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Differentiating biology homework to enhance academic achievement

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DIFFERENTIATING BIOLOGY HOMEWORK
TO ENHANCE ACADEMIC ACHIEVEMENT

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APPROVAL:

DIFFERENTIATING BIOLOGY HOMEWORK

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by

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DEDICATION

This study is dedicated to my sons, Matthew and Mark. I began teaching eight years ago in hopes of trying to figure out my own son's learning preferences. Hopefully, I am a better teacher as a result.

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ABSTRACT

The purpose of the study is to determine if differentiating homework for biology will motivate students to complete and turn in homework, address the needs of diverse learners, and improve academic achievement. The rationale assumes there is a positive relationship between homework completion and academic achievement and that students have different learning styles that can be addressed by allowing choice of homework assignment based on Gardner's multiple intelligences and Bloom's taxonomy.

The research employs an experimental design composed of a control group (consisting of two classes) that received the traditional homework, and an experimental group (two classes) that was offered a "menu" of homework assignments. The results validate that differentiating homework is just as an effective tool for student learning as traditional homework. Differentiating homework benefits students of all ability levels; it enriches gifted students while it enables struggling learners to be appropriately engaged in the learning process.

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INTRODUCTION AND BACKGROUND

Rationale

How can we make biology homework relevant? Can we differentiate homework so that students will be motivated to complete it and turn it in? What is the relationship between the choice of homework assignment and the completion rate? Over the past seven years that I have taught biology, I have observed that there seems to be a correlation between homework completion and academic success. I teach biology to tenth-grade students at a local high school. Of 60 students this last school year, 24 performed below 70% in the homework category. Homework constituted 20% of the overall grade, with the rest being laboratory work (40%) and tests and other assessments (40%). The majority of the homework consisted of outlining chapters, answering section review questions, and completing study guides for test review. Failure to do homework usually has a detrimental effect on student achievement, and because it is a required component of my class, it has a detrimental effect on their grade. When I have asked the students why they don't do their homework, some shrug and say it is boring, they don't have time, it doesn't help them understand the material, or they simply forget about it. Some students admit they don't do homework because they know they can pass the class without doing it. For others, homework needs to be interesting enough to warrant the time invested in it.

The biology course at our school is considered "college-preparatory" level, as opposed to the life science course for the non-college-bound students also offered at our high school. The student population at my high school is multicultural and from diverse socioeconomic backgrounds, and all of these groups are represented in my biology classroom. Despite the 2-tiered "track" for life science courses, there is a great difference in reading ability, prior knowledge, and interest within the student population enrolled in the biology course. Reading ability is measured by the Star Reader Program, which is administered to all entering freshmen at the high school. Prior knowledge is often determined by a simple "show of hands" in response to an inquiry by the teacher. Other times, prior knowledge is determined by having students write a response in a journal to the "Question of the Day." Students are asked to share what they have written after I have gone around the room scanning the responses. The "Question of the Day" is usually used as a launch point for the next major unit or concept to be covered in class. The type of homework I am currently assigning does not address the diverse learning styles I have in my classroom. Different learning styles have been described by Howard Gardner (1993) as "multiple intelligences," and individuals will learn according to their preference. The learning preferences have been described as verbal/linguistic (word expression), logical/mathematic (numbers and reasoning), visual/spatial (diagrams and pictures), bodily/kinesthetic (body movement), musical, naturalistic (nature and observation), interpersonal (relating to people), and intrapersonal (working independently).

Considerable research has been conducted on differentiating curriculum as it applies to the classroom environment, but can the same principles be applied to differentiating homework? Is it possible to allow students to pursue activities outside the classroom without creating the burden of too much homework? How can homework be individualized to meet the needs of the diverse student population found in my biology classroom? If differing learning styles among students require an adjustment in instruction methodology, shouldn't the same adjustment occur in the type of homework students are required to complete? If students learn better in a group learning environment, wouldn't that also apply to homework assignments? My hypothesis is that if given a choice for what type of homework assignment to complete, students will be more compliant and motivated to complete it. As a consequence of doing homework, students will have higher academic achievement. The null hypothesis is that there will be no difference in the percentage of students turning in homework, regardless of choice of assignment.

Statement of the Problem

The problem is that students do not complete and turn in homework, which has a negative impact on learning and academic success. The research I will conduct in this study is to determine whether given an opportunity to choose the type of homework assignment to complete (differentiate), students will be more likely to complete and turn in their work. The following research questions will guide my inquiry:

1. Will differentiating homework motivate students to complete and turn in homework?
2. By differentiating homework, will the needs of diverse learners be addressed?
3. Will differentiating homework improve academic success?

REVIEW OF RELATED LITERATURE

A three-pronged approach will be utilized to conduct a literature review concerning the differentiation of homework for science. The first section will target the current philosophy regarding homework for the understanding of science. Is homework really necessary to achieve scientific literacy, and how much time should students devote to it? The second section will look at the "best practice" for science literacy. What is the most effective way to teach science (specifically biology) to high school students? The third section will focus on the needs of diverse learners, by applying differentiated assignments to individualize homework for biology students. Will providing choice for homework increase the completion rate and, hence, improve student achievement?

Purpose of Homework

Is homework necessary for scientific literacy? Is homework assigned because it improves academic success and student learning, or is it just a waste of time? Homework has been assigned by teachers for a variety of reasons: reinforcement and practice of concepts introduced in class, or for younger students, learning time-management skills. According to Gill and Schlossman (2003a), homework has been controversial for the past century, as parents, educators, and students have all differed in their opinions on what role it plays in academic success.

Conducting a review of previous research, Gill and Schlossman (2003a) discuss the debates that have ensued since teachers began assigning homework over a century ago. Their findings suggest that homework is viewed as the bridge between school and home, and provides parents the opportunity to observe what is being taught to their student. They indicated that homework tends to have opposing effects on the family: on one hand, some parents view homework as an intrusion on family time and authority, interfering with leisure activities and chores; on the other hand, it gives parents a window to the educational process and gives them some limited opportunity to help influence their child's academic success. A historical parental perspective toward homework, and its results, posed two different models of homework: "school imperialism" versus parent-school connection (Gill and Schlossman, 2003a).

Gill and Schlossman (2003a) discovered that as early as 1887 in the State of Texas, a 13-year-old child and his family challenged the authority of the teacher to require homework (Balding v. State, 1887). The court ruled in favor of the child, stating that the teacher's authority over his charges was "limited to the time when pupils are in the school room" (Balding v. State, 1887, p. 579). Twenty-one years later, the Mississippi Supreme Court limited the reach of the school's authority into the home. The courts declared that the school, by mandating homework, "invades the home and wrests from the parents his right to control his child…In the home the parental authority is and should be supreme" (Hobbs v. Germany, 1909, p. 517). In 1901, the State of California passed a law abolishing homework in grades 1-8. An anti-homework crusade ensued, and became known as a movement called "progressive education" (Gill and Schlossman, 2003a). For the next 25 to 30 years, several groups became actively involved in limiting homework for children. One of the members of this group happened to be the editor of the *Ladies Home Journal*, Edward Bok, who used his position to editorialize his opinions about the supposed detrimental effect that homework had on children, indicating that homework could cripple children by damaging their nervous systems.

To the “progressive” experts and families, homework was a threat to the child’s health, had little proven educational value, and threatened family authority and autonomy. The flip-side to the progressives was the parents who viewed homework as a collaborative tool for parents and teachers. Citing the Aries 1962 study, Gill and Shlossman (2003a) noted that not all parents perceived school, and consequently homework, as a threat to authority or to their children. In colonial America, some parents viewed their children as economic assets, and sent them off to live with other families who would hire them as servants or apprentices. With the advent of compulsory education in the 19th century, some parents reported that they had greater contact with their children because they were coming home at the end of the school day. Parents began to realize that children should not be treated like adults, and that childhood was a unique and special period of time. Children were no longer viewed as working assets, and were no longer sent away from home to work as servants or apprentices. As stated in the Aries (1962) study, as reviewed by Gill and Schlossman (2003a), these parents viewed compulsory education as consistent with their own preferences, viewing school and homework as reinforcement to parental authority. As early as 1916, pro-homework parents observed improvements in their children’s report cards when the children had homework. E.C. Brooks (1916), an education professor at that time, started to see a correlation between homework and improved grades. He proposed that the more attention parents gave to their children, the better they would do in school (Brooks).

Soon homework became viewed as a tool for more parental authority, not less. Some parents even used homework as an excuse to keep their children home and off the streets (Gill and Schlossman, 2003a). Homework was the connecting link between parents and their children’s school life. Homework gave parents an opportunity to view the school’s educational agenda and methods. Gill and Schlossman (2003a) asserted that homework enabled parents to oversee and participate in a limited capacity, by assisting their student with school work. Homework made students accountable to parents, by letting parents make judgments regarding their children's academic progress (Gill and Schlossman).

