THE EFFECTS OF INTRODUCING E-TEXTS AND E-MATERIALS IN 100-200 LEVEL COLLEGE BIOLOGY COURSES ON TEACHING PEDAGOGY

Rebecca Garrison[1], Kerrie McDaniel[2], Jerry Daday[3]

[1]Department of Health and Human Services, Western Kentucky University
[2]Department of Biology, Western Kentucky University
[3]Department of Sociology and Division of Extended Learning and Outreach, Western Kentucky University

Abstract

A new generation has entered higher education that learns differently from generations before. To meet the changing needs of this generation, a biology department at a four year university introduced e-textbooks and e-materials in the fall of 2013 to most low-level classes. An unforeseen product of this shift was a change in the way that some faculty taught and assessed their classes. This study examines the changes in pedagogical techniques among professors of 100- and 200-level biology classes due to introduction of new e-text and e-materials. Syllabi were collected from these classes pre- and post-implementation and common characteristics were inductively coded and statistically analyzed to identify changes in pedagogy. Interviews were conducted of faculty teaching these classes. It was found that biology professors increased their average number of homework assignments by 23%. There was also a 458% increase in the number of courses that offered homework assignments as a means of assessment, indicating a shift from traditional summative assessments to more formative assessments after the implementation of the e-materials. This work provides insight into simple strategies that affect pedagogy in higher education STEM disciplines

I. Subject/Problem/Introduction

A new generation has entered higher education, a cohort that, as of 2013, has as many as 19 million students enrolled in college courses across the United States (United States Census

Bureau, 2013). This is the Net Generation, a population that learns contrarily to generations before who studied by visiting libraries, using dial-up internet connections, and reading print material. With the Net Generation comes what Jones, Ramanau, Cross, and Healing call a "generational shift [that] has consequences for approaches to learning because the new generation requires rapid access and quick rewards, is impatient with linear thinking and displays a novel capacity for multi-tasking" (Jones et al., 2010, pg. 2).

This shift can be seen in all aspects of life, but especially in the way they learn (Palfrey & Gasser, 2008). In the last 15 years, this has proven to be a problem as professors are being forced to teach in a way that they themselves were not taught (Palfrey & Gasser, 2008). These students have grown up in an age where information is only a few internet searches away and now they demand an education that is individualized and autonomous (Barnes et al., 2007; Palfrey & Gasser, 2008). To meet the needs of students, professors' pedagogies must adapt to take mere information and turn it into acquirable knowledge in a form that Net Geners learn (Barnes et al., 2007).

Professors of STEM courses, especially those of biology, have been called to improve their pedagogical content knowledge to develop a new system of teaching to improve education (Brewer & Smith, 2011). A change in pedagogy can be a daunting task, but is necessary to meet the needs of the Net Geners that continue to enter colleges. This change has been recognized as a difficult task, but especially difficult for classes in the sciences (Henderson et al., 2011). Approaches that target this generation, interactive and active learning, are what the American Association for the Advancement of Science believes is the kind of methodology that biology professors need to develop in undergraduate courses (Brewer & Smith, 2011; Brownell & Tanner, 2012). College professors may know extensive content about their subject, but they may not possess the skills or be aware of the teaching methodologies needed to transfer to their knowledge to students and promote student learning and excellence (Jang, 2009). The concept of mixing these ideals results in pedagogical content knowledge (PCK), or as Jang expresses it, "representation of concepts [and] pedagogical techniques…" (2011). In biology courses, professors resist pedagogical change because it is time consuming and "change" comes with the connotation that professors are not teaching effectively (Brewer & Smith, 2011). This resistance contributes to what Brownell and Tanner (2011) consider are the three main sources of delay in pedagogical modernization: lack of training, time, and incentives. If biology professors are expected to learn how to teach in a way that they were not taught, it would take consistent feedback and several trials; something they cannot simply learn in a short workshop (Brownell & Tanner, 2011). While there are no simple answers to this problem, interventions that shift pedagogy in the teaching of biology at the college level with minimal effort are desirable.

A biology department at a 4-year university recently shifted from using traditional texts to e-texts and e-materials in their introductory courses. This initiative to introduce an e-text for global use in 100- and 200-level courses in the biology department began as an attempt to standardize content across professors, facilitate the transition for professors between courses, and to reduce the price of textbook costs for students. A side effect of this transition was a change in teaching pedagogy.

This study evaluates pedagogical change that has occurred in the biology department at a university due to the introduction and implementation of e-textbook and e-materials in freshman- and sophomore-level undergraduate courses in an attempt to meet the needs of the Net Generation. The study looks further at changes specifically in Human Anatomy and Physiology courses, a subset of the biology courses, which has attempted to modernize a once very traditionally taught course.

