THE EFFECTS OF DIFFERENTIATED HOMEWORK ON STUDENT PERFORMANCE, INTEREST, AND DILIGENCE IN A HIGH SCHOOL BIOLOGY COURSE

by

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STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE program shall make it available to borrowers under the rules of the program.

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July 2014

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ABSTRACT

The use of differentiated homework structures and vodcasts were investigated to determine if they improved student interest, diligence, and understanding of high school biology content and concepts. The project results support the notion that the use of vodcasts increase student interest and provide a useful alternative homework tool. The results do not support the use of a differentiated homework structure for the acquisition of biology content or mastery of concepts.

INTRODUCTION

A growing body of research, as well as my own experience, indicates that differentiated learning has distinct and measurable benefits for students. I have already adopted a number of such teaching methods and intend to adopt additional methods. Therefore I want to know whether my efforts are benefiting my students. Specifically, I want to measure changes in performance in meeting learning goals as well as effect on student interest and diligence. While I continue to adopt and refine a number of teaching strategies and tools aimed at creating a more student-centered and differentiated classroom, I am just beginning to investigate differentiated homework strategies. A differentiated homework strategy sets specific learning goals for a particular homework assignment and allows students to choose the medium in which they achieve those learning goals. For example, if a teacher wishes a student to have an introduction to macromolecules in a given homework allotment, instead of assigning a specific page range for the student to read the teacher would designate specific learning goals regarding macromolecules the student is required to accomplish and allow the student access to reading pages, teacher made video podcasts (hereafter "vodcasts"), or other internet resources. Similar to differentiated teaching strategies employed in the classroom, this technique is meant to allow students to pursue the mode of exploring the material in the manner that most interests them and best suits their learning preferences.

The differentiated learning structures appeals to me as a means of improving 1) the efficiency and effectiveness of teacher-student time, 2) increasing student responsibility for their own learning, 3) teaching metacognition and learning skills, and 4)

improving student diligence. First, as to the efficiency and effectiveness of teacher-student time, my experience has suggested that utilizing differentiated student-centered learning during the class day greatly improves the teacher's ability to work one-on-one with students in the areas where they need the most direct teacher intervention. I am interested to learn whether adopting a differentiated homework structure would allow students to focus their, often limited, homework time and effort on areas of greatest need. Second, I have also found that switching from a lecture-based strategy to a student-centered strategy allows a teacher to hold students more accountable for their own effort in synthesizing, analyzing, and evaluating core concepts and mastering skills on a daily basis. Utilizing techniques such as Process Oriented Guided Inquiry Learning (POGIL), allows daily formative assessment on scientific thinking skills along side of content acquisition. I am interested to learn whether a differentiated homework structure would encourage students to be more thoughtful and active in their own acquisition of content, by forcing them to review learning goals and choose methods that achieve those goals—not simply mechanically reading through a passage, regardless of comprehension. Third, forcing students to reflect on whether their homework activity is effectively and/or efficiently enabling them to achieve course learning goals would force them to consider what activities best suit their own learning. Fourth, I am interested to see how providing choice in the media in which they use to complete assignments affects student diligence.

The project collected student data from 34 students from three biology sections at Cate School in Carpinteria California. Cate is a private boarding high school and includes a student body of approximately 275 students. Cate is primarily a residential school; 84%

of Cate students are boarders. The school maintains a diverse student body with 41% students of color and with 22 states and 16 foreign countries represented. Cate also includes significant economic diversity with both full pay students and needs-based full scholarship students; each year Cate offers more than $2,600,000 in financial aid (C. Brownlee, Director of Admissions, personal communication, October 1, 2011).

CONCEPTUAL FRAMEWORK

Teachers face an apparent conflict between meeting demanding generalized standards and addressing the great range of their students' individual needs and strengths. Many critics have challenged teacher-centered instruction's effectiveness at balancing these two goals (Demski, 2012; Ellis & Worthington, 1994; Erdogan & Abd-Hamid, 2011; Fisher, 2003; McTighe & Brown, 2005; Moog & Spencer, 2008). Many researchers, commentators, and teachers present differentiated instruction techniques as a potentially effective means of meeting rigorous standards and appropriately addressing the diversity of student needs and strengths (Fisher, 2003; Hall, 2002; Landrum & McDuffie, 2010; Lawrence-Brown, 2004; McTighe & Brown, 2005; Moog & Spencer, 2008; Rock et al., 2008; Sternberg & Grigorenko, 2005; Tieso, 2005). Differentiated instruction refers to a pedagogical approach to both teaching and learning for students of varying readiness levels, interest, and modes of learning (Landrum & McDuffie, 2010). Differentiated instruction is "the process of matching learning targets, tasks, activities, resources, and learning support to individual learners' needs, styles and rates of learning" (Strandling & Sanders, 1993, p. 129).

One strategy available in the effort to achieve a differentiated classroom is the

flipped classroom technique. As described by one if its creators, Aaron Sams, this technique originated, and is still widely thought of, as using videos to move teacher-centered activities (i.e. lecturing) out of the classroom in order to make room for individualized instruction during the class day (Electronic Education Report, 2011; Sams, 2011). However, the creators of this technique have since articulated that video instruction is now simply one of the tools of flipped classroom and is no longer the centralizing principle. Rather, the technique is a collection of tools that serve a philosophy that promotes the use of class time for student-centered activities and differentiated instruction. Along with vodcasting (video podcasting of lectures), flipped classroom techniques include the use of learning-goal based curricular design and employing student-centered active lessons, utilizing tools including as web-based learning environments, PBL (Problem Based Learning), and POGIL (Process Oriented Guided Inquiry Learning) a student-centered group inquiry teaching technique based on constructivist principles (Sams, 2011; Moog & Spencer, 2008).

POGIL is one such student-centered instructional approach utilized in flipped classrooms (Moog & Spencer, 2008). In a POGIL classroom or laboratory, students work in small groups with the instructor acting as a facilitator. The students use carefully designed activities focusing on three key characteristics that require that these POGIL lessons:

- are self-managed by student teams, while the instructor serves as a facilitator of learning rather than as a source of information;
- structure student exploration to allow them to construct their own understanding;

- use discipline content to develop process skills including higher-level thinking, collaboration, communication, and the ability to learn and to apply knowledge in new contexts (Moog & Spencer, 2008, p. 3).

As articulated by Moog and Spencer (2008), the use of POGIL has two broad aims: to develop content mastery through student construction of their own understanding and to develop and improve important learning skills such as information processing, oral and written communication, critical thinking, problem solving, metacognition and assessment. The use of student groups as a learning tool has been subject of broader study outside of the POGIL context (Heller et al., 1992). While the existing studies of the effectiveness of POGIL are promising, they are rather limited in number (Farrell et al., 1999; Hanson and Wolfskill, 2000; Hinde and Kovac, 2001; Lewis and Lewis, 2005). Hanson and Wolfskill (2000) investigated the use of POGIL in general chemistry at a large, public university. Their research indicated higher student performance on assessments for students ranging from low to high performing. Lewis and Lewis (2005) investigated integrating POGIL with regular lecture-based instruction. They compared students who attended the POGIL sessions to those who did not and found that participating students showed higher average test scores on common examinations.