In a qualitative study conducted by Kralovec and Buell (2001), it was reported that homework had a negative impact on students and their families. The 45 students who participated in the research interview were at-risk students in alternative school settings in Maine. Parents, school personnel, and school board members were also interviewed about reasons why the students dropped out of traditional schools. Participants claimed that homework was a major contributing factor to those who dropped out of school before graduating. Some parents reported that homework interfered with their ability to pass on cultural heritage because of time constraints. Other findings from the study suggest that in addition to interfering with family life, homework discriminated against students in poverty for being poor. Some families cannot afford computers or educational resources at home. Many students have to help out financially and spend the evening hours working to help with household bills, instead of doing homework.

Another problem with homework proposed by the survey was the inability to determine whom to hold accountable for the actual work turned in by the student. Teachers do not really know if the student completed the work or if a friend or family member completed it for him. Kralovec and Buell (2001) asked educators to focus on reform that would benefit student achievement in the classroom. They support smaller class size, more pre-kindergarten education, resources for teachers, and after-school programs staffed by educators.

Frances Van Voorhis (2000) undertook a study to determine if parental involvement in homework assignments would have a positive impact on student achievement. The specific target of the study was to investigate a type of interactive homework assignment in the science subject area. Sixth- and eighth-grade students, a total of 253, participated in the study. The school was located in a mid-Atlantic state and included 53% Caucasian, 36% African American, and 11% multi-racial, Asian American, or other ethnic groups. A cross-section of learning abilities was represented in the classrooms involved in the study. Students were to involve family members in some activity prescribed by the teacher. The method used was called Teachers Involve Parents in Schoolwork (TIPS) Interactive Homework. The TIPS activity was linked to the curriculum being studied and was designed for interaction between student and family members. An experimental and control group were formed, the control group receiving similar content homework but without instructions for family member involvement. Van Voorhis performed statistical analyses to identify the effects of interactive and noninteractive homework in four categories: family involvement, homework return rates, homework accuracy, and science achievement indicated by report card grades (Van Voorhis). The results of the study indicated that students involved in TIPS were more likely to complete and return assignments. The study also indicated that there was a strong and positive relationship with the accuracy of the assignments done by the TIPS students. The final implications from the study reported that if science homework was carefully designed with clear content and linked to the curriculum, parents and students would give high marks to the assignments (Van Voorhis). Van Voorhis admits some limitations of interpreting the results because standardized achievement scores were not utilized at the end of the study period. Another limitation was that researchers could not measure the amount of time or how well parents interacted with their student.

In 1989, Harris Cooper conducted a meta-analysis of research on the effects of homework on student achievement. Two types of studies were conducted to determine if homework improved academic achievement. The first study compared the achievement of students given homework versus the achievement of students doing no homework. The result of this study indicated that high school students who did homework outperformed the students who did no homework. The effect of homework diminished with the age of the student: the younger the student, the less impact homework had on achievement. The second type of study Cooper investigated compared the amount of time students spent doing homework with achievement levels. Many of the correlations Cooper used came from national assessments and state surveys. Students who spent more time doing homework had greater academic achievement. The correlations for achievement were higher for high school students than for middle and elementary-level students (Cooper, 1989).

In summary, homework was beneficial for high school students in pursuit of scientific literacy. The Van Voorhis (2000) study reinforces the idea that parental involvement in their child's education results in positive results. Although some students who dropped out of school claimed homework had influenced their decision to drop out of school (Kralovec and Buell, 2000), overall, the negative consequences of homework, infringement on family time and extra-curricular activities, were outweighed by the positive benefits that spending time on homework had on academic achievement.

Attitudes About Homework

In a later study, Cooper, Lindsay, Nye and Greathouse (1998) presented results from research in attitudes toward homework from both the parent and student perspective. The research investigated the amount of homework assigned by the teacher and completed by the student, and the relationship the homework had on student achievement (Cooper et al., 1998). The study used a questionnaire called the Homework Process Inventory (HPI). Students, teachers, and parents were administered the questionnaire to determine if they differed in their beliefs about the amount of homework assigned by the teacher and the amount of work completed by the student. A second set of questions asked whether teachers', students', and parents' attitudes about homework were consistent.

One question asked teachers, students, and parents how much homework the teacher typically assigned each night: none (scored 1), 1-15 minutes (scored 2), 15-30 minutes (scored 3), 30-60 minutes (scored 4), and more than one hour (scored 5). The HPI included a question that asked students and their parents how much of their assigned homework the student finished. Possible responses were none (1), some (2), about half (3), most of it (4), and all of it (5). These questions were asked to determine time on task.

Some of the questions in the HPI were geared toward beliefs and affective reactions to homework, such as "How do you feel towards homework?" "Do you think homework increases or decreases students' interest in school?" The results of the study determined that students reported being assigned less homework than their parents thought was assigned. For secondary students, teacher and student reports did not differ. Concerning the portion of homework completed by students, 75% of parents reported that their child completed all homework, whereas 65% of the students reported completing all homework. As for time spent on homework, students reported less time working on homework than their parents reported (Cooper et al., 1998)

The set of questions that pertained to differences in behavioral attitudes toward homework showed consistent ratings among parents, students, and teachers. In general, the respondents had similar attitudes toward homework. The relationship between homework attitudes and achievement were not significant; but in the upper grades, there was a positive correlation between the amount of time spent on homework and academic achievement. For the lower grades, there was no correlation between the amount of time spent on homework and academic achievement (Cooper et al., 1998). Cooper related this difference to development; homework for many of the younger students consisted of items that the student could not finish in school. These students were not reinforcing concepts learned in school; they were simply finishing at home what they could not accomplish in the time allotted at school. For older students it did not seem to matter if they liked homework or not; that did not affect performance. What did matter was how much of it they completed.

Are the views of students considered when assigning homework? Some researchers believe that the attitudes and views of students are not considered when debating the purpose and benefits of homework (Warton, 2001). In Warton's observations, the purpose and benefits of homework were debated among adults, parents and teachers, but did not involve the viewpoint of the students. Warton reviewed seven different studies about homework (involving more than 3,500 students) over the past 5-10 years that tried to link purpose and benefits of homework to academic achievement. Responses for homework included reasons such as practice skills, responsibility, communication between home and school, academic learning, developing generic skills, and easing time constraints on the curriculum, to list just a few. Warton (2001) reported that students do not acknowledge the adult viewpoint about the purpose of homework. Students view homework as boring. They complete homework for extrinsic reasons, citing better grades and avoiding punishment, rather than intrinsic values related to learning and academic achievement. In citing the Cooper et al. (1998) study, Warton remarks that "In general, researchers have asked children how homework increases interest in school, rather than about the interest in the homework activity itself" (Warton, 2001, p. 162). Furthermore, she questions whether homework assignments have kept up with changes in classroom pedagogy. Warton refers to a study in Scotland conducted by MacBeath (1996), which discussed differences between homework and class work, where learning *in* school had become more differentiated and imaginative in contrast to learning *out* of school. The comment suggests that homework may be undermining rather than supporting interest in school. Warton (2001) further argues that educators are not taking into account non-academic goals of students in addition to the academic goals. Non-academic goals such as peer approval, friendships, and having fun are endorsed by high school students, and these may be related to and impact academic achievement (Wentzel, 1989). Research conducted by Leone and Richards (1989), cited by Warton (2001), indicates that influence of friends on homework had a positive effect when they worked together rather than by themselves.

Warton concludes by stating that more research needs to be conducted to determine the type and quality of homework and the impact on achievement. She advocates homework that provides students the opportunity to "socialize, is enjoyable, valued, and not seen as a disliked solitary activity" (Warton, 2001, p. 164).

In general, according to the Cooper study (1998), attitudes toward homework by parents, teachers or students does not impact student achievement, but the time spent on homework does have impact on achievement. The argument presented by Warton (2001) indicates that although homework has been suggested to increase academic achievement, educators are not applying new paradigm to this aspect of education. Education researchers have recognized that students learn best when the task is student-centered, and geared toward students' interests (differentiated). Changes are being implemented in the classroom, but teachers are not extending the changes to include homework.

Time Spent on Homework

How much time should students spend on homework each night? If homework does have a positive impact on academic learning, is there a point at which there are diminishing returns? Cooper and Valentine (2001) discuss the difficulty of trying to mandate homework policy based on research evidence. An abundance of research that supports evidence of differing opinions allows advocates for and against homework, to point to studies that support their position. The results of a research synthesis and a survey study conducted by Cooper and Valentine (2001) present examples of how to use research results to evaluate recommendations for homework policy and practice.

The meta-analysis included three kinds of studies that examined the relationship between homework and achievement (Cooper and Valentine, 2001). The first type of study compared the achievement levels of students who received homework to the achievement level of students who received no homework and no other treatment to compensate for lack of homework. These studies indicated a strong relationship between grade level of the student and the effect that homework had on student achievement: the higher the grade level (9-12), the more that time spent on homework related to academic achievement. In comparison, at lower grade levels (elementary), the time spent on homework had little impact in regard to academic achievement. The second type of study compared homework to "in-class" supervised study. The results showed that in-class supervised study for high school students reported a positive relationship, about one-half of what it was when homework was compared to no treatment (Cooper and Valentine). The in-class study proved more beneficial to elementary students than high school students.