II. Design/Procedure

The central goal of this research was to evaluate if and how pedagogy has changed in introductory biology courses after adopting and implementing e-materials. This was accomplished through content analysis of course syllabi and interviews with faculty members. The e-text and e-materials were implemented to the biology department in fall of 2013. Syllabi for the low-level biology courses were collected for a total of three years. A total of 150 syllabi were collected pre-implementation, starting 2 years prior in the fall of 2011. Additionally, 104 syllabi were collected for a year and half post-implementation, ending in spring of 2014. Together, 254 syllabi were collected for the analyses.

After the 254 syllabi were collected from the school's website, they were individually numbered and then analyzed for apparent themes. This was an inductive process, where course syllabi were initially read and examined by a single coder for items that would be appropriate for subsequent coding and analysis. This reading and examination of course syllabi by the coder resulted in the development of eight main themes, including:

- Class name and section (ex: 131-001)
- Professor teaching the class
- Semester this class was taught
- Grade distribution of assignments (exams, quizzes, homework, and other)
- Total number of assignments (exams, quizzes, homework, and other)
- Form of text used (e-text vs traditional text)
- Other open education resources (OERs) used

- Type of tests, quizzes, and homework (online vs. traditional)

These themes were expanded to 27 total items that were collected from each syllabus. A codebook was created to specify rules on how the items in the syllabi should be coded. The codebook allowed for the further extraction of specific information from each of the 254 course syllabi. The coder read and examined each of the 254 course syllabi identified for this study, and entered relevant information on a corresponding coding sheet, each numbered to match the corresponding numbered syllabus. A single coding sheet was generated for each course syllabus. A simplified coding sheet is shown in Table 1.

Coding Sheet	
1. **Class name**	### (Class) - ### (Section)
2. **Professor**	# (Corresponding with a professor)
3. **Semester**	Semester, Year
4. **Percent of total grade in tests**	Calculated numerical value
5. **Percent of total grade in quizzes**	Calculated numerical value
6. **Percent of total grade in homework**	Calculated numerical value
7. **Percent of total grade in discussion**	Calculated numerical value
8. **Percent of total grade in other**	Calculated numerical value
9. **Total number of tests**	Numerical value
10. **Total number of quizzes**	Numerical value
11. **Total number of homework**	Numerical value
12. **Total number of other**	Numerical value
13. **Use of e-text**	Absent = 0, Present = 1, Unclear = 2
14. **Use of e-text from McGraw Hill™**	Absent = 0, Present = 1, Unclear = 2
15. **Use of e-text from other**	Absent = 0, Present = 1, Unclear = 2
16. **Use of traditional text**	Absent = 0, Present = 1, Unclear = 2
17. **Use of a general video to teach**	Absent = 0, Present = 1, Unclear = 2
18. **Use of a Tegrity™ video to teach**	Absent = 0, Present = 1, Unclear = 2

19. **Use of a class website**	Absent = 0, Present = 1, Unclear = 2
20. **Use of other OERs**	Absent = 0, Present = 1, Unclear = 2
21. **Use of Blackboard™**	Absent = 0, Present = 1, Unclear = 2
22. **Use of online homework**	Absent = 0, Present = 1, Unclear = 2
23. **Use of online homework from McGraw Hill™**	Absent = 0, Present = 1, Unclear = 2
24. **Use of online homework from other**	Absent = 0, Present = 1, Unclear = 2
25. **Use of online quizzes**	Absent = 0, Present = 1, Unclear = 2
26. **Use of online tests**	Absent = 0, Present = 1, Unclear = 2
27. **Use of extra credit**	Absent = 0, Present = 1, Unclear = 2

Table 1. Coding Sheet

Items 4-8 in the coding sheet represented how much of the total grade for a single course was allotted to different forms of assessments, including: tests, quizzes, homework, discussion, and other. Items 13-27 in the coding sheet were common characteristics or resources that were seen thematically throughout the syllabi. These characteristics were accounted for on the coding sheet as “present” or “absent” for each syllabus, which is clarified in the following Table 2:

Description of Characteristics in the Coding Sheet

#	Characteristic	Description
13	E-text	Includes the general use of any online textbook
14	E-text from McGraw Hill™	If item is present in syllabi, it is counted in both the general “e-text” category and here
15	Other E-text	If item is present in syllabi, it is counted in both the general “e-text” category and here
16	Paper text	Any traditional textbook, can be offered alongside of e-text
17	General video	Videos made by someone other than the professor
18	Tegrity™ videos	Videos professors have made of themselves teaching for students to access
19	Class website	Any additional website made specifically for given course