While the use of student-centered and differentiated techniques in the classroom is growing, it has recently been proposed that a similar philosophy should be applied to out-of-class work as well. The co-inventor of the flipped classroom teaching strategy, recently described how his flipped classroom concept has expanded beyond simply using video lectures as homework assignments to include student-centered activities in the

classroom and differentiated homework assignments (Sams 2011). The new technique sets learning goals for homework assignments and allows students free choice in how they achieve those goals. Employing these concepts, Paul Andersen of Bozeman High School, has created an entire course structure, modeled after video games, for his A.P. Biology class that allows students to proceed through selected activities and assessments at their own pace (Andersen, 2011). Using a differentiated homework structure challenges the familiar model for content acquisition homework, where students are assigned reading from a text. In a differentiated structure, students are given specific learning goals and provided options for achieving those learning goals. Those options can include reading from the text, teacher made vodcasts, Internet resources, etc. (Sams, 2011).

METHODOLOGY

The subjects of the research project were 34 students, in their junior year, in three separate sections of an introductory high school biology course. The Montana State University's Institutional Review Board approved an exemption for the methodology used in this project and the project maintained compliance for working with human subjects (Appendix A).

The research project was conducted over twelve weeks and included a non-treatment unit on population and community ecology, which employed vodcasts, a non-treatment unit on cell growth and division, which employed text reading, a non-treatment unit on evolution, which employed both vodcasts and text reading, and a treatment unit on cellular respiration. The treatment consisted of providing students with specified

learning goals for each homework assignment and allowing students to choose either vodcasts or text reading to meet those goals. In the non-treatment unit, students were given specific learning goals for each homework assignment, were not given discretion in the homework activity but were directed towards either a vodcast or a specific page range from the textbook, depending on the unit, to achieve the learning goals. All units included a variety of teaching methods, including laboratory activities, student-centered inquiry activities, small group and whole class discussion, problem-based learning, student presentations, and mini-lectures. In each unit, students were directed to utilize homework time to achieve specific learning goals.

The project used a number of qualitative and quantitative data collection instruments to investigate the effect of utilizing vodcasts as a homework option and employing student preference for homework material as a means of allowing for differentiated learning during homework assignments. The project obtained data through a number of instruments to compare the effects of vodcasts and student choice on performance, interest, and diligence. The multiple data sources were triangulated for each focus question and cross-referenced for non-treatment and treatment units. The project employed the Post-treatment Survey (Appendix B), Nightly Homework Surveys (Appendix C), and Teacher Field Notes and Reflections to assess student interest and diligence (Table 1). Pre-Unit and Post-Unit Assessments and Nightly Homework Surveys gathered information on student content acquisition and understanding for each unit. For determining the effects of vodcasts and a differentiated homework structure on student content acquisition and concept understanding, the project collected and

triangulated data using student Pre-unit and Post-unit Assessments, a Post-Treatment Survey, Nightly Homework Surveys, and Teacher Field Notes and Reflections. For determining the effects of vodcasts and a differentiated homework structure on student interest and diligence, the project collected and triangulated data using student Post-Surveys, Nightly Surveys, and Teacher Field Notes and Reflections.

All units included both Pre-unit and Post-unit Assessments to measure changes in student understanding. Pre-unit and Post-unit Assessments were given to all students in all three sections for to assess content acquisition and concept understanding. Assessments were designed to draw on all levels of Bloom's taxonomy, with questions on knowledge, comprehension, application, analysis, and evaluation. Understanding was determined using criteria defined by *Wiggins* and McTighe (2006) in *Understanding by Design*. The Pre-unit Assessments utilized a quiz format consisting of around 10 questions each, largely multiple-choice with a few short answer questions. The Post-Unit Assessments utilized a summative unit assessment format consisting of around 25 multiple choice, 5 short answer, and 1 short essay question. Both Pre-unit and Post-unit Assessments were graded. The results of both Pre-unit and Post-unit Assessments were evaluated for demonstration of content acquisition and concept mastery. An Analysis of Variance (ANOVA) was used to evaluate the distribution of student performance on the Post-unit Assessments (Appendix D).

Short Homework Quizzes were added mid-study in order to provide a more direct measure of the effect of the various homework assignments on content acquisition. Students completed the quizzes in the class period following the completion of the

relevant homework assignment. The quizzes consisted of around 10 questions each, largely multiple-choice with a few short answer questions.

A Post-Treatment Survey investigated student perception of their own interest and diligence and of the effectiveness of a differentiated homework structure on content acquisition and concept mastery. The survey included 11 Likert scale questions asking students to evaluate statements regarding the effect of a differentiated homework structure on their interest in the homework and varying aspects of their learning. The questions also sought to elicit student perception of the affect of vodcast and reading assignments. In addition, the survey included an open-ended text question asking students to evaluate the value of a differentiated homework structure.

Each unit included mandatory online Nightly Homework Surveys requiring student self-assessment on comprehension of core content, areas of confusion, and student curiosity. In order to gather data on these topics the surveys posed three questions: *What was the clearest point from the homework? What was the least clear or "murkiest" point?* and *What would you like to know more about?* The results of the survey were evaluated in a number of ways. Simple completion rate of the survey was used to assess student diligence. The number of student responses identifying a specific "murkiest" point was used to evaluate student learning and self-evaluation. The number of student posed extension questions were used to evaluate both student learning and interest. The nature and quality of student responses was evaluated to assess student content acquisition, concept mastery, diligence, and interest.

Teacher Field Notes and Reflections were recorded to catalog teacher perception on

student content acquisition, understanding, and interest. The reflections and notes recorded teacher observations and analysis of student behavior and performance in class during treatment and nontreatment units.

Table 1
Triangulation Matrix for Vodcasts and Differentiated Homework

Focus Question	Data Source 1	Data Source 2	Data Source 3	Data Source 4	Data Source 5
1. What are the effects of vodcasts on student acquisition of high school biology content?	Pre- and Post-assessments	Post-Treatment Survey	Nightly homework surveys	Homework Quizzes	Teacher journal reflections and field notes
2. What are the effects of vodcasts on student understanding of high school biology concepts?	Pre- and Post-assessments	Post-Treatment Survey	Nightly homework surveys	Homework Quizzes	Teacher journal reflections and field notes
3. What are the effects of vodcasts on student interest and diligence?		Post-Treatment Survey	Nightly homework surveys		Teacher journal reflections and field notes
4. What are the effects of differentiated homework assignments on student acquisition of high school biology content?	Pre- and Post-assessments	Post-Treatment Survey	Nightly homework surveys		Teacher journal reflections and field notes
5. What are the effects of differentiated homework assignments on student understanding of high school biology concepts?	Pre- and Post-assessments	Post-Treatment Survey	Nightly homework surveys		Teacher journal reflections and field notes
6. What are the effects of differentiated homework assignments on student interest and diligence?		Post-Treatment Survey	Nightly homework surveys		Teacher journal reflections and field notes

DATA AND ANALYSIS

Student content acquisition and concept understanding showed greater numerical improvement in the treatment unit compared to each nontreatment unit, regardless of the type of homework assigned. The treatment unit's percent change between Pre-unit and Post-unit Assessment was 19 percentage points higher than the next closest treatment unit and 32 points higher than the lowest. However, there was also notable variability in the percent change between the nontreatment groups with 13 percent points between the highest and lowest values (*N*=34).