The third type of study used state-wide and national surveys that correlated the amount of homework completed with students' achievement test scores (Cooper and Valentine, 2001). Of 50 correlations, 43 indicated that students who did more homework showed higher achievement scores. Like the studies comparing homework to no homework and homework to supervised study, the correlation studies on the amount of time spent doing homework reflected the relationship to be influenced by the grade level of the student; high school students have greater benefit than elementary students. Some of the reasons suggested by the researchers for differences among age levels included the explanation that homework has a different purpose at the elementary level than at the high school level. At lower levels, homework is often assigned to help students learn to manage time effectively, not to learn material (Cooper and Valentine).

Despite the findings that the relationship between the amount of time spent on homework and academic achievement is not significant for elementary-aged children (Cooper and Valentine, 2001), the Institute for Social Research at the University of Michigan found that time spent on home study by this age group more than doubled between 1981 and 1997 (Hofferth and Sandberg, 2001). Hofferth and Sandberg examined how children under age 13 utilized their time and associated it with achievement and behavior. They addressed four categories of activities: school and day-care time, free play versus organized activities, homework, and family time. An interviewer-administered time diary asked questions about the four types of activities over a 24-hour period. Depending on the age of the child, the questions were administered to the child or parent and child combined. Some of the demographic information used to analyze the way families utilized time included age and gender of the child, age and race of parents, household income, education level of head of household, and number of other children. The assessments used to associate between the child's activities and achievement were standardized tests, such as the Woodcock-Johnson Revised Test of Basic Achievement. Gill and Schlossman (2003b) used data from this study to include in their 50-year perspective on time spent on homework. Since the Institute of Social Research data (Hofferth and Sandberg, 2001) did not include children over age 13, Gill and Schlossman (2003b) reviewed the background questions given to students taking the National Assessment of Educational Progress (NAEP). The students were asked, "How much time did you spend on homework yesterday?" The report indicated that 17-year-old students spent less time than 9- and 13-year-old students doing homework. The expectation was that older students, who are more likely to benefit from homework, would spend more time on home-study. As far as the amount of actual time spent doing home-study, it was reported that at all grade levels, it was less than one hour daily (Gill and Schlossman). The results of this study refuted the claims made by Kralovec and Buell (2001) that students were so overburdened by homework that they had little time left for family activities.

The literature supports the purpose of homework; it has a positive impact on academic achievement, especially for high school students. Several studies indicate that time spent on homework also has a positive benefit on achievement. Homework reinforces the concepts being taught in the classroom, and if the assignments are authentic, students are more likely to complete them. The literature revealed that even though students thought homework was mundane, the fact that they completed it increased achievement. Homework is a necessary component of school; it is possible that by improving the selection and offering choice, more students are likely to complete it.

Science Literacy

The No Child Left-Behind Act of 2001 is an educational reform designed to improve student achievement and change the culture of America's schools (U.S. Department of Education, n.d.). A major targeted area of this reform is science achievement. According to the U.S. Department of Education, American schools are not producing students with science expertise that will be required for global competition in the 21st century. The solution is to ensure that schools use research-based methods to teach science (Department of Education).

What is science literacy, and how do students achieve it? Two major sources addressing scientific literacy have been published within the past two decades. The American Association for Advancement of Science published *Benchmarks for Science Literacy* in 1993; and three years later, the National Research Council based in Washington, D.C., published *National Science Education Standards*. The *Benchmarks for Science Literacy* consisted of statements and goals of what all students should be able to do in science by the end of grades 2, 5, 8, and 12. The recommendations came from a team of more than 150 teachers and administrators from elementary, middle, and high schools. The belief of this group of educators is that it is not adequate to have children memorize facts about science; they need to be able to *perform* scientific inquiry in the manner that scientific research is conducted using the scientific method. By making observations, forming hypotheses, designing and conducting experiments, analyzing data, and making conclusions, students will have a better understanding of how real scientists work because they have experienced it themselves. It is believed that by doing actual investigations, students will be able to interpret information about products advertised on television, and be able to make educated and informed decisions regarding their use (American Association for Advancement of Science, 1993). The *National Science Education Standards* defines scientific literacy as follows:

> Scientific literacy means that a person can ask, find, or determine answers to questions derived from curiosity about everyday experiences. It means that a person has the ability to describe, explain, and predict natural phenomena. Scientific literacy implies that a person can identify scientific issues underlying national and local decisions and express positions that are scientifically and technologically informed. A literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Individuals often will have differences in literacy in different domains, such as more understanding of life-science concepts and words, and less understanding of physical-science concepts and words (National Research Council, 1996, p. 22).

Both the *Benchmarks* and the *Standards* make recommendations for teachers to follow to help students learn science concepts. The *National Science Education Standards* differs from the *Benchmarks* in several ways. In addition to content standards for students, it includes standards for teachers, school districts, professional staff development, communities, and national education systems. It describes a vision of what science education should look like in the United States. In addition to describing what students should learn and how students should learn science, the *Standards* describes what and how teachers should teach science.

> Teachers need to use many different strategies to develop the understanding and abilities described in the Standards. Teachers select teaching and assessment strategies that support the development of student understanding and nurture a community of learners. Teachers select science content and adapt and design curricula to meet the interest, knowledge, understanding, abilities, and experiences of students. (National Research Council, 1996, p. 23)

Inquiry-based Learning

What are considered the "best practices" for teaching science, specifically biology? To develop curricula for biological literacy, Roberts (2001) recommends that students must be able to conduct investigations to discover the answer to a "problem" or question they may have about a biological concept. Students should learn about the concept of photosynthesis by asking questions like, "How does light intensity affect the rate of photosynthesis?" It is not sufficient for students to memorize the facts of photosynthesis; they need to design and conduct experiments to determine for themselves how light intensity affects photosynthesis. By being taught biological concepts in conjunction with the scientific method, students are able to think "scientifically." The rationale for investigative scientific inquiry is that "for someone to be able to solve problems and judge evidence in science requires them to have both a substantive evidence of science and procedural understanding" (Roberts, ¶ 4). By teaching biology students procedural understanding, students will be able to make decisions about biological issues such as pollution, conservation, and health care. They will have learned the skills necessary to design, conduct, and analyze investigations, using controls and variables. They will learn about sample size, trial and error, and relationships among the variables. By having this procedural understanding about biological issues, they are better equipped to critique information in advertising, news, and their own health concerns (Roberts).

The traditional "hands-on" laboratories employed in biology classrooms do not lend themselves to true "inquiry." All students are doing the same activity. They are following the directions stated in the text or lab manual, and there is no ownership to the task or product. Students are not required to design the experiment; they are following step-by-step instructions. Teachers are urged to "move beyond worksheets and step-by-step procedures…to engage students in inquiry" (National Research Council, 1996, p. 25). A suggested way to facilitate inquiry is to start with a demonstration of a "discrepant event." A discrepant event is described as a "counter-intuitive observation that will capture the student's attention and stimulate interest" (Huber and Moore, 2001, ¶ 19). Such a discrepant event is the "Dancing Raisins," which is a good model used to introduce inquiry of density and buoyancy (Martin, 2000). When the raisins are dropped into a clear, carbonated beverage, they initially drop to the bottom of the flask; but then they float back to the top as the carbon dioxide bubbles attach to them and cause them to become more buoyant. The raisins will then sink again as the bubbles dissipate on the surface. The teacher will lead students to start thinking of ways to make the raisins dance faster or for longer durations. A brainstorming session takes place, with students making suggestions such as changing the type of beverage, the temperature of the beverage, the brand of raisins, etc. Students will then choose which variable, or inquiry, they would like to pursue. Students then design the investigation, record data, and interpret and share the results with the rest of the class. The teacher can follow up the discussions with instruction about buoyancy and density that will enable the students to answer the questions they will ask about why the raisin floated up and down (Huber and Moore, 2001).

Several models for implementing inquiry-based science have been described in the literature. Two types, project-based science and problem-based learning, will be discussed in this review. The first type, project-based science, is centered on constructive theory of learning as described by University of Michigan educational researchers as follows: a) students construct multiple representations of their understanding; b) students work on authentic problems that are meaningful and complex; c) students collaborate in a community of learners; and d) students use cognitive tools to construct and represent knowledge (Marx, Blumenfeld, Krajcik, Blunk, Crawford, Kelly, and Meyer, 1994).

Project-based science (PBS) is centered on a “driving question” that is tied to curricular content. The students and teachers brainstorm questions that are open-ended, can be investigated, and have no “wrong or right answer.” Students develop meaningful projects that can be investigated, meeting procedural as well as conceptual goals. In the course of the project, students produce “artifacts,” such as lab reports with design, hypotheses, data, and results; research papers; three-dimensional models; and computer models. Students share their findings with peers and the community. Other features of project-based science are that it is student-centered as opposed to teacher-centered. Students, by coming up with the questions they want to investigate, become actively engaged in the process because it is meaningful to them (Marx et al., 1994).