20	Other OER	Open Educational Resource
21	Blackboard™	An online learning management system which both professors and students can access to post content, grades, assignments, etc.
22	Online homework	Any general homework to be completed online
23	Online homework from Learnsmart™	If item is present in syllabi, it is counted in both general “online homework” category and here
24	Other online homework	If item is present in syllabi, it is counted in both the general “online homework” category and here
25	Online quizzes	Quizzes completed on a computer, whether in class or a testing center
26	Online tests	Tests completed on a computer, whether in class or a testing center
27	Extra credit	Can be a variety of options, has to be specifically stated as an extra credit option

Table 2. Description of Characteristics in the Coding Sheet

After the coding sheet and codebook were created, all syllabi were coded separately by two coders to ensure inter-coder reliability, represented by coders “A” and “B.” Their findings were then compared to find the amount of error between the coders. Both sets of data (one from each coder) were analyzed in a computer software program, STATA, to generate a corresponding percentage of agreement and a kappa value for each characteristic that could be quantified numerically. The kappa value can range from 0.0 to 1.0; the closer the kappa value is to 1.0, the higher the relationship is between the two sets of data. Landis and Koch (1977, p165) further clarify the possible kappa values by dividing them into 5 categories. Inter-coder reliability for all characteristics had a Kappa value above .81 making the interpretation “almost perfect”.

In addition, faculty interviews were conducted to clarify e-text and e-materials use along with changes in pedagogy that resulted from this implementation. The interviewer was trained in interview techniques, met with biology faculty and transcribed the conversation. Transcripts were reviewed, summarized, and compared with syllabi data.

III. Analysis/Findings

Data collected from the syllabi were entered into a Microsoft Excel spreadsheet and analyzed with IBM SPSS using two main statistical procedures, crosstabs and t-tests. Crosstabs were used to compare the presence or absence of course characteristics for syllabi pre-implementation and post-implementation. Each crosstab showed the percentage of syllabi that had a specific course characteristic pre- and post-implementation along with a Pearson chi-square statistic to test for significant differences between these two groups. An alpha of $p < .05$ was used to determine if there was a significant difference in the percentages of course syllabi possessing certain course attributes pre- and post-implementation (Figure 1&5).

T-tests were conducted to compare the average number of assignments pre- and post-implementation (items 9-12 in Table 1) and to compare the grade distribution based on percentages pre- and post-implementation (items 4-8 in Table 1). Given the continuous nature of these variables, t-tests were employed to compare these course attributes pre- and post-implementation rather than cross-tabs.

Pre- and post-implementation totals and averages of each characteristic were compared to establish significance using an independent sample t-test. Levene's Test for Equality of Variances is first used to determine if there is a significant difference in the variances of each group with $p < .05$ used as the threshold for significance. If the alpha for the Levene's test was greater than or equal to .05, equal variances are assumed and the two-tailed test listed in the first row of the IBM SPSS output is used to determine significance. However, if the Levene's test had an alpha of less than .05, equal variances are not assumed between the pre- and post-implementation groups for each course characteristic, and the two-tailed test listed in the second row of the IBM SPSS output was used to determined significance.

Through inductive coding of course syllabi, fifteen characteristics were identified and coded. These characteristics were compared pre- and post-implementation using cross-tabs to determine percentages and level of significance across both groups.

Additionally, t-tests were used to analyze the percentage of courses that utilize each form of assessment (tests, quizzes, homework, and other) pre- and post-implementation, average number of each assessment per syllabi, and the amount of the total grade allotted to each assessment. The characteristics marked with an asterisk (*) in the figures symbolize a significant result with an alpha of $p<.05$. This process and tests were completed first for all general biology course syllabi (Figures 1-4) and then repeated for findings specifically related to anatomy and physiology course syllabi as a sub-set sample (Figures 5-8).

The percentages in Figure 1 showed the presence of each characteristic on course syllabi pre- and post-implementation. The darker bars represented the percentage of course syllabi pre-implementation of e-text and e-material (before Fall 2013) and the lighter bars represented the percentage of course syllabi after the implementation (Fall 2013 and after). If a course characteristic was significantly different pre- and post-implementation, an asterisk (*) was listed next the attribute in Figure 1. The value above each bar was the raw score of the syllabi with the present characteristic. The raw score is especially interesting because the total number of syllabi pre-implementation (150) was much larger than the total number of syllabi post-implementation

(104). Most notable from Figure1 is the change in total number of syllabi that use general online homework, specifically, Learnsmart™. Before the implementation of the e-learning system, only 19 syllabi showed any use of online homework, while post-implementation that had increased to 82 syllabi. The presence of Learnsmart™ also increased drastically in syllabi, from 1 to 75.