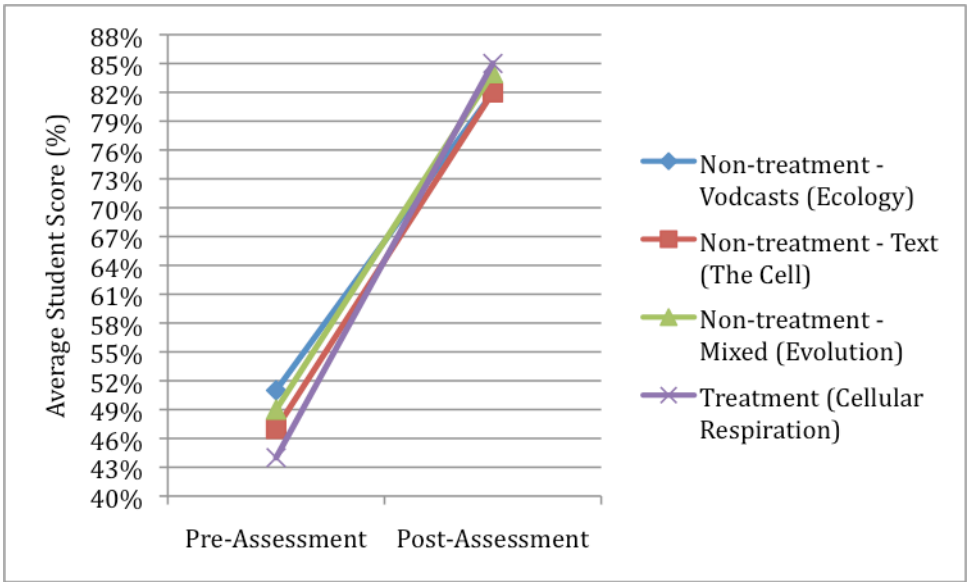

Figure 1. Average of Student Performance on Pre-unit and Post-unit Assessments, (*N*=34).

Looking at the Post-unit Assessment alone, the students demonstrated very similar summative levels of content acquisition and concept understanding. The student scores on Post-unit Assessments varied only within a 3 percentage point range. Thus, regardless of the homework method, students demonstrated a similar level of summative content

acquisition and concept understanding. A review of written, open-ended portion of the Pre-unit Assessment results indicated that students showed similar levels of content knowledge and conceptual understanding of each subject. It was the objective multiple choice question portions that led to the variance in student performance from unit to unit. Teacher field notes recorded that students, when asked about their performance on the Pre-unit Assessments, described making educated guesses.

Table 2
Pre-unit and Post-unit Assessment Averages Reported with Percent Change, (N=34)

Description of Data	Nontreatment—Vodcasts (Ecology)	Nontreatment—Text (The Cell)	Nontreatment—Mixed (Evolution)	Treatment (Cellular Respiration)
Pre-unit Average	51%	47%	49%	44%
Post-unit Average	82%	82%	84%	85%
Percent Change	61%	74%	71%	93%

In light of the narrow distribution of average student performance on Post-unit Assessments (82%, 82%, 84%, and 85%), an Analysis of Variation (ANOVA) was undertaken to evaluate whether a statistically meaningful variance between the treatment unit's and nontreatment units' data sets existed. The ANOVA resulted in a relatively large *p* value of 0.242, which did not increase confidence in the meaningfulness of the difference between the Post-unit Assessment results (Table 3).

Table 3
Post-unit Assessment Data Analysis of Variance (N=34)

Sources of Variation	Sum of Squares	d.f.	MS	*F*	*p*
Between	0.033	3	0.011	1.413	0.242
Within	1.015	132	0.008		
Total	1.048	135			

On the Homework quizzes, students demonstrated a notably higher content acquisition and concept understanding in the nontreatment unit compared to the treatment unit (Table 4). Thus, student performance on a focused homework quizzes does not support the notion that differentiated homework assignments improve student content acquisition and concept understanding.

Table 4
Homework Quiz Performance, (N=34)

Description of Data	Evolution Nontreatment—Mixed	Cellular Respiration Treatment
Average Student Performance	93%	83%

When responding to the Nightly Homework Survey questions following a differentiated homework assignment, students had a greater number of clarification questions and a greater number of extension questions (Table 5). The survey asked students to identify the "murkiest" or least clear point as a means of assessing both the effectiveness of the assignment and the level of reflection the student undertakes to evaluate his own learning. Only 18% of the responses during the treatment unit indicated that they did not have any clarification questions. This was 18 percentage points fewer than vodcast assignments and 4 percentage points fewer than reading assignments. The treatment unit also had the highest percentage of extension questions, where students

indicated what—beyond what was provided in the homework assignment—they would like to know about a subject. The treatment unit had 2 percentage point fewer responses lacking extension questions compared to vodcast assignments and 3 percentage points fewer than reading assignments.

Table 5
Student Response to Online Homework Survey, (N=34)

Description of Data	Response to Reading Assignment	Response to Vodcast Assignment	Response to Differentiated Assignment
Number of Student Responding	94%	95%	96%
Number of Student Responses Stating "No Need For Further Clarification" In Response To Question 2	22%	36%	18%
Number of Student Responses Lacking Extension Questions In Response to Question 3	5%	4%	2%

In reviewing the text of the responses, when asked what was the *most clear or helpful* portion of the homework and what was the *murkiest or least clear* portion of the homework, students had a great range of responses, but there was no discernable difference in the quality or type of the questions posed by students between treatment and nontreatment units. In each unit, many of the responses indicated that students reflected on their level of understanding and the areas that they wish further clarification. For both the text reading assignment, the vodcast assignment, and the differentiated homework assignments, these responses ranged from simple identification of terms or concepts, such as "the murkiest point was the polygenic trait," to detailed questions on a concept, such as

"if species usually divide resources then why can't no [sic] two species occupy the same exact niche in the same exact habitat and at the exact time?" However, the reading assignments did result in slightly more detail used to describe the lack of understanding or request for clarification.

Teacher journal entries and field notes showed a correlation between students engaging in post-homework follow up questions and student use of teacher made vodcasts. At the start of most classes the students were asked if they had questions from the prior night homework. When students had questions or comments notations were made in the field notes indicating the general nature of the question. An analysis of the field notes indicated that vodcasts generated a greater number and frequency of follow up questions than did text readings. This appeared to be the case regardless of whether students were utilizing vodcasts as part of a differentiated or non-differentiated homework structure.

The Post-Treatment Survey asked the students to assess if they *prefer to have a choice, for every homework assignment, between text reading or vodcasts*? *If so, why? How does that help? If not, why not?* Only three students (8%) expressed that they preferred having a choice between assignments. As can been seen by the samples in Table 5, the vast majority of students expressed that they preferred that the teacher select the most appropriate medium for the assignment. A minority of the respondents expressed an appreciation for one medium over another, for example vodcasts over text reading. Of this minority, four students expressed appreciation for vodcasts over reading and two expressed appreciation for reading over vodcasts. Seventy-three percent,

expressed concern with differentiated homework. All of these responses indicated that they preferred specifically designated homework as it reduced the uncertainty in the material covered. The responses appeared to reflect a strong student perception that the two mediums inherently lead to difference in content and concept acquisition. A close reading of the responses that indicated a preference for a differentiated homework structure revealed that each of those responses appeared to express a preference for access to both vodcasts and reading, not necessarily a preference for student choice between mediums.