In 1991-1992, ten Ann Arbor, Michigan, middle school science teachers collaborated with University of Michigan educational researchers to help implement this strategy as a teaching tool. The resulting case studies provided some insight into the difficulties faced by the teachers in enacting this type of instructional strategy. Teachers admitted to being frustrated with the open-endedness of inquiry-based investigations. Project-based science takes much more classroom time than lecturing and the traditional "recipe" labs. Another factor in PBS is that not all students are working on the same task, making it difficult to monitor what everyone is doing. Another acknowledged difficulty for some teachers is that the traditional curriculum provides security, because they are not likely to run into unexpected content if they follow the guide provided in the teacher textbooks. Yet another concern is the preparation time required by the teacher. After teaching a few years, most teachers have the material necessary for following their district's standard curriculum. How can teachers prepare in advance if they are unsure of the direction that students' driving questions will lead? The technology component of PBS also presents a dilemma for some teachers. Unless there is substantial technology support staff available, making sure the equipment is set up and working takes a toll on precious teacher time (Marx et al., 1994).

In a later report, a contingent of the Michigan researchers addressed some of the technology issues and described software they developed to demonstrate how technology can be used more effectively (Krajcik, Soloway, Blumenfeld, and Marx, 1998). Computers can be used as the "cognitive tools" that help learners solve problems by allowing access to information and data, and, ultimately, to create artifacts. One particular software program, "Model-It," was designed to reflect the constructivist pedagogy that suggests that "allowing learners to build and run their own models is cognitively more effective than allowing them to run someone else's model" (Krajcik et al.). The Model-It program has been used since 1993 at Community High School in Ann Arbor, Michigan. One advantage cited by the researchers is that it addresses one of the challenges teachers reported in earlier case studies about the problem of monitoring multiple student tasks. Model-It provides supportive scaffolding so that students can work independently (Krajcik et al).

The second type of inquiry-based learning, problem-based learning (PBL), was developed for medical education. It was used as an enrichment activity in an urban-minority middle school to see if it would help increase the achievement of urban minority students (Gordon, Rogers, Comfort, Gavula, and McGee, 2001). PBL is also a constructivist method, and it is similar to project-based science. PBL is described as "problem-based and student-centered, using small groups with facilitators" (Gordon et al., ¶ 1). The problems selected serve as the vehicle for independent, yet collaborative, research by the students. The student learners apply their existing knowledge to the problem and extract relevant data. Students work in small groups of five to eight, developing individual and teamwork interpersonal skills. The teacher facilitator keeps the students focused and on track. Multiple groups can be working on related but different aspects of the problem, and there is no single "right answer" (Gordon et al.).

Two groups were compared over a two-year time period at the middle school: those using the PBL curriculum and a group using the traditional science curriculum. The students involved in the study were 90 percent African American and 10 percent Hispanic. Two classrooms at each of the grade levels (sixth, seventh, and eighth grade students) participated in the study, a total of approximately 60 students for each grade-level. The goal of the curriculum studied related to health science issues, careers in health professions, developing students' self-directed learning skills, and promoting critical thinking skills. The conclusion from the report indicated that the sixth-grade students who engaged in the PBL activities over the two-year period had higher science grades (21 percent) than those who used the traditional curriculum. Seventh-grade students showed dramatic improvement in science but not in overall grade point average. The overall grade point average improved most dramatically for the 6th grade students over the two-year period (Gordon et al., 2001). Another benefit that was cited and reported to an independent evaluator was that the students who participated in the PBL activities related that they enjoyed learning with this method because it gave them responsibility, it was challenging, and most important, they found personal relevance. Teachers related that the students involved in the PBL classrooms demonstrated improved behavior (Gordon et al.).

Does inquiry-based learning relate to higher academic success? To determine if teaching by inquiry is feasible and desirable, a controlled study was conducted by Tamir, Stavy, and Ratner (1998) to compare the achievement of biology students who learned biology using an inquiry-based curriculum with students who studied a traditional curriculum. A module designed (Friedler and Tamir, 1986) for teachers to use for inquiry-based learning, entitled Basic Concepts of Scientific Research, was used in the study. The study took place in Israel using three groups. One group studied physics and chemistry; the other two groups studied biology. The second and third groups consisted of biology students. One of these two groups was taught with the traditional method, and one with the inquiry-based module. All three groups took a high school exit exam that tested their science skills in observation, experimental design, manipulation of variables, communication, and reasoning ability. The scores among the three groups were not statistically significant in the area of observation and experimental design. However, the students who had taken the inquiry-based courses performed substantially better in the higher thinking skills and were able to reason and explain the results and ramifications of the investigations they conducted (Tamir et al., 1998).

In addition to scientific inquiry, Uno and Bybee (1994) describe a biologically literate individual as understanding biological principles and biological concepts, including the impact of humans on the biosphere and the historical development of biological concepts. One model of biological literacy is explained as having four levels of understanding about biological concepts: nominal biological literacy, functional biological literacy, structural biological literacy, and multidimensional biological literacy (Uno and Bybee). Nominal biological literacy is characterized by the ability of a student to recognize terms and questions as biological in nature, but not necessarily understand or explain what the terms mean. A student who has "functional biological literacy" can define biological terms correctly, but still may have limited understanding of them. Structural biological literacy indicates that the student understands conceptual ideas and procedural knowledge about the natural world. This level is the foundation on which greater understanding of biological concepts is based. At this level, students can apply information such as the life cycle of a virus to the type and duration of the disease it causes. The most advanced stage of biological literacy is "multidimensional." At this stage, students can investigate a problem concerning a biological concept, collect data, analyze data, and then apply that knowledge to resolve the problem being investigated. It is hoped that at the multidimensional level, students can make associations between cause and effect in the natural world, and apply what they have learned to solve the problem with a plan of action. For students to reach this level of biological literacy, educators need to move away from texts and lectures and toward inquiry-based science investigations (Uno and Bybee).

The No Child Left-Behind Act of 2001 has resulted in many states adopting a variety of testing and accountability programs. In North Carolina students are required to take a standardized test when they complete a core-subject course (Tretter, 2003). The State test to determine if the student has attained “proficient” academic achievement is usually in a multiple-choice format. As a consequence of being held accountable, many teachers are concerned that inquiry-based instructional strategies are too time-consuming, and they revert to direct instruction (Tretter). In North Carolina, a case study was designed to determine if there was a difference in the standardized scores of seniors who took physical science being taught in the traditional didactic mode and those who took physical science using the inquiry-based model. Data were collected over a four-year time period. The first two years consisted of the non-inquiry group of 161 students, of which 67% were African American, 27% Caucasian, and 6% Hispanic. The third and fourth years were taught using inquiry-based strategies. Ninety-four students were in this group composed of 65% African American, 26% Caucasian, and 9% Hispanic. Three different aspects of student improvement were investigated: student participation, standardized test scores, and classroom grades. The result revealed that the inquiry group had higher attendance scores and better course grades. The advantage of inquiry-based instruction for standardized test scores was inclusive. Although more students scored proficient in the inquiry-based group than the non-inquiry group, they did not score as high as some of the non-inquiry group. This may be due to the format of the test, which was multiple-choice. Multiple-choice tests tend to favor fact-based knowledge, rather than procedural or process knowledge, which inquiry-based instruction favors (Tretter).

After reviewing the literature, most researchers (Gordon, et al., 2001; Huber and Moore, 2001; Krajcik, et al., 1998; Marx, et al., 1994; Tretter, 2003; Uno and Bybee, 1994; Tamir et al., 1998) are in agreement that inquiry and problem-solving are the ideal methods for students to learn about science. Didactic instruction is not perceived as the best way to teach students science. Memorizing facts about science is not adequate for global competition in scientific technology, which relates to economic prosperity. Students must be able to apply what they have learned to "real-world" experiences, and by performing scientific investigations and analyzing the results, students will be able to learn the concepts as they apply critical thinking skills to their work. Although teaching students' science using inquiry takes more time, both in terms of teacher preparation and classroom time, it is thought to be worth the time and effort for the benefit of student learning.

Instructional Strategies

What are some instructional strategies that can be employed to help students achieve science literacy? According to the *National Science Education Standards*, all students are capable of participating, learning, and contributing to the science classroom. The diversity of students' needs, experiences, and backgrounds requires that teachers and schools support varied, high-quality opportunities to learn science (National Research Council, 1996). Teachers are being challenged to change their pedagogy of teaching, to move from a "teacher-centered" environment to a "learner-centered" environment. Many teachers have not been exposed to a learner-centered environment and find it difficult to change and create new curricula.

A biology professor and a teacher education professor (Darden and Richardson-Jones, 2002) at the Citadel collaborated to improve instruction designed to address how students learn best. Darden based the design of her genetic courses on the Citadel's (2002) conceptual framework for learning, "Learning occurs best in an environment that contains positive interpersonal relationships and interactions…learning is a process that occurs best when what is being learned is relevant and meaningful to the learner…learning is a fundamentally natural process" (Darden and Richardson-Jones, ¶ 19). Darden described the process she went through to change her teaching style to "learner-centered" pedagogy. Her rationale was two-fold: one, it is a better environment for the students; and two, she wanted to model what a learner-centered environment looked like to her future-teacher students (Darden and Richardson-Jones).