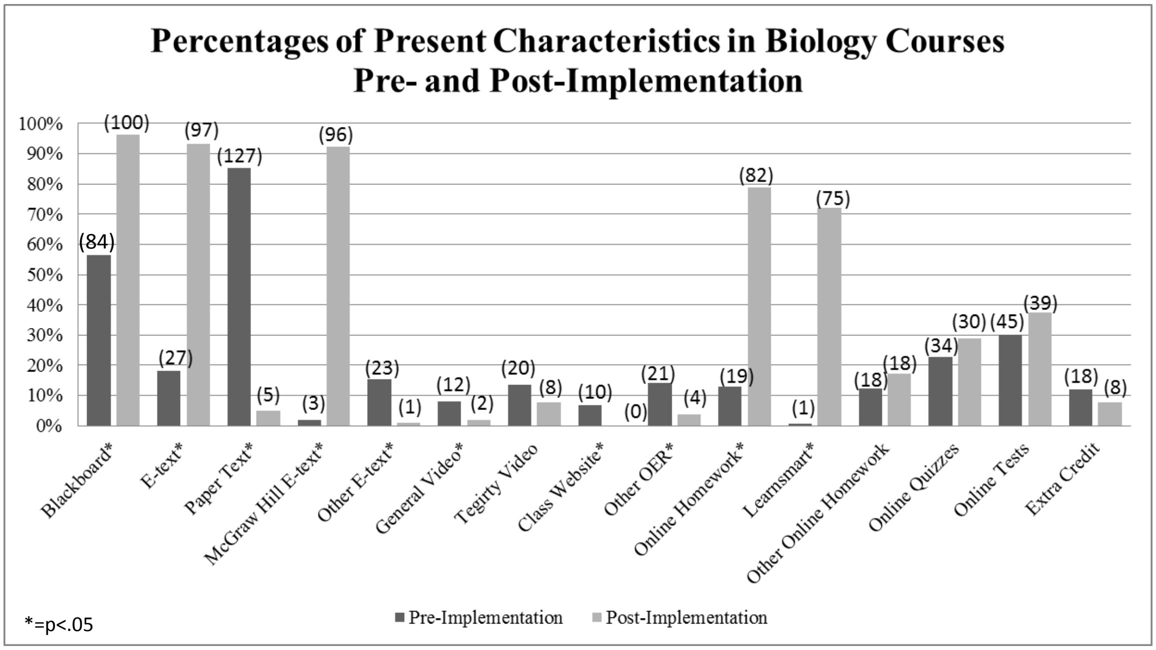


Figure 1. Percentages of Present Characteristics in Biology Courses Pre- and Post-Implementation

As the presence of e-text in syllabi increased, paper text significantly decreased from 85.2% to 4.8%. The syllabi listing use of e-text other than from McGraw Hill™ significantly decreased from 15.4% to 1% after the implementation. Use of general videos and Tegrity™ videos both decreased in syllabi, general video from 8.1% to 1.9% and the Tegrity™ videos from 13.4% to 7.7%, but only general videos saw a significant relationship. Syllabi reporting use of class websites also significantly decreased from 6.7% to 0% and syllabi including other open education resources (OERs) from 14.1% pre-implementation to 3.8% post-implementation. For online homework, all three areas saw an increase with the new implementations, including online homework in general, online homework through Learnsmart™, and other online homework assignments. General online homework significantly increased in presence from 12.8% to 78.8%. Also, online homework specifically from Learnsmart™ significantly increased from 0.7% pre- to 72.1% post-, and other online homework included in syllabi from 12.2% to 17.3%. Many of the other online homework assignments came from professors posting additional homework on Blackboard™, rather than a separate source. Online quizzes also saw change, though insignificant, and increased from 22.8% pre- to 28.8% post-. Online tests were also affected as indicated by their increase from 30.2% to 37.5% in the syllabi.