Table 6
Sample Student Responses to Survey Question on Whether They Prefer a Differentiated Homework Structure, (N=34)

Example responses against differentiated homework	Example responses in favor of differentiated homework
"No because then you have to make vodcasts that no one would watch. or we watch your vodcasts and not read from the book. You should be using both tools, as they both help us learn in different ways."	"yes I prefer a choice to watch a vodcast becasue [*sic*] the textbook is occassionally [*sic*] vague and after reading I do not have a firm grasp of the topic where as vodcasts are usally [*sic*] pretty easy to understand. But I like the textbook as an option for studying for tests and reviewing vocab."
"I prefer to have one or the other, because if I don't do the reading or don't do the vodcast then I feel like I missed something if I didn't do both of them. It is nice to have both and then do one as hw and have one as a resource for later."	"yes, because sometime the book explains the topic well and in a concise fashion and other times vodcasts are more easy to understand"
"no because we all get different information"	
"I think that it's good to not have a choice between the two. I think it makes class a little confusing because the students are doing different homework, and especially when they asked questions in class about certain material that other students don't know about yet. I like both textbook reading and vodcasts, and think that vodcasts should be homework more often in every unit because sometimes it's nice to take a breather from reading through the book."	

Some of the questions within the Post-Treatment Survey were specifically designed to distinguish between 1) a student preference for simple access to both vodcasts and reading without a differentiated homework structure and 2) student preference for a differentiated structure. When asked if having access to both vodcasts and readings improves their learning (Post-treatment Survey #9), 82% of students (*n*=28) agreed that access to both mediums improves learning (Figure 3). Of those agreeing, 41% students strongly agreed. None of the students disagreed with the statement and only 17% (n=6) students expressed a neutral opinion. When asked if having the choice (e.g. vodcast or reading) in picking how they complete their homework learning goals helps improve their learning (Post-treatment Survey #10), 62% of students agreed with the statement. In addition, over 6% of students actively disagreed that a differentiated homework structure improved their learning. Thus the results indicate that a larger number of students view simple access to both mediums as a benefit to their learning. However, in contrast to the open-ended response, a majority of students still indicated that a choice between homework types would benefit their learning.

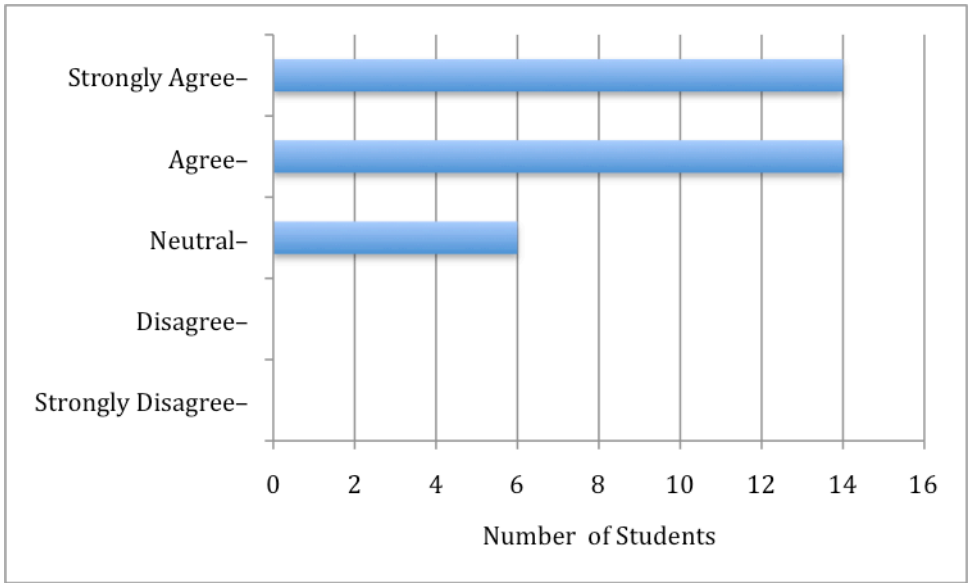

Figure 2. Student responses to Post-Treatment Survey question on whether access to vodcasts improves their learning, (*N*=34).

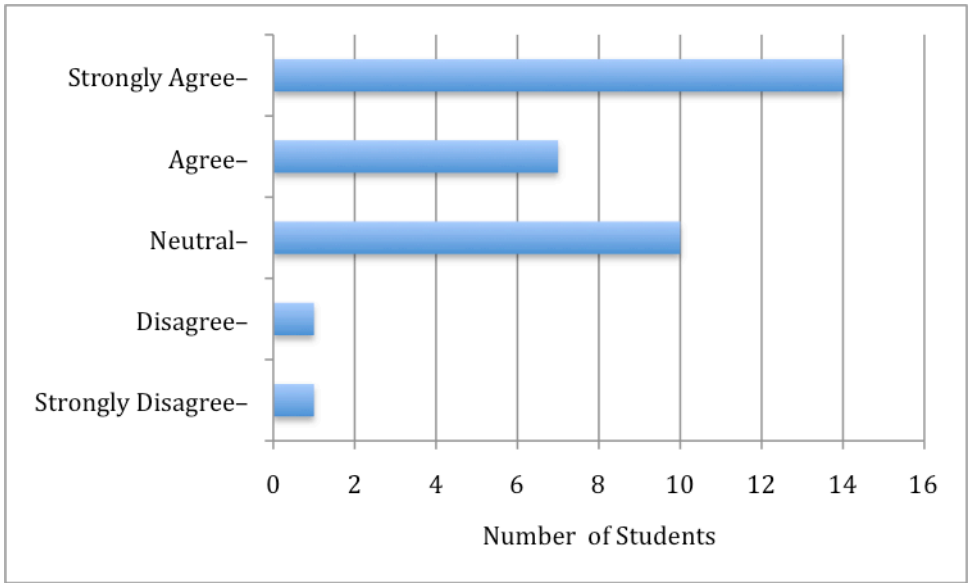

Figure 3. Student responses to Post-Treatment Survey question on whether having a choice of homework improved their learning, (*N*=34).

The Post-Treatment Survey may also shed some addition a light on the effect of vodcasts on student perception of their learning. One line of questions (Post-treatment

Survey #5, 6, and 8) investigated the effects of vodcasts as a homework tool on student content acquisition and understanding. Question 5 asked students to evaluate if the use of vodcasts helped improve their learning (Figure 4). A majority of the students, 67%, agreed that vodcasts improve their learning. As shown in Figure 2 below, 29% of respondents *strongly agreed* and 38% simply *agreed*. Only 5% of students *disagreed* and none indicated that they *strongly disagreed*.