Several techniques were employed to promote active learning: think-pair-share, low-stakes quizzes, modeling activities, literature review, ethical debates, and book reports. The students involved in the study were enrolled in a college-level genetics course. Students were required to work in pairs for lab work, problem-solve, and bring a flow chart of the activities they would be doing in lab. Her previous teaching style was traditional lecturing while students took notes. A qualitative exit survey was compiled with students responding to open-ended questions with statement responses. The greatest number of responses to the survey related to learning styles and meanings. Most students thought the course was structured in a way that they learned best: visual examples, hands-on activities, lab activities, and problem-solving. The findings of the survey reinforced the inclusion of a variety of instructional strategies to promote learning (Darden, Richardson-Jones, 2003). It should be pointed out that the experimental design did not measure how much students learned using this method, but whether the method addressed the personal learning style of the student involved in the activity.

Recognizing that students have varied interests and learning styles, teachers use alternate methods to assist in the learning process. One of the activities used to promote active learning in biology is the use of games and crossword puzzles. Crosswords are useful in helping students with biological terminology (Franklin, Peat, and Lewis, 1996). Games were developed to stimulate group discussion in biology. The games included logic, memory, and problem-solving tasks. The games are meant to make the class more interesting, to encourage group discussion, and to help students gain confidence as independent learners. To determine the effectiveness of the games, the students enrolled in first-year, college-level biology courses were randomly divided into 21 different groups by lab session. The card games were offered as a non-required resource. Participation in the activities was voluntary and anonymous. Of the 81% of students who used the card games, only 28% rated them as "good/very good," and 50% rated them as "okay." Forty-five percent reported that they were "fun," and 47% responded that they would like to see a game for every topic in the course. When asked if the games enhanced learning, 20% indicated they learned how to make flow charts, and 13% responded that the games helped them understand course content. Some students responded that they did not like this type of material, preferring to use some other resource. For those who did not use the games, it was suggested that the games did not fit their particular learning style and that they preferred some other method. Of students who used crossword puzzles, 69% responded that the puzzles helped them learn the terminology (Franklin et al., 2003). There were no data indicating whether the use of games and puzzles impacted student achievement.

Choice and Learning

What effect does choice have on cognitive learning and task performance? Does choice in the classroom help motivate students to stay on task and ultimately increase learning? Advocates for student-centered learning recommend that students have some decision in determining which activities to pursue to learn to their specific needs (Gardner, 1993). It has been reported that students in self-controlled classrooms are more satisfied with their learning performance than those in teacher-controlled situations (Flowerday and Schraw, 2003). Flowerday and Schraw designed an experiment to determine if choice would increase student learning and if it would have a positive effect on attitude, satisfaction, and effort toward learning. The researchers used 84 undergraduate college students for the experiment that was designed to allow students in one group to choose the type of task to complete: an essay or crossword puzzle. The control group had no choice in assignment selection; they were either given the crossword puzzle or the essay. The researchers used an analysis of variance design (ANOVA) that included task selection and choice selection. A second component of the experiment was to determine if self-pacing would have a greater effect on learning than if the pace were predetermined by the researcher. The method employed utilized two independent group designs (t test): the control group was research-paced; the experimental group was self-paced. A Likert-type scale was utilized to determine affective behavior about the assignments and the ability to choose type of task to perform. The results of the task selection component revealed that there was little significant difference for improved learning. However, the second component, pacing, resulted in an increase in effective performance, but had little effect on cognitive learning. The second component of the experiment confirmed that choice increases positive effect with regard to attitude, satisfaction, and increased effort (Flowerday and Schraw).

Differentiated Instruction

How can a teacher provide an environment for all learners with such a diversity of learning styles in a single classroom? How is it possible to maintain order, present the curriculum in an organized manner, and still allow students freedom of choice? Teachers can adapt classroom activities to meet the varied needs of students through "differentiated instruction" (Tomlinson, 2001). Differentiated instruction provides a variety of strategies that cater to the specific learning needs of the individuals that make up a classroom. Differentiated instruction provides multiple approaches to three curricular elements: 1) content—what students will learn; 2) process—type of activities that will help students learn; and 3) product—how students will demonstrate what they have learned (Tomlinson). In a differentiated classroom, instruction will be student-centered as opposed to teacher-centered. Some of the instruction will be provided in whole class settings, small group settings, and individual settings. Differentiating instruction does not mean giving some students more work, and other students less work. It means adjusting the quality of the work, not the quantity. Students will have the opportunity to select a learning style that is suited to their needs; it will have relevance and meaning to the lives of the student learner. Tomlinson presents a "how to" instruction manual for teachers to change the way they deliver instruction in mixed-ability classrooms. She discusses how to plan lessons based on student readiness, interests, and learning profile. She examines how to manage behavior in the classroom and how to prepare students and parents (Tomlinson).

Several articles have been written by educators describing the rationale and the difficulties of implementing differentiated instruction. Differentiating instruction can contribute to changing the climate of a school. Small school districts with diverse student populations lead to tracking, with instructional programs that are not fair to all students (Fahey, 2000). Differentiated instruction can be applied to satisfy state standards and eliminate the need for tracking. Lower track courses do not provide rigorous academic instruction, and students placed in these courses realize that not as much is expected of them, and this usually results in behavior and discipline problems. The advanced classes often have fewer students per class, resulting in increased teacher attention and fewer discipline problems. By eliminating the tracking and instituting differentiated instruction, a school in a Virginia school district was able to improve the quality and equity of education for all of its students. The district utilized student contracts that allowed students to explore areas of interest but still correlated to the curriculum (Fahey).

Teachers reported that the combining of mixed-ability students worked well in the classroom. However, parents of “honor” students commented that they felt their student was being “punished” by having extra work. Some disgruntled parents challenged the program and wanted to terminate the learning contracts. After one year, a new superintendent capitulated to parental pressure, and the tracking system was reinstated. The district reverted to the old system with its inherent inequity and the discipline problems that went with it. Some words of advice about the experience from the principal concerning differentiated instruction: “move slowly during change. Include all the stakeholders in the process…provide training…” (Fahey, 2000, ¶ 24).

Changing the way instruction is implemented is challenging (Pettig, 2000; Smutny, 2003). Differentiating instruction is not a simple changeover when considering the needs of a variety of student learning styles in a diverse classroom. To have success, educators who are advocating change need to have peer collaboration; it is not recommended that they try to do it alone. It is necessary to make sure the objectives are clear and aligned with curriculum goals. Provide activities and choices that reflect the curriculum. How can teachers prevent redundancy or over-challenge students if they do not know what knowledge they already have on a particular topic? Make meaningful pre-assessment part of the differentiation. Provide choice; it contributes to motivation and time on task. Attaining a differentiated classroom is not done all at once; it is done in small steps (Pettig, 2000).

One way to plan curriculum for all types of learners, from special education students to gifted students, is to integrate Gardner's multiple intelligences theory with Bloom's taxonomy. A matrix of multiple intelligences activities with Bloom's hierarchy of thinking activities provides the vehicle for driving curriculum in this plan (Noble, 2004). The multiple intelligences are the horizontal dimension, and the Bloom's taxonomy is the vertical dimension. A revised Bloom's taxonomy orders thinking processes from simple to complex, such as "remember, understand, apply, analyze, evaluate, and create" (Anderson, 1999; Anderson and Krathwohl, 2001). The matrix is designed to offer breadth and depth of learning activities. The plan was introduced to all the teachers in two elementary schools that contained kindergarten though sixth grade. No comparative studies were conducted; the results were tabulated by teacher response to a questionnaire. One of the advantages that the teachers reported about designing activities was that the method "facilitated the student's awareness of how they learn best. Students picked tasks that they liked to do; and they were good at it" (Noble, 2004, ¶ 18). Teachers reported that students were more involved and, by being more aware of their own strengths and weaknesses, had a greater respect for their peers' learning styles. Many teachers saw that taxonomy ensured that all children can work on the same topics, yet work at a level to meet success. It allows students who are gifted to be challenged, and it offers reinforcement to others who may be less developed (Noble).

Sometimes one of the biggest challenges for teachers is just getting started (Pettig, 2000; Smutny, 2003). Pettig and Smutny contend that it is difficult to know where students are developmentally at the beginning of the school year. They recommend that to differentiate instruction, start with observing students while they are practicing new concepts in exercises or problem-solving. Another way to get started is to keep a folder or portfolio of the students' work. Discuss with the student the work that demonstrates both areas of strengths and weaknesses. Make students aware of how they learn best. If it is not apparent to them, solicit advice from parents about their child's strengths and weaknesses, interests, and experiences. Create a flexible working environment, provide a multitude of materials, and cover a range of multiple intelligences. Allow students the freedom to express their creativity and thinking process. Diane Heathcox, an assistant professor and specialist in differentiated instruction, provides an interest inventory checklist for teachers in her book, *Differentiating Instruction in the Regular Classroom* (Heathcox, 2002). This inventory can be administered to the students at the beginning of the school year. The checklist describes many attributes that relate to Howard Gardner's Multiple Intelligences Learning Styles (Gardner, 1993). Teachers just starting to differentiate instruction should start small. It is easier to monitor and adjust as teachers learn more about the learning styles of the individual students. Teachers who try to tackle too much feel overburdened and give up (Smutny, 2003).