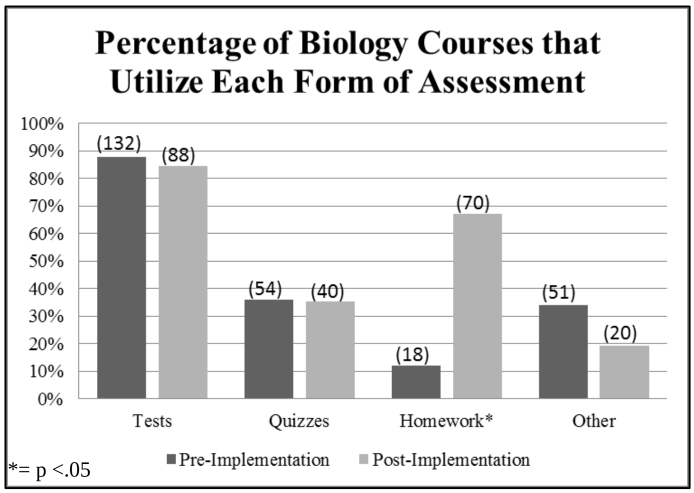
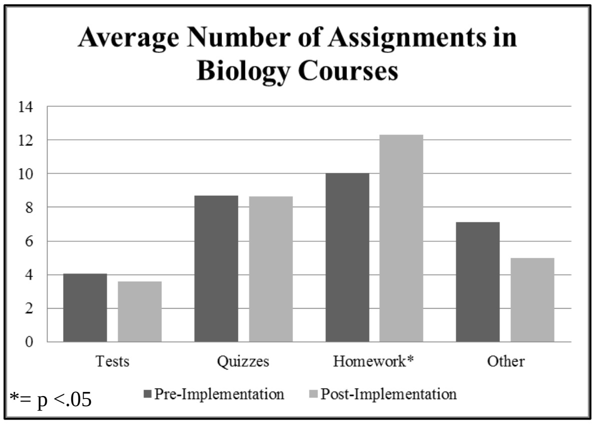


Figure 2. Percentage of Biology Courses that Utilize Each Form of Assessment

The percentage of syllabi that included tests, quizzes, homework, and other assignments pre- and post-implementation are shown in Figure 2. Biology courses that listed homework as a means of assessment significantly increased by 458% from 12% pre- to 67.3% post-implementation. Pre-implementation, 88% of the syllabi from general biology courses included tests as a means of assessment and this decreased to 85%. The percent of syllabi that used quizzes stayed constant from 36% pre- to 35% post-. Presence of other assessments in syllabi decreased from 34% to 19%, a 44% decrease.



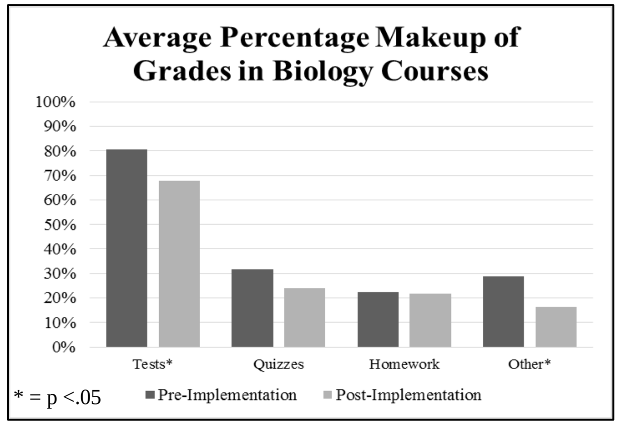
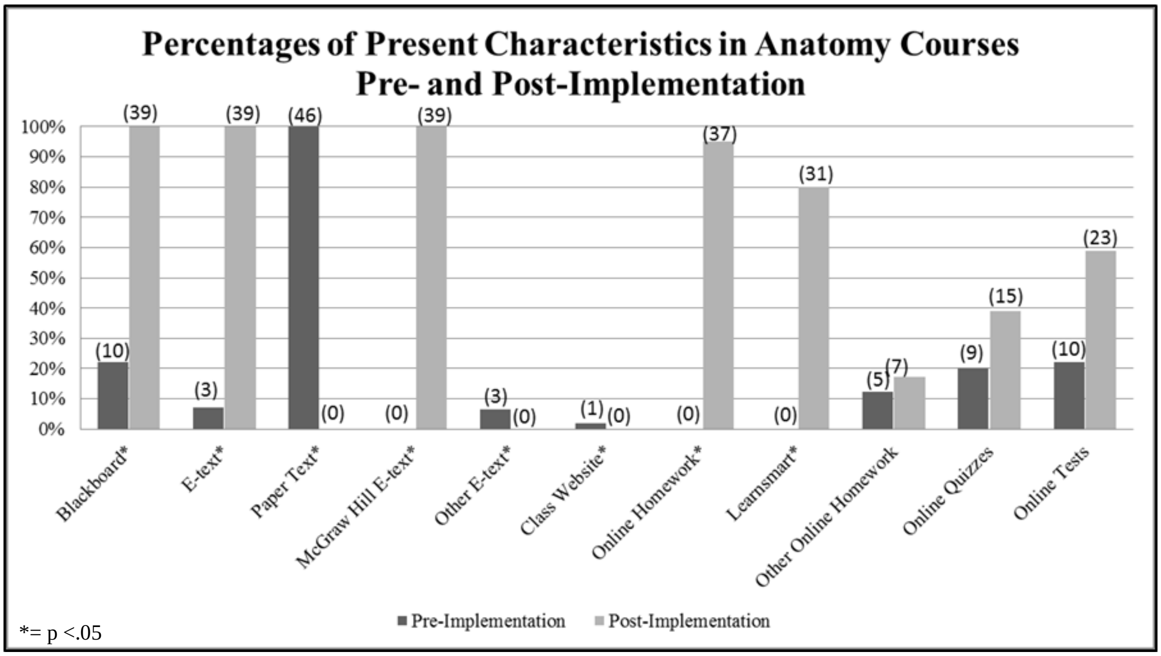