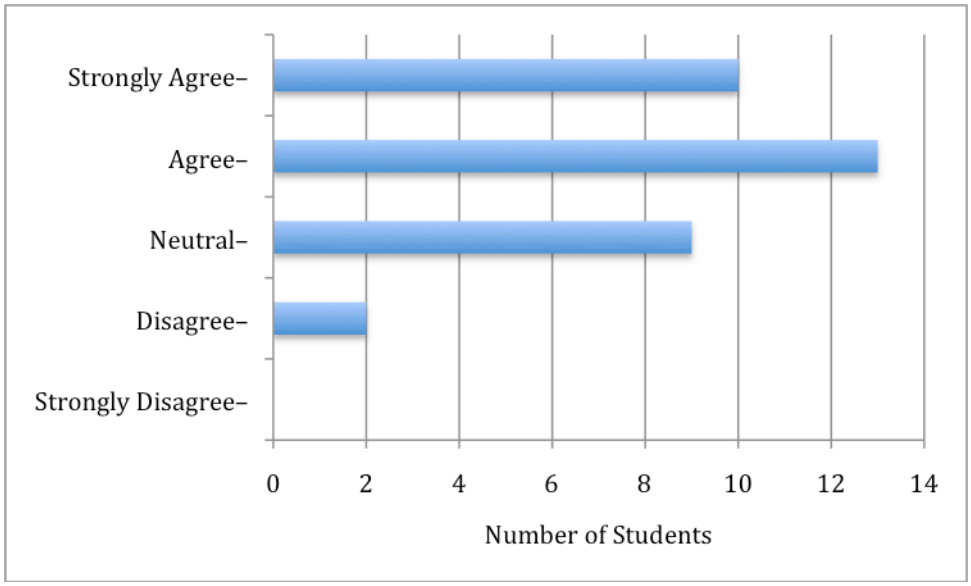

Figure 4. Student responses to Post-Treatment Survey question on whether the use of vodcasts improving learning, (*N*=34).

However, when the students responded to a question that specifically asked them to analyze the affect of vodcasts on the student's preparation for tests and quizzes, the number of positive responses decreased (Figure 5). Only 44% students agreed with the statement and the number of disagreeing students tripled to 6 (17%). Thus, while there was not strong disagreement from the students that vodcasts improved preparation for

assessments, students identified other value in vodcasts besides preparation for quizzes and tests.

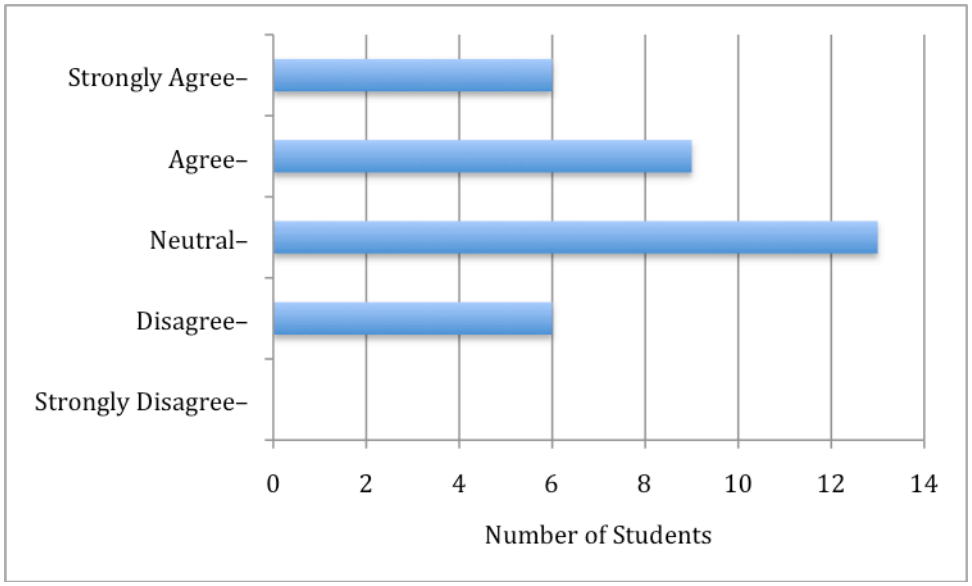

Figure 5. Student responses to Post-Treatment Survey question on whether vodcasts improved preparation for assessments, (*N*=34).

Students responded most positively to the suggestion that vodcast improves their interest in the material (Figure 6). Almost 80% of students agreed that vodcasts improved their interest (*n*=27). Of those agreeing, 41% strongly agreed. Thus, the strongly positive student response to the statement that vodcasts improve their learning may be attributable to their belief that vodcasts improved their interest level. Yet, when asked if they would prefer more vodcasts and less reading the largest number of students, 26%, disagreed with the statement (Figure 6).

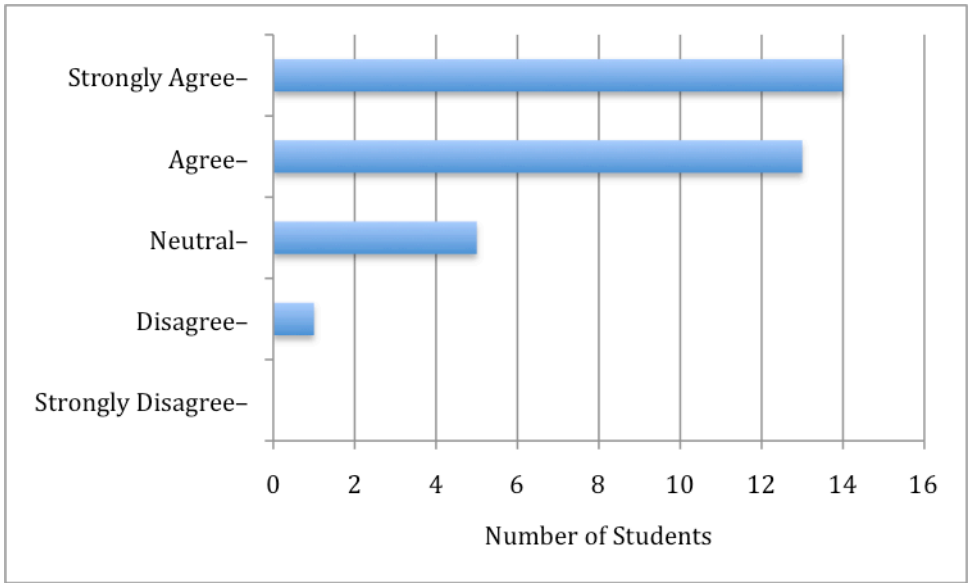

Figure 6. Student responses to Post-Treatment Survey question on whether vodcasts improved their interest in course materials, (*N*=34).

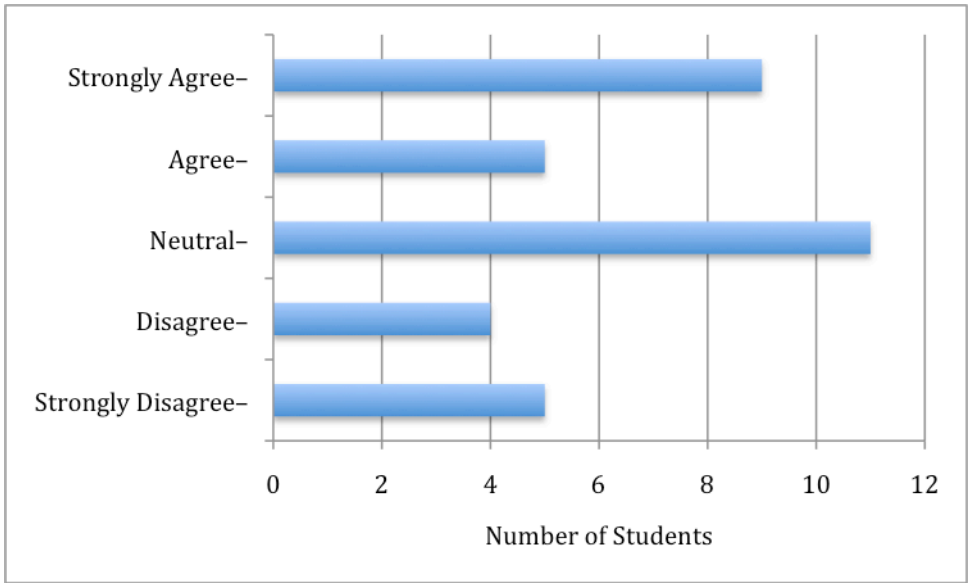

Figure 7. Student responses to Post-Treatment Survey question on whether they had a preference for vodcasts over reading assignments, (*N*=34).