Finally, why should teachers attempt to differentiate instruction? Pressure to cover a curriculum so that students will perform proficiently on state-mandated tests leaves teachers little time to change existing lesson plans. Recent studies on how the brain responds to learning situations is sufficient catalyst to get started. An over-challenged student will produce too much noradrenalin, causing over-stimulation of the brain, resulting in attention being diverted from learning to self-survival, which may result in misbehavior and discipline problems. If the student is bored, the brain does not get enough noradrenalin, and the brain is under-stimulated. This too can lead to behavior problems, because the student is not engaged in a learning activity (Tomlinson, 1999). Teachers should change the way they practice teaching because it is in the best interests of the students.

Conclusion

The literature reveals that homework is beneficial as a method to improve student learning, especially for high school students. Evidence points to time spent on task increases achievement for this grade-level. If the task is relevant to the student, it is more likely the student will be interested and engaged for a longer period of time. Offering students a choice in homework tasks is one way to increase interest and, consequently, increase achievement. The "best practice" for teaching high school biology indicates that students should be pursuing investigations through inquiry, discovering relationships about science through their individual interests, and applying it to new information. Inquiry can include literature reviews, interviews, questionnaires, and model building. A strategy that can be pursued to teach to individual students' learning needs is differentiated instruction. In line with

Tomlinson's (2001) three curricular targets—content, process, and product—differentiating homework would make a good place to start differentiating "product" in the form of homework. Differentiation can be applied to individualize homework for biology students.

RESEARCH DESIGN AND METHODOLOGY

Methodology

The research proposal is to determine if differentiating homework for tenth-grade biology students will have an effect on homework completion rate, accuracy, and academic achievement. The literature reveals that homework continues to be a controversial issue for educators (Gill & Schlossman, 2003a). The purpose and value of homework are still being debated, but research has indicated that there is a positive influence on academic achievement for high school students who spend time doing homework assignments (Cooper, 1998.) It has also been suggested that although educators recognize that differences in learning styles and abilities impact what is being done in the classroom, changes in homework pedagogy are lagging (Warton, 2001). Tomlinson (2001) describes how teachers can modify content, process, and product by differentiating instruction. An important component of differentiation is offering assignment selection by the student, based on ability and interest (Tomlinson). The target of this study will be differentiating product, specifically, homework. In the past, students in this teacher's classroom were given a traditional homework assignment that consisted of chapter outlining and study guides. The purpose of the homework was reinforcement of the vocabulary and concepts being studied in the classroom. The intent was to foster "studying," as opposed to turning in a daily "homework" assignment. Students were reading for comprehension and trying to reconstruct the information into a logical, systematic outline.

In the proposed study, one group of students will continue to receive the traditional homework assignment (Appendix C), and one group of students will be offered the differentiated assignments from the homework menu (Appendix D). The varied homework assignments will be based on two educational models: Gardner's multiple intelligence theory and Bloom's taxonomy of thinking. Interest and learning style, as described by Gardner's "multiple intelligences," are verbal-linguistic, bodily-kinesthetic, visual-spatial, musical, interpersonal, intrapersonal, naturalistic, and math-logical (Gardner, 1993). Gardner's theory claims that students have strengths in thinking and learning in different areas and will learn best when offered assignments that target those learning styles. Students will take an "Interest Inventory" to help determine learning style preference (Heathcox, 2002). Another means of differentiation is to provide assignments for students who differ in developmental ability. A revised Bloom's taxonomy describes a hierarchy of readiness or ability: "remember, understand, apply, analyze, evaluate, and create" (Anderson and Krathwohl, 2001). Bloom's taxonomy offers a way to categorize assignments based on the level of challenge and rigor. The differentiated products (homework) in this study will be tangible items, such as outlines, book reports, lab reports, games, puzzles, and models. Homework assignments will draw on a variety of skills and abilities, including verbal skills, such as oral presentation, speeches, debates, and songs. Assignments can also include performance skills, such as skits, plays and dances, and traditional academic skills such as analysis and recall. Even though homework products will be differentiated in terms of developmental ability, (i.e., they will vary in their level of challenge), the focus of the study is student choice.

Participants and Setting

This study will be conducted in a high school college-preparatory biology class room at Lincoln High School in Ypsilanti, Michigan. Lincoln High School does not have a school-wide or district mandated policy regarding homework. Each teacher at the high school determines how much homework is assigned and how much weight it has toward grades.

Individual teachers determine whether the homework is graded for completion or for a correct response. Even within a department, there is no agreement among teachers how much homework should be assigned and what percent of it should be applied to quarter grades. The only requirement placed upon teachers is to submit a homework policy in writing to the administrative office. Homework data will be collected from September 2004 through January 2005. It will encompass the first and second quarters of the school year. Participants are all tenth grade, 15-16 year old, students. The school district is undergoing rapid growth and draws students from five surrounding townships. The demographics of the district are changing due to the rapid development of the rural landscape from farmland to upscale, middle-income homes and neighborhoods. The district is multiethnic and socio-economically diverse. A division of the U.S. Department of Education, the National Center for Education Statistics (2003), reports that Lincoln High School has a population that is 24% African American, 2% Asian, 72% Caucasian, 1% Hispanic, and <1% Native American. Nineteen percent of the students receive free or reduced-price lunch. At the time of the report, there were approximately 1,300 students enrolled at the high school. The biology classroom population generally reflects the school district population, with slight variation from classroom to classroom. The projected number of students taking biology in 2004-2005 is 305, based on current enrollment. There are three biology teachers in the high school; students are randomly assigned to a teacher by computer scheduling. The teacher involved in the study will be teaching four biology sections, each section having approximately 28 to 30 students.

Research Design

This research design is a comparative study, in which the researcher has control over the independent variable (homework assignments) and utilizes random assignment to conditions (classes assigned to traditional as opposed to differentiated homework). Two of the biology sections will be the control group and assigned the traditional homework, which consists of chapter outlines and study guides and other miscellaneous assignments, such as section reviews and work sheets. The other two sections will be the experimental group and will be given a choice of the type of homework to be completed for credit. The experimental group will select from a homework menu of differentiated assignments, such as making a model, poster, writing a story or poem using key concepts, or designing an experiment. Rubrics (Appendix E) have been designed for all assignments, including the traditional outlines and study guides. All homework assignments total the same number of points. The null hypothesis is that type of homework will have no impact on completion rate or student achievement.

The four biology sections will be divided into two groups. To determine which classes are to be included in the experimental group, a simple coin toss will be employed. To reduce variation in student attention based on time of day, the morning session will be composed of one control group (C1) and one experimental group (Ex1). The afternoon session will be treated the same (C2) and (Ex2).

Data Collection and Measures

Data will be collected with both quantitative and qualitative methods. The qualitative measures will include a Likert survey (Appendix F), student interviews (Appendix G), and parent surveys (Appendix H). The independent variable is the type of homework assigned, traditional or differentiated. Four different dependent variables in this experiment can be measured: the homework return rate, homework grade (accuracy and /or completion), academic achievement on test scores, and quarter grades. The homework return rate measures whether the student chose to do the assignment. It can be used to measure an attempt at engagement for learning by the student. The homework grade measures whether the student included all the requirements necessary for completion and was able to apply accurately what he or she has learned to the finished product. Quarter grades are included because homework is a required component of the course and will have impact on overall grades, a measure of achievement. There will be two quarter grades that will be computed and used to evaluate progress, and they will be combined with a semester final exam to compute a final semester grade.

Student and Parent Experiences

The qualitative portion of the study will involve whole-class surveys and focus group interviews. The researcher will be looking for evidence of behavioral changes toward homework assignments. Previous researchers (Warton, 2001; MacBeath, 1996; Wetzel, 1989) have indicated that more work needs to be done to improve the quality of homework being assigned to students. It is their belief that students will be more motivated to attempt and complete homework if it is interesting and geared toward their learning preferences. Students will complete the learning style preference inventory to determine their preferred style of learning based on Gardner's multiple intelligences. Differentiating homework assignments is a way to meet student needs in this category (Tomlinson, 2001; Heathcox, 2002). All students will be given a pre- and post-survey to elicit affective behavior response to the homework assignments. Questions pertaining to choice of homework assignment will be included in a Likert survey. Students will be asked to rate a response on a 1-5 scale, with 1 indicating "strongly disagree," and a 5 indicating "strongly agree." One of the statements being asked pertains to desirability of having choice for homework assignment: "I would like to have some choice in selecting the type of homework I have to do for my class." The pre-assessment survey will be given in mid-September; this will establish a baseline comparison on homework attitudes between the control group and the experimental group. There will also be interviews conducted with a focus group of students pertaining to how choice or non-choice affected homework engagement and completion. If possible, a group of parents from each section will be interviewed to discuss their students' response to the homework assignment. Questions asked of parents will pertain to how they perceived their student's attitude toward doing biology homework in comparison to other homework they may have been assigned, such as, "Did having choice (or non-choice) impact your students' response to doing homework?" All the information collected for this research study will be kept under lock and key in the investigator's office.

