.* 2007;10:53-64. http://associatie.kuleuven.be/altus/seminaries/1011/seminarie7/QualityBL.pdf

[4] Dziuban C, Moskal P. Evaluating distributed learning in metropolitan universities. *Metropolitan Universities.* 2001;12 (1):41-9. http://net.educause.edu/ir/library/pdf/eqm01412.pdf

[5] Boyle T, Bradley C, Chalk P, Jones R, Pickard P. Using blended learning to improve student success rates in learning to program. *J Ed Media.* 2003; 28(2-3): 165-78. http://staffweb.londonmet.ac.uk/~chalkp/res/Boyle-et-el-2003.pdf

[6] Derntl M, Motschnig-Pitrik R. The role of structure, patterns, and people in blended learning. *Internet and Higher Ed.* 2005;8: 111-30. http://elearn.pri.univie.ac.at/lehre/diss/dev-tel/papers/IHEduc-BlendedLearning.pdf

[7] Kerres M, Witt CD. A didactical framework for the design of blended learning arrangements. *J Ed Media.* 2003; 28(2-3): 101-13.

[8] Rovai AP, Jordan HM. Blended learning and sense of community: A comparative analysis with traditional and fully online graduate courses. *Int Rev Res in Open and Distance Learning.* 2004; 5(2):1-13. http://www.irrodl.org/index.php/irrodl/article/view/192/274

[9] So H-J, Brush TA. Student perceptions of collaborative learning, social presence and satisfaction in a blended learning environment: relationships and critical factors. *Computers & Ed.* 2008; 51(1): 318-36. http://hjso.home.nie.edu.sg/publication/CAE_SoBrush_2008_Preprint.pdf

[10] Oliver M, Trigwell K. Can 'blended learning' be redeemed? *E-Learning.* 2005; 2(1): 17-26. http://www.luispitta.com/mie/Blended_Learning_2005.pdf

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