The results of the Nightly Homework Survey indicated that student diligence increased by 2% using a differentiated homework strategy over text based homework and

1% over vodcast homework assignments as shown in Table 5 above (N=34). The determination of diligence was based on student completion of the survey questions after the homework assignment as an indirect measure of the number of students completing the homework assignment. Thus the results of the survey indicated that there is only small difference between the treatment and nontreatment units regarding student diligence.

Similarly, the Nightly Homework Survey results showed a small difference, between treatment and nontreatment units, in the number of extension questions posed by students. For the purpose of the survey, student posed extension questions are assumed to be an indirect measure of student interest in the material. As described above, the range in the number of responses based on treatment or nontreatment spanned only a few percentage points. In addition, as described above, there was no discernable difference in the nature or quality of the questions posed in response to treatment and nontreatment units.

The Post-Treatment Survey sought a direct measure of student's perception of how a differentiated homework structure and vodcasts affected their own interest and diligence in the homework assignments. As described above, the open response question resulted in numerous statements from students indicating a strong preference for a non-differentiated homework structure. None of the responses indicated that the differentiated structure encouraged greater interest or diligence. When asked to assess how much they enjoy completing homework assignments, 50% of the students either agreed or strongly agreed that they enjoyed the reading assignments, while 8% disagreed and 2% strongly

disagreed (Figure 8). However, when asked if they enjoyed vodcast assignments 67% students either agreed or strongly agreed, 14% disagreed, and no students strongly disagreed (Figure 9). These results correspond with teacher field notes, which record students, before class, engaging several spontaneous and excited discussions of the prior night's vodcast. No similar discussions were observed following a reading assignment.

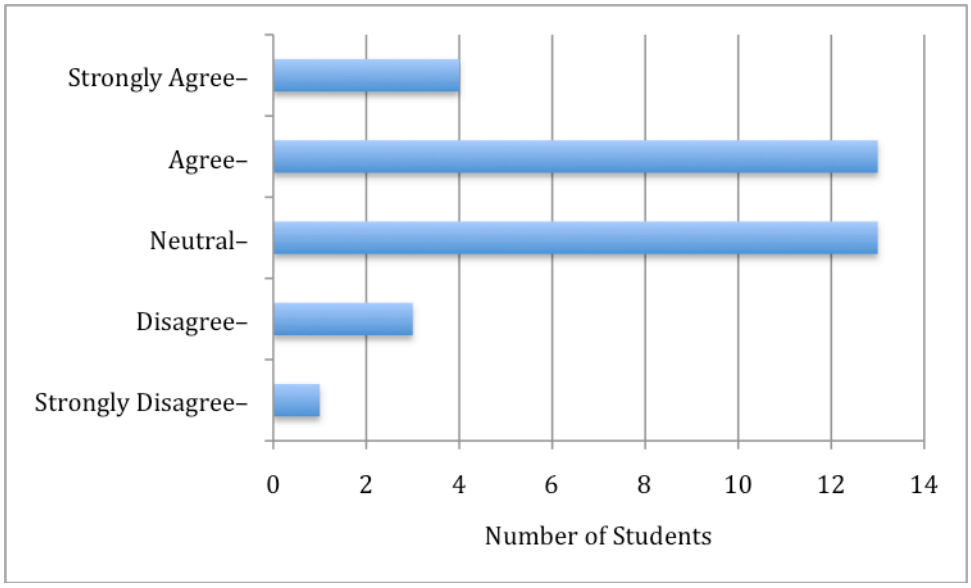

Figure 8. Student responses to Post-Treatment Survey question on whether they enjoy reading assignments, (*N*=34).

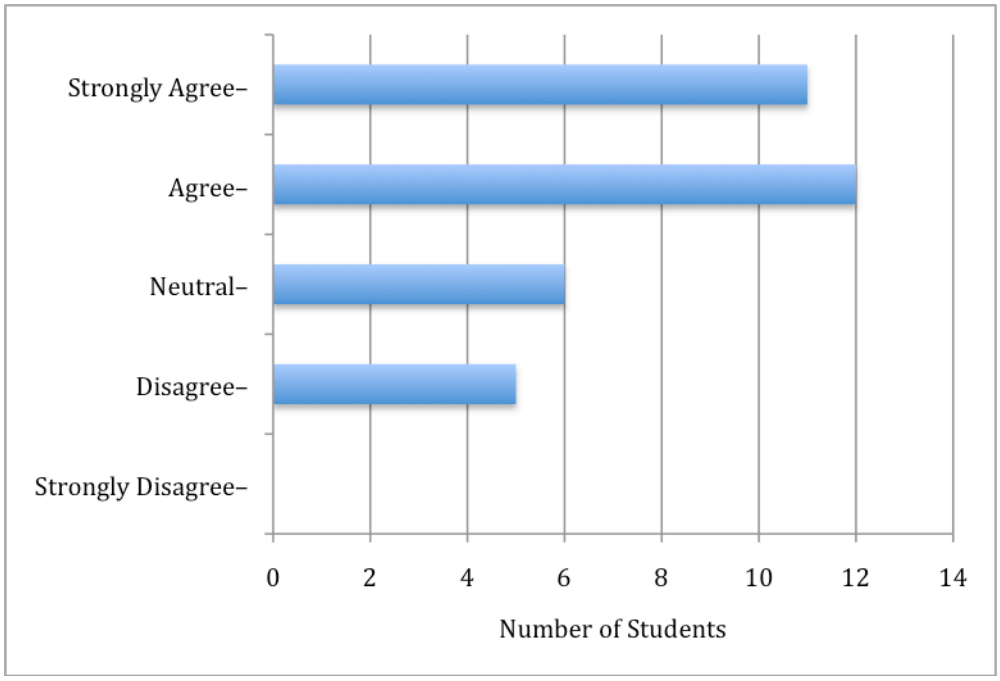

Figure 9. Student responses to Post-Treatment Survey question on whether they enjoy vodcast assignments, (*N*=34).

INTERPRETATION AND CONCLUSION

Data were analyzed to answer the focus questions on the effect of differentiated homework and vodcasts on students' concept acquisition, understanding, diligence, and interest. The data collected from the four units of study suggest mixed results as to the effectiveness of differentiated homework. Similarly, there were mixed results on the effect of vodcasts. However, triangulation of the data collected allowed for some relatively definitive conclusions. The data showed a slight numerical benefit from a differentiated homework structure on student acquisition of content and concept understanding. Yet, there was a strongly negative student perception of the technique and its effects. The use of vodcasts showed a slight numerical detriment on student acquisition of content and concept understanding. Yet, there was a very strong positive

student perception on the use of vodcasts effect on their interest level and learning.