Data Analysis

If choice has impact on homework completion, and homework impacts academic achievement, then the dependent variables, test scores and quarter grades, should increase. An independent group t-test will be used to compare the means between the two groups, the control group and the experimental group. Since four classroom sets of data are being used, the Analysis of Variance between Groups (ANOVA) will be utilized to determine if the data between the different biology sections are significant. Since four different groups are being used, the ANOVA will measure if differences between the groups already exist. If differentiation has no impact on homework, the null hypothesis will be correct, and there will not be significantly different averages for homework return, completion and accuracy, or academic achievement. A statistical analysis will be conducted on the survey response, comparing the attitudes of homework between the two groups, in an effort to determine if choice had an impact on completion and accuracy rate on homework. Surveys, interviews, and anecdotal stories will be collected to determine qualitative responses to attitude and behavioral changes.

Validity and Limitations

To ensure content validity of the Likert survey, the same questions will be asked in the pre- and post-survey. All interviews will be recorded on audio cassette. Students being interviewed will be given a pseudonym. The classroom teacher will grade all sets of homework, ensuring consistency in grade reporting; this is also a limitation, because the teacher knows that intervention and experimenter bias is a threat to validity. To reduce experimenter bias, all the students' names and classroom hours will be blocked out prior to grading. All students will take the same test, usually on the same day. The tests will be shuffled so that the investigator does not know whether the test is from the control group or experimental group. Another threat to the validity of the homework grade is that it is never known if the student completed it himself or received help from parents or friends. Due dates and grading rubrics for all assignments will be published and posted in the classroom. All students will receive written hand-outs of the assignments and rubrics.

PRESENTATION AND ANALYSIS OF DATA

The results of this study indicate that there are no significant quantitative statistical differences between the experimental group (differentiated homework) and the control group (traditional homework). The qualitative analysis suggests that there may be benefits to differentiate homework, not just for students but also for teachers and parents. The results validate that differentiating homework is just as effective a tool for student learning as traditional homework.

I. Quantitative Analysis

One of the focal points of the study was to determine if choice would impact student motivation to complete the homework assignment and turn it in. Analyses of Variance (ANOVAs) and t-test (Appendix H) were performed on the homework return rate data, homework grades, test scores and final grades, using the online calculating page from Interactive Statistical Calculations web site (http://StatPages.net, 2005).

Table 1.
Overview of Data Results

	Number of males	Number of females	Total number of students	Homework Return rate%	Homework Grade %	Test scores %	Final grade %
Experimental group-differentiated homework	25	23	48	Mean = 81.2 %	Mean = 67.8%	Mean = 70.8%	73%
Control group-traditional homework	19	28	47	Mean = 88.9%	Mean = 72.3%	Mean = 76.6%	77%
ANOVA probability score				0.167	0.106	0.166	0.106
t-test probability score				0.589	0.4015	0.0704	0.1083

The homework/return-rate mean for the experimental group (N=48), was 81.2%, and the control group (N=47) mean was 88.9% (t-test p=0.589). (See Table 1 for overview of data.) A second aspect of the study was to determine if choice would increase the accuracy and completion rate of the assignment. All of the homework assignments were graded using a rubric, and the difference was also found to be statistically insignificant; the experimental group averaged 67.8%, while the control group averaged 72% (t-test p=0.4015). A third component of the study was to determine if the differentiated assignment would impact test scores. The test scores from the first and second quarter were added and averaged; the mean for the experimental group was 71%, while the control group mean was 77% (t-test p=0.0704), deemed not quite statistically significant ($p>0.05$). The fourth component was to determine if differentiating homework impacts final grades.

A Pearson correlation (r) analysis was conducted between the homework grade and test scores. The control group Pearson correlation r=0.45819, while the differentiated homework group showed a stronger correlation between their homework scores and test scores with an r score of 0.522335. Both of these r scores indicate a positive relationship between homework grades and test scores, with the difference between the two groups not being statistically significant. This test was conducted to determine and support the rationale for giving homework; it correlates to academic achievement. This supports the findings of Cooper et al. (1998), which indicated a positive correlation between homework and academic achievement, especially among high school students.

Even though the data reveal that there is no significance difference in achievement between the two groups, the populations of the four different classes could have influenced the outcome. In designing the study, it was assumed that there would be no major differences between the different populations (classes) at the start of the study. Normal gender ratio was expected to be close to a 50/50 distribution of males to females in each classroom. One of the control group populations (C2) consisted of 17 females and 6 males. To determine if there were any academic differences between the groups at the onset, an ANOVA analysis was conducted using the students grade point average. The results of the ANOVA revealed not quite statistically significant between the four classes, with a probability of 0.09. However, the t-test rated the initial difference between the experimental group (Ex1 and Ex2) and control group (C1 and C2) as statistically significant, with the experimental group lagging in overall GPA with a probability of 0.039. This difference could help explain the slight lag that the experimental group exhibited in all of the recorded variables collected in this study. The initial grade point average mean of the experimental group (N=48) was 2.54, while the initial grade point average mean of the control group (N=47) was 2.89. Another difference that became apparent after the study was underway was that one of the populations in the experimental group (Ex2) had more “struggling learners,” indicated by special support services they received throughout the day.

Even though the data reveal no significant difference in achievement between the two groups, it is important to point out that giving students choice in homework did not impair or hinder academic achievement either. Because the t-test results of the initial grade point average indicate a statistical difference between the experimental group and the control group ($p = 0.039$), it could be argued that the experimental group did benefit from the differentiated homework by the observation that the outcomes in homework grades, test scores, and final grades indicated that there was no statistical difference in the t-test scores for those four variables.

The data were analyzed to determine if there were any gender differences in achievement. Overall, the data indicated no statistical differences between males and females in homework grades or test scores (Table 2).

Table 2.
Gender Differences between Homework Grade and Test Scores

	Overall homework grade (mean %)	Overall test scores in percent
Females N=51	70.9%	72.3
Males N=44	69.2%	74.9

Table 3.
Gender Differences between the Experimental and Control Groups

	Control group Males	Experimental group Males	Control Group Females	Experimental Group Females
Homework Scores %	72.5%	66.0%	71.9%	69.9%
Test scores %	77.7%	72.2%	75.8%	69.3%
Pearson r	r = 0.21	r = 0.40	r = 0.59	r = 0.67

The data were also analyzed to determine if any gender differences were apparent between the control group and experimental group (Table 3). Statistically, there was no difference in homework scores between the control group and experimental group for both males (t-test p=0.35) and females (t-test 0.80). However, the Pearson correlation indicated that there was a higher positive relationship between homework scores and test scores for girls than for boys. For boys in the control group, the Pearson r= 0.21, while the experimental group, r=0.40. For control group females, the Pearson r=0.59, and for the females doing the differentiated homework, the Pearson r=0.67. The Pearson correlation factor does not imply a cause-and-effect relationship, just that the two events are related. However, the results indicate that the females in the experimental group showed a strong positive relationship between homework and test scores, which may imply that females chose homework assignments based on their preferred learning style.

The observation that there was no negative effect, and possibly a slight positive advantage, indicated that differentiated homework is one of the strategies that teachers can utilize to support the development and understanding of science as mandated by the National Research Council (1996) as published in the *National Science Education Standards*. Researchers who contributed to this publication advocate strategies that allow students to pursue activities that are of interest to them and advocate that teachers design curricula in science to meet the needs and interests of students with varied abilities.

II. Qualitative Analysis

Student Interviews

Interviews were conducted with students from both the experimental group and the control group; these provide another aspect of the study that cannot be quantified by statistics. The students in the interview group self-selected; an open invitation to participate was extended to all classes. A total of ten students participated in the taped interviews. Seven of the students were in the control group; three were in the experimental group. Two of the students were identical twins, one from each group. Students began the session by identifying themselves with a pseudonym and revealing which group they belonged to, experimental or control.

When asked if the outlines reflected their learning styles (based on Gardner's multiple intelligences), indicated by an inventory survey taken earlier in the year (Heathcox, 2002), five of the control students were unable to recall their learning style, and those that did stated that the outlines did not reflect their preferred learning style. Two of the experimental members revealed that they remembered their learning styles and were able to complete assignments that reflected their preferred style. One student, "Stefanie," knew that her learning style was verbal/linguistic and chose creative writing assignments. When asked if she believed that it helped her achieve academically, she explained, "When you write the stories, you have to understand what you are doing, so it will make sense. Writing stories and reports really helped me (learn the material)."