Figure 3. Average Number of Assignments in Biology Courses
Figure 4. Average Percentage Makeup of Grades in Biology Courses

Figure 3 shows the average number of assignments that were listed in the syllabi pre- and post-implementation. The only significant finding was in the average number of homework assignments in a single syllabus, which increased from 10.06 to 12.33. Average number of tests decreased from 4.03 pre- to 3.6 post-implementation; the average number of quizzes stayed almost constant with 8.72 to 8.65; and other assignments average decreased from 7.1 to 5 per general biology course.

Figure 4 shows how professors, on average, distributed their grades as reflected on their course syllabi. Before the implementation, larger percentages of grades relied on tests, significantly decreasing from 80.56% to 67.72%. Percentage of total grade in other assignments also significantly decreased from 28.8% to 16.35%. Percentage placed in quizzes, on average, also decreased from 31.65% to 24.05%. Percent in homework stayed almost completely the same from 22.4% to 21.8%. This data indicated a shift away from summative assessment as the sole method of evaluation to include more formative assessments.

A sub-study focusing specifically on Anatomy and Physiology 1&2 (A&P) was conducted because of radical changes made in these courses in addition to implementation of e-texts. Figures 5-8 represent data that were drawn ONLY from A&P courses. These courses were very traditionally taught pre-implementation with limited use of technology and where the entire grade for the lecture and lab consisted of a few tests and quizzes and very little online material. After e-text implementation there was an increased emphasis on hands-on learning. In addition to the e-text changes in the anatomy courses included using the Anatomy in Clay System, case studies, and the partitioning of large amounts of material into smaller, more manageable portions

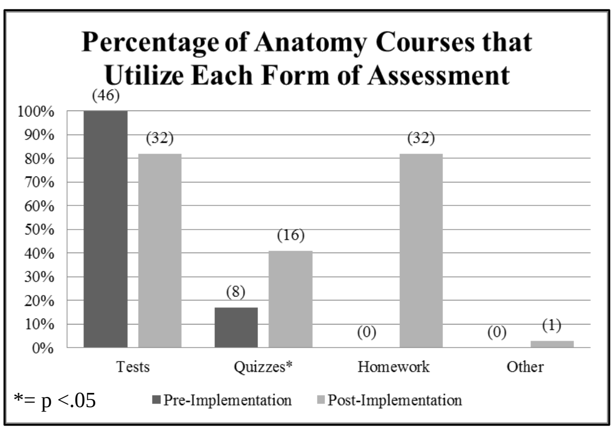


of information.

The percentages in Figure 5 show the presence of each characteristic in Anatomy and Physiology (A&P) syllabi pre- and post-implementation. General online homework remained a prominent feature of the implementation within A&P courses with the total number of syllabi including online homework assignments significantly increasing from 0 pre- to 37 post-. This is even more interesting as the total number of syllabi pre-implementation was larger at 46 syllabi than post- at 39 total syllabi. The percentage of A&P syllabi that included online homework significantly increased from 0% to 95%. Presence of online homework specifically from

Learnsmart™ saw a meaningful increase as well from 0% pre- to 80% post-implementation. This data represents professors providing more progressive learning opportunities for students to experience and work with the content.

The use of a learning platform (Blackboard™) increased significantly post-implementation from 22% to 100%, a 354% increase. Presence of general e-text also significantly increased from 7% to 100%, and presence of e-text specifically from McGraw Hill™ significantly increased from 0% to 100% in the A&P class. Paper-text and other e-text use experienced a significant decrease from 100% to 0% and 6.5% to 0%. The presence of syllabi accounting for the use of a class-website also decreased from 2% to 0%. Syllabi that included the use of online homework assignments increased from 12% pre-implementation to 17% post-implementation, online quizzes increased from 20% to 39%, and online tests increased from 22% to 59%.