Analysis of the percent change between the Pre-unit and Post-unit Assessments show increased student growth in content acquisition and concept understanding during the treatment unit. However, there is reason to question the meaningfulness of the observed differences in percent change as a means of assessing the effectiveness of these homework methods. The data suggest there may be reason to question the effectiveness of the Pre-unit Assessments as a measure of pre-unit content and concept mastery. Teacher field notes record student descriptions of their experiences on the Pre-unit Assessment. The students described making educated guesses on the multiple-choice section of the Pre-unit Assessments. The Pre-unit Assessments employed a quiz format of around 10 questions consisting of mostly multiple-choice and a few short answer questions. An analysis of the short answer responses indicates a similar low level of content and concept mastery, regardless of the unit. Given the small sample size ($N = 34$) and the small number of questions, it is possible that chance played a role in creating the variance between the Pre-unit Assessments. Thus the student performance on the Pre-unit Assessments, and consequently the percent change in student performance between the Pre-unit and Post-unit assessments, is suspect and may be of limited value.

Given the concerns with the Pre-unit Assessments, the results of the Post-unit Assessments alone appear to be a better measure of the effectiveness of each homework method on improving student content acquisition and concept understanding. Considering the narrow distribution of the average student performance (82%, 82%, 84%, and 85%), the actual student demonstration of content acquisition and concept understanding does

not appear to support the conclusion that a differentiated homework structure or the use of vodcasts has meaningful impact. In light of the narrow distribution of average student performance an Analysis of Variation (ANOVA) was conducted. The analysis resulted in a relatively large *p* value and thus confirmed that there is little statistical difference between the experimental unit test results.

In addition, there is some difficulty in establishing a conclusive causal relationship between the assessment results and the treatment. Each unit unavoidably differed in its subject matter, the unique laboratory and learning activities, and in the questions within the Pre-unit and Post-unit Assessments themselves. While a consistent and significant effort was made to control these variables, given the real-world setting it is impossible to fully mitigate these concerns. Thus, there is only limited means to conclusively attribute trends in the assessment results with the homework strategies themselves. At best a strong correlation in the results could suggest a possible connection. However, given the limited visible trend here, this particular source of data (the Pre-unit and Post-unit Assessments) does not support the suggestion that a differentiated homework strategy or the use of vodcasts improves student content acquisition and concept understanding.

The Analysis of the Nightly Homework Survey does suggest a small value to both a differentiated homework structure and the use of vodcasts. When responding to the Nightly Homework Survey questions following a differentiated homework assignment, students had a greater number of clarification questions and a greater number of extension questions. Given the larger percentage of clarification questions, students appear to engage in greater reflection on their level of understanding of the material.

Given the larger percentage of extension questions, students also appear to engage in greater reflection on the subject matter. Similarly, when comparing vodcast assignments to reading assignments, vodcasts had a greater number of extension questions. However, the reverse was true for the clarification questions. Thus, the survey results are more mixed on the value of vodcasts. However, one interpretation of the results of the Nightly Homework Surveys may indicate students felt greater confidence about their understanding after the vodcast than they did after the reading or after a differentiated homework assignment. If students are not identifying an idea in response to *What was the murkiest point (least clear idea)?,* perhaps it is a results of greater confidence born from a more effective teaching medium. This interpretation calls into question one of the assumption of the analysis of the Nightly Homework Survey, namely that responses to the *murkiest idea* question demonstrate greater student reflection. Teacher reflection and field notes cannot conclusively resolve this issue. Conversations with students and whole class discussion following homework assignments in each unit did not provide a clear and consistent distinction in student confidence or a means to accurately assess student self-reflection. Another limitation in the Nightly Survey results stems from the fact that they were graded assignments and that the treatment unit followed all of the non-treatment units. As a relatively new and novel activity, nightly online responses to homework assignments appear to improve over the school year as students are trained in and become accustomed to the activity. Given the treatment units placement in the year, following all the non-treatment units, improved student performance could be explained by improved understanding and diligence in completing a graded assignment after many

months of direct teacher feedback on the activity. Moreover, given the small sample size (*N*=34) a great number of events in the personal lives of students could have a large enough effect on the results to explain some of the observed differences between units. In fact, teacher journal reflections do note a great number of events that could have influenced the results including: prolonged student illness, death of a family member, increased work or difficulty in another class, romantic struggles, involvement in school performances, frequent absences due to sport commitment, and absences due to school suspension. Of course, while the study was undertaken at a boarding school where the teacher has a relatively high level of knowledge of student's lives outside the classroom, there are undoubtedly other unobserved events that could have also influenced student performance and effected the results given the sample size. Thus, while the Nightly Survey results could be a persuasive source of evidence given a larger sample size, in this case the observed degree of difference between units appears to be of limited value.

On the other hand, triangulation with Teacher Journal Entries and Field Notes support the Nightly Survey question results on the effect of vodcasts and extension question. Teacher notes indicate a correlation between students engaging in post-homework follow up questions and student use of teacher made vodcasts. However, there are several plausible explanations for this observation. It may be that a professionally written and edited textbook generates less questions than a teacher made vodcast simply because it is clearer and more accurately predicts and addresses student questions in the text itself. Alternatively, the students may take a more passive approach to reading assignments than vodcasts, the latter resembling lecture classes in which students

routinely ask questions. Lastly, it may be that teacher made vodcasts successfully generate greater student reflection and thus student inquiries. Student responses to Post-unit Survey questions and comments made to the teacher throughout the year support the notion that vodcasts do in fact generate greater interest and reflection. Yet, further research is needed to determine whether this observed correlation is accurate and, if so, what is the precise cause of the student behavior.

By far the strongest and most compelling data resulted from the Post-treatment Survey. The results provide persuasive evidence for conclusions on the value of a differentiation homework structure. The open-ended question asking students to evaluate the value of their choice in media for completing assignments overwhelmingly reflected student concern with differentiated homework. The student responses indicated that they preferred specifically designated homework as it reduced the uncertainty in the material covered in the assignment. Although a well designed differentiated homework structure would facilitate equal access to content and concepts regardless of the homework medium, there appears to be a strong student perception that the two mediums inherently lead to difference in content and concept acquisition. Moreover, a close reading of the responses that did indicate a preference for a differentiated homework structure reveal that each of those responses may express a preference for simple access to both vodcasts and reading, not necessarily a preference for student choice between mediums. The likert scale questions provided additional clarification on this particular issue. When specifically distinguishing between “access to” versus “choice between” both mediums, students more strongly agreed that it is access to both vodcast and text reading, not their

ability to chose between the two on a given assignment that most improves their learning. Thus, it may be possible to address these student's learning preferences by making both vodcasts and designated reading available for their use, while still assigning one or the other for a specific homework assignment. This would also alleviate the majority concern expressed in the open-ended question, while supporting students who like to have access to both mediums. Students would then complete the homework as assigned and then access the additional resource at their discretion.

The Post-treatment Survey also provides conclusive results on student perception of the value of vodcasts. The results strongly support the conclusion that students both enjoy the use of vodcasts and have a general preference for them over text reading. The results also indicate that students perceive an education benefit from vodcasts. However, slightly fewer students agree that vodcasts prepare them well for assessments. The students show the strongest support for the notion that vodcasts increase their level of interest. Thus the results indicate that student perception that vodcasts improve their learning may be a result of their improved engagement with the course material.