Another student, identified as "Hilda," reported that she chose one of the assignments based on topic interest, not on learning preference. She had been curious as to how kidney dialysis worked, and researching it and writing a report was one of the choices offered for the concept of homeostasis and transport. She stated that as long as she had to do something for homework, it might as well be something that she was interested in doing.

All three students interviewed from the experimental group expressed positive attitudes toward having choice, and they all felt that having choice helped them choose assignments that contributed to their academic success. One of the students stated that she went with the outline every time, didn't mind doing it, and felt it helped her learn the material.

The students interviewed from the control group expressed varying opinions regarding having choice for homework. "Billy" stated, "Ideally, I would have liked to have choice when selecting my homework assignment, although it is not expected. It should not be necessary (in order) to achieve high success in homework, to have differentiated homework." "Franz'" response was, "I would rather have had choice, because I don't like outlines." "Carlos" didn't have a problem with not having choice, because, "What if I had selected the wrong homework assignment, like, maybe it would not have helped me on the test." "Jessica" felt it did not matter much: "The traditional homework was pretty good, I knew what I was going to do, the chapter outlines and such."

Even though Billy believed students should do whatever homework the teacher assigned, he opined that the outlines were monotonous and boring and did not really help him learn the material. He believed he would have attained greater academic success if he had been allowed to choose his homework assignment. Billy remembered that his learning style was intrapersonal and mathematical, and the outlines did not address his preference.

Pre-and Post-Likert Survey

The Likert homework survey revealed some significant positive gains for the experimental group in terms of finding homework assignments geared toward their individual learning style. In response to the question, "The type of homework I am usually assigned is geared toward the way that I learn best," the experimental group reported an increase of 36 percentage points (Appendix I) between the pre-and post-survey. The control group reported a negative three percentage points in response to this same question (Appendix J). The experimental group also indicated in a positive manner an increase in confidence that homework helped prepare them for the test given in class, while the control group response went down 18 percentage points between the pre-and post-survey. The increase in confidence toward finding assignments geared toward their learning style and academic achievement supports research that recommends alternate methods of instructional strategies (Franklin, Peat and Lewis, 1996; Tomlinson, 2001).

The most positive statements and attitudes toward homework were anecdotal, and some comments were related to the teacher as the assignments were being handed in. Students who made games wanted to share them with their peers and were given the opportunity to play them on the day reserved for test review sessions. Students who made "Jeopardy" games were given the option of presenting the game to the class or having the teacher present it. Most students chose to conduct the game. Students who chose crossword puzzles were required to switch with another student and fill out each other's puzzles. All students were given the option to present their posters, stories, and models to the class. Some chose not to present it themselves, but were fine with the teacher presenting their work to the class, especially the poems and narratives that were written for some of the assignments. Some of the games were considered so well done that they were presented to the control group classes as well for purpose of review.

Some of the assignments were designed to be done as a group project. This resulted in a positive response for three students in one of the experimental classes. They worked together on two of the games and indicated that they probably would not have done any of the homework for that chapter if they had had to work alone. Two of the members of this group were considered "struggling learners" and made a point of presenting the game to the class during their test review time.

The advantage of differentiated homework became more apparent as the semester progressed; students were actually talking about their homework in a positive way. By allowing choice, it addresses some of the concerns Warton (2001) and Macbeath (1996) had about the lack of student input regarding homework and school. The assignments gave students the opportunity to socialize, to be creative, and to have some fun, while still having a positive impact on academic achievement. Another benefit of differentiated homework is that it contributed to a student-centered review session in the classroom rather than a teacher-centered session. Students took ownership of their learning by conducting and participating more fully in the review sessions the day before the test, which is what Tomlinson (2001) advocates for delivery of instruction in mixed-ability classrooms.

Parent Survey

Twelve parents responded to a post-study survey regarding the homework study. Seven of the respondents had a student in the control group; the other five had a student in the experimental group. In response to the inquiry, “Did the homework assignment your student was required to complete create a hardship on family/student time?” ten of the respondents reported “no” while two left the answer blank. The general consensus, whether in the control group or the experimental group, was that the student seemed to have the “right” amount of homework.

Parents were queried if they perceived any attitudinal behavior from their student regarding homework. In the experimental group, three parents reported “no,” while one commented that at first her child felt “overwhelmed by all the choices, thought the assignments were harder than the control group, but after selecting the homework choice, she enjoyed doing the work.” The other parent in the group reported that her son thought some of the assignments were dumb. All the parents in the control group reported no attitudinal behaviors from their student.

In response to the question of whether or not students should have choice in selecting homework, four of the parents did not think students should have choice (three from control group, one from experimental group). Their rationale was that they thought it was the teacher's job to select homework, that the students might pick whatever was easiest, and that students would adapt to whatever the teacher gave as homework. (See Table 4).

Table 4.
Parent Survey Comments

Q. 5. Do you think it is important for students to have some choice in regard to the type of homework they are required to complete? Elaborate.

- No, I think that most students adapt to what the teacher says homework will be.
- No, some will choose what sounds easier to try to get out of studying.
- No, that is the teachers' job.
- No. When they go to college, will they have choice? Do choices in homework prepare them more than traditional homework assignments?

- Yes. At the college level, they don't make you do anything; you have to be solely responsible for yourself. This gives them some options to better understand something they are missing.
- Yes, to some extent. My student is a high achiever, so having a choice may have helped her to have homework that would be more of a challenge.
- Yes. If they always had a choice on their homework, then they would feel more comfortable on the things they did, and they wouldn't be stressed out.
- Yes, if the choice is to create challenge and thought.
- Yes.
- Yes. They would learn better by doing the homework the way they learn best.

Q. 6. Do you think homework is necessary for biology? Why or why not?

- Yes, not everything can be taught in the classroom.
- Yes. Any exposure to new information is needed to learn. Many times new information given in school is not understood or absorbed. It takes other types of exposure in other environments to help internalize it.
- Yes, it reinforces what is learned in class.
- Yes, I think at the high school level, homework should be required for every class.
- No. You should learn more by the class notes and class discussions.
- No. I think he should learn what he needs to know about this subject in the classroom.

The other eight respondents had a positive attitude about the option of choice for homework assignments. The general consensus among the positive response parents was that having choice prepared students for independent decision-making, allowed students to choose assignments geared toward individual learning styles, and offered an opportunity to create challenge for students who were high achievers.

Three out of the twelve parents responded negatively to the question regarding homework for biology. These respondents believed that anything their child needed to learn about biology should happen in the classroom. The nine "yes" respondents had students in both control and experimental groups and stated that homework is necessary because not everything can be taught in the classroom.

The parent responses seem to refute the arguments Kavolec and Buell (2001) claim about homework infringing on family time. None of the parents from the control group or experimental group indicated that homework infringed on family time. Overall, parents are in support of homework, especially when it gives their child the opportunity to select homework geared toward their particular learning style. Parents reported positive attitudes from their child regarding choice in homework assignments. Most of the parent responses agreed with earlier studies (Gill and Schlossman, 2003a) with regard to purpose of homework, that it is beneficial and supports academic achievement.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR FURTHER RESEARCH

The questions that guided my research have been addressed and answered in my research study. The first question, regarding motivation and homework completion rate, was, by qualitative measures, a success. The results of this study support the rationale for differentiating homework assignments; it has a positive impact on the attitudinal behavior of students in regard to homework completion and academic achievement. The study supports the findings of my second question: will the needs of diverse learners be addressed by differentiating homework? By administering a learning style preference, students were able to determine their own preference and to choose assignments accordingly. A strong positive response was recorded by the differentiated groups in regard to learning style choices available to them determined by the pre-and post-Likert survey. This also supports the work of Tomlinson (2001), who advocates gearing instruction toward the diverse learning styles of students. The third problem was: will differentiating homework improve academic success? The experimental group also increased their confidence level in the survey in the category that indicated whether the selected assignment helped them learn the material better and prepared them for the tests, while the control group showed a decline in confidence in regard to the same question.

The quantitative data, while deemed statistically not significant, supports the rationale for providing differentiated curriculum; by allowing students choice, it does not do them harm academically but can increase the intrinsic motivation for completing school work based on social and interest needs. The students in the experimental group demonstrated that they are capable of selecting assignments that will enhance their academic achievement by selecting assignments that were geared toward their interests and helped them learn the material for tests.

Some of the unexpected discoveries encountered during the research involved my own attitude toward grading and assessing homework. I generally find grading to be tedious and monotonous. Outlines are not very interesting or exciting to grade, any more than they can be interesting or exciting for students to complete. I found myself looking forward to seeing what the students chose to complete and often was surprised at what some of the students were able to achieve. Some of the narratives were very creative and required a lot of thought on the behalf of the student. I found out that some of the males were quite poetic. The games were the most fun, both from a teacher perspective and student perspective. The students looked forward to playing the games, and they were used as teaching tools in the classroom to help review for the upcoming tests.

One unexpected outcome on the Likert survey was in response to having choice. The experimental group showed a significant negative response to the desirability of having choice. When I polled the class about this at the end of the study, the response was surprising. They are not used to having choice, and it creates some tension trying to decide on which assignment to select. For some, they were afraid they would