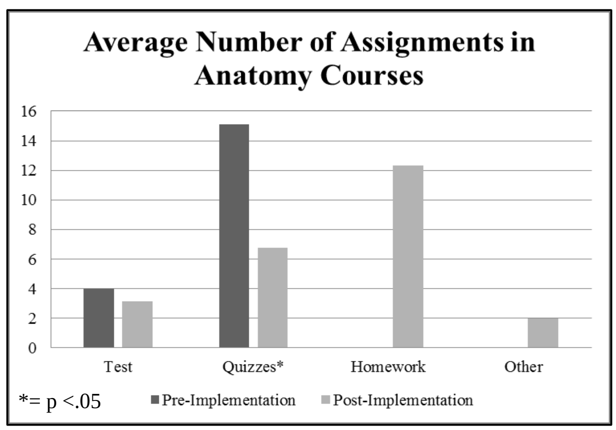


Figure 6. Percentage of Anatomy Courses that Utilize Each Form of Assessment
Figure 7. Average Number of Assignments in Anatomy Courses

In Figure 6, the percent of A&P course syllabi that use each type of assessment (tests, quizzes, homework, and other) and their raw score are displayed. A&P syllabi that use tests decreased from 100% pre-implementation to 82% post-implementation. Presence of quizzes significantly increased from 17% to 41%. Use of homework increased the most, from 0% to

82%, while significance could not be calculated because there were no syllabi pre-implementation that had any homework assignments, the total number of A&P course syllabi that used homework increased from 0 to 32. Other assessments slightly increased from 0% to 3%. The shift in assessment and assignments documented from the syllabi corresponded with changes made in the course designed to reduce cramming of large amounts of information for high-stakes exams in favor of more frequent quizzes covering smaller amounts of information. In addition, the increase in homework offered more formative assessment to guide students learning of content.

Figure 7 displays the average number of assignments in both levels of anatomy and physiology pre- and post-implementation. This more clearly displays the average number of each assignment given in A&P courses and is not skewed by an uneven raw score like Figure 6. Results showed a statistically significant decrease after the implementation in the average number of quizzes in A&P courses from 15.13 to 6.75. The average number of tests remained close to the same with an average of 3.98 tests pre-implementation to 3.13 post-implementation. The average number of homework and other assignments both increased from a pre-implementation average of 0 to 12.35 homework assignments and from 0 to 2 other assignments.

Because data was none existent in the homework and other assignment sections pre-implementation, their significance could not be computed.

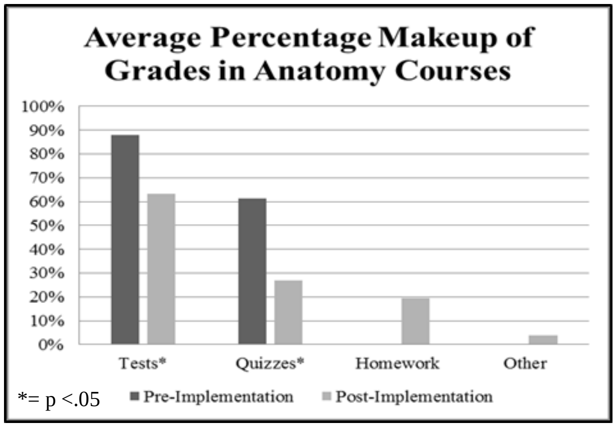


Figure 8. Average Percentage Makeup of Grades in Anatomy Courses

In Figure 8, the average percentage allotted to each assignment in anatomy and physiology courses is shown. As mentioned before, these courses did not have homework or other assignments besides tests and quizzes prior to the implementation, making it impossible to calculate the significance of change. However, the average percent of grade for tests did see a statistically significant decrease from 88.02% to 63.18%. The average percentage of total grade determined by quizzes also saw a significant decrease from 61.22% pre-implementation to 27.06% post-implementation. The average percent of total grade allotted to homework assignments increased from 0% pre- to 19.45% post-. The presence of other assignments increased from 0% to 4%. While statistical significance could not be calculated, there is a meaningful increase in the percentage of grade accounted for in homework assignments.

Biology Conclusion

Many faculty members have changed pedagogy in the Biology Department of Western Kentucky University as the new e-text and e-material are being used at a much higher degree than before fall of 2013. Changes were measured in fifteen characteristics coded from course syllabi, including use of: Blackboard™, e-text, e-text from McGraw Hill™, online homework, online homework from Learnsmart™, other online homework, online quizzes, and online tests (Figure 1). In addition, faculty interviews were used to clarify numerical data collected from the syllabi. Faculty reported during interviews an unwillingness to alter teaching methods unless there was little requirement of time for set up, grading or training. These concerns are consistent to barriers of pedagogical change reported by Brownell and Tanner (2011).