Overall, the results lead to several distinct conclusions. First, there is not compelling evidence to support the use of this form of differentiated homework structure. In addition, there is a strong student perception that this form of differentiated homework structure is a detriment to their learning. Thus, the results lead me to conclude that I should not employ this homework technique in the future. Second, there is a strong student perception of the value of vodcasts in improving their interest level and thus their learning. Teacher field notes and reflection support this student perception. However, this

study did not result in compelling evidence that vodcasts improve diligence or performance on assessments. Therefore, the use of vodcasts appears to have an important place in my homework structure, but they should be used for the specific purpose of engaging students and providing an alternate source of explanations for difficult concepts.

VALUE

My experience as a teacher has led me to appreciate differentiation as an important tool for improving student learning. I have long suspected that differentiation increases student investment in their own learning and consequently improves their interest, diligence, and mastery. Over the last half decade, I have been working to improve and expand my use of tools and techniques that allow for greater differentiation. I have aspired towards the fully differentiated course structures employed by pioneers in the field. However, I have been limited by practical concerns such as coordination of laboratory experiments, presentations, and whole class discussion. Thus, I have attempted to *pluck the low hanging fruit* by looking for discrete means of employing differentiation while I attempt to design a feasible structure that would allow full differentiation. Vodcasts have been a useful tool for capturing and controlling homework time in a manner that allows me to better utilize class time for differentiated group work—by decreasing the time used for teacher-centered presentation. Before this project I had never attempted to employ a differentiated homework structure, but it struck me as a potential means of enlisting student more fully in their education by giving them some greater control and ownership over their homework assignments.

This action research-based classroom project has confirmed what my observation and intuition suggested about vodcasts. Given the very positive response from students on the use of vodcast as a tool to increase their interest and as an alternate tool for explaining concept, I intend to refine and expand my use of vodcasts. Vodcast production is a very time consuming process for me. I invest around 10 min of work for every 1 min of vodcast. Teachers more experienced with vodcasts encourage "first-take" vodcasts, where the teacher uses their first attempt without spending significant time on revisions and refinement. I have been unable to adopt this mentality and as a result my ability to produce vodcasts is limited by time; thus, I create most of my vodcasts over the summer. I have already created a good number of vodcast aimed at spurring student interest. I now intend to expand the number of vodcast that are designed for review or tutoring of difficult concepts.

This action research-based classroom project has convinced me that I should not spend any more time on differentiated homework structures of this nature, given the strong student dislike of the technique and lack of compelling evidence for a benefit resulting from its use. I do wonder whether the negative response towards homework differentiation was a direct result of the binary choice I gave the students. Perhaps a more open-ended differentiation, where students were entirely free to research and explore topics, would receive greater support. I can imagine using such a system in a project based learning setting. Yet that is a very different structure from the one I explored and would achieve very different learning goals.

As my small class sizes resulted in a very small sample size for this study, I would

be hesitant to claim that all of these results are widely applicable. However, the study does indicate that vodcast may provide a distinct benefit in engaging students and providing them with an alternative review tool. Although my sample size was small, there was a widely held opinion among my student that vodcasts played an important role in their education. Thus, a clearly applicable result from this action research project is the potential value of vodcasts as an education tool.

My experience in developing and executing this research project has changed my teaching by increasing my belief in the importance of the use of written reflection as a teacher. Prior to the project I engaged in active observation of my student's behavior, practices, and performance in class and I would occasionally make notes to myself on my observations. However, as part of the research project I took weekly field notes and reflection. The regular and systematic written recording of observations and reflection provided a much richer, more accurate, and more useful set of information. By providing a formalized practice of reflecting on student behaviors, practices, and performance, this regular note-taking improved my ability to assess students and provide both more meaningful and more immediate feedback.

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APPENDICES

APPENDIX A

INSTITUTIONAL REVIEW BOARD APPROVAL

MONTANA
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INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
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MEMORANDUM

TO: Joshua Caditz and John Graves

FROM: Mark Quinn, Chair Mark Quinn CHf

DATE: December 3, 2012

RE: *"The Effect of Differentiated Homework on Student Performance, Interest, and Diligence"* [JC120312-EX]

The above research, described in your submission of December 3, 2012, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

_X_ (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

_X_ (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

____ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

____ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

____ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

_____ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

POST-TREATMENT STUDENT SURVEY

Post-Treatment Student Survey

Please indicate your level of agreement with the following statements, with 1 indicating that you strongly disagree and 5 indicating that you strongly agree.

Strongly Disagree Disagree Neutral Agree Strongly Agree

1. Homework in general is important for my understanding of course materials.
2. The homework is important for my preparation for class.
3. I enjoy doing the regular nightly homework, when it is watching a vodcast.
4. I enjoy doing the regular nightly homework, when it is reading from the text book.
5. The use of vodcasts helps improve my learning.
6. The use of vodcasts improves my preparation for quizzes and tests
7. The use of vodcasts helps improve my interest in the material.
8. I'd prefer more vodcasts and less reading.
9. Having access to both vodcasts and readings improves my learning.
10. Having the choice (e.g. vodcast or reading) in picking how I complete my homework learning goals helps improve my learning.

Free response question

11. Would you prefer to have a choice, for every homework assignment, between text reading or vodcasts? If so, why? How would that help? If not, why not.

APPENDIX C

NIGHTLY HOMEWORK SURVEY

Nightly Homework Survey

1. What, in the reading or vodcast, did you find to be the most helpful?
2. What, in the reading or vodcast, was the murkiest point (the least clear)?
3. What would you like to know more about?

APPENDIX D

ANALYSIS OF VARIANCE (ANOVA)

Analysis of Variance (ANOVA)

Groups	4
Nmax	34

	Mean	*n*	Std. Deviation	Between
Group1	0.817647059	34	0.094389869	0.011639672
Group2	0.8261	34	0.083737302	0.003433798
Group3	0.843082353	34	0.065632819	0.001634154
Group4	0.857768908	34	0.102655225	0.015891441
Overall	0.83614958	136	0.088104099	

Source	*Sum of Squares*	*df*	*MS*	*F*	*p*
Between	0.033	3	0.011	1.413	0.242
Within	1.015	132	0.008		
Total	1.048	135			

η^2	0.031

Analysis of Variance (ANOVA) - Continued

Ecology	Cells	Evolution	Cellular Respiration
0.76	0.57	0.68	0.73
0.83	0.84	0.82	0.88
0.64	0.69	0.88	0.67
0.90	0.82	0.84	0.90
0.95	0.91	0.85	0.93
0.81	0.85	0.89	0.89
0.79	0.89	0.89	0.90
0.79	0.88	0.76	0.85
0.60	0.81	0.89	1.00
0.88	0.87	0.73	0.61
0.95	0.75	0.91	0.90
0.90	0.90	0.75	0.84
0.79	0.80	0.97	0.98
0.95	0.94	0.90	0.73
0.62	0.73	0.73	0.77
0.74	0.77	0.81	0.66
0.83	0.77	0.85	0.95
0.88	0.86	0.90	0.87
0.88	0.92	0.84	0.84
0.64	0.81	0.85	0.90
0.79	0.92	0.95	0.80
0.90	0.79	0.92	0.97
0.90	0.92	0.80	0.97
0.88	0.92	0.88	0.96
0.88	0.86	0.81	0.88
0.81	0.64	0.81	0.93
0.83	0.86	0.85	0.91
0.74	0.76	0.86	0.83
0.79	0.77	0.78	0.69
0.69	0.87	0.84	0.75
0.86	0.88	0.86	0.91
0.86	0.80	0.85	1.00
0.88	0.88	0.83	0.88
0.86	0.83	0.91	0.89