A decrease in the use of educational resources outside of Learnsmart™ and e-text, such as videos, websites, and other open education resources was observed. From the interviews this decrease can be explained by faculty exploiting the many features of McGraw Hill™'s online system rather than outside resources or by lack of inclusion of this material in the syllabi. The ease and access of these materials reduced the need to search for other materials to use for classes. Other resources that did not show up on the syllabi but were noted during interviews were online modules, videos, case studies, or even programs where students respond to online questions in class using their phones and laptops. The increase in professors' utilization of Learnsmart™, a series of adaptive learning questions administered online before class, leads to the assumption that students are now learning or at least becoming familiar with and working with the content before they come to class (Figure 1 & 2). In fact, several faculty members commented in their interview that they "depended on the LearnSmart homework system to prepare students in basic concepts and vocabulary." Although a total flipped classroom was not the primary pedagogy used by biology faculty, some flipped components were employed into the class because of the implementation of the e-text. When students are more prepared for class there is more class time for professors to build on these basic ideas and answer questions rather than use time covering simple information (Berret, 2012). One faculty member commented that his classes were more engaging because of the e-materials. The publisher-generated online learning resources also reduces grading time because most assignments are computer-graded and the students' scores are automatically transferred to Blackboard™ (or other learning platform), addressing the main impedance of pedagogical change, lack of time. Giving students more assignments with quick feedback provided the formative assessments students need to self-adjust their learning (Biggs & Tang, 2011). The time-saving attributes or the e-material to providing more formative assessment without increasing grading load was another common theme echoed among faculty members during interview. Faculty interviews revealed that some faculty would not be willing to assign homework in their large classes if it increased their workload by increasing grading time. The increase in these activities demonstrated that the ease of assigning and grading these homework tasks was not a barrier to faculty use of these materials. Other interviews with faculty reported using the online homework as a partial "flipped" element for vocabulary and basic concepts. Learnsmart™ and other online homework have not only changed the way professors evaluate their students with more formative assessments, but produced students who come to class more prepared and ready to learn.

While the percentage of the overall grade earned from homework remained mostly constant, the average number of homework assignments increased (Figure 3 & 4). This is likely because professors reported using a Learnsmart™ assignment from most chapters they covered in the e-textbook, with each assignment accounting for only a few points. Although the change in point value is not significant, the learning value of these assignments is high. Learnsmart™ is an adaptive learning environment that requires students to answer questions about reading material from the parallel e-text. If a student misses a question in the Learnsmart™ homework assignment, he/she has the opportunity to return to the e-text to review the section that was missed. A student who answers the questions correctly moves on to the next objectives in the text; while, a student who does not correctly answer the questions reviews the content with another similar question that Learnsmart™ generates. In this way, a student who has mastered a section of content does not spend additional time on content he/she understands, but a student who has not mastered the content can go back and review. Faculty reported in their interviews being able to review material that students missed on homework assignments before class and spending more time on this material during class. In addition, this adaptive system gave students the immediate feedback that Nichol and Macfarlane-Dick said Net Generation students need (2006). Formative assessments, not just summative, are important to student learning at the university level (Nicol & Macfarlane-Dick, 2006; Biggs and Tang, 2011). Learnsmart™ provided the necessary formative assessments to guide students but did not demand faculty time. Immediate feedback and remediation are part of the formative assessment model. In addition, Learnsmart™ asks the students how confident they are about each question before allowing them to answer. It shows the students that they often have a false sense of how well they understand material. This attribute of Learnsmart™ helped the students realize that they had not mastered content they thought they knew. Self-awareness of content mastery is an important part of the learning process.

Aside from online homework, the average percentage of general biology courses that used online quizzes and tests increased (Figure 2). Some of these online quizzes and tests were done on students' own computers, in a testing center, or even on iPads provided by faculty to complete online quizzes or tests. The Net Geners have grown accustomed to and are quite savvy with technology, making online tests and quizzes similar to what students have used during childhood. These online assessments are also entered into the gradebook more quickly, seen as an advantage by both professors and Net Geners who receive immediate feedback.

V. Contribution

Pedagogical change in the STEM disciplines is hard and slow. While use of technologies such as e-text and e-learning has been reported to increase student learning, the effects on faculty teaching is not well documented. This study examined the change in pedagogy through syllabi analyses and interviews. Findings show increases in formative assessment through the use of e-test and e-materials. Biology faculty were open to experimenting with flipped components of the course because of the support these materials offered. The strength of this studying is in providing another piece of understanding how STEM teaching can meet the changing learning styles of modern students.

VI. Implications/General Interest

This paper should interest faculty and administrators who struggle with how to coax faculty to change pedagogy to meet the needs of tech savvy learners. It provides data on how one institution moved to using e-texts and the changes in pedagogy that progressed with this shift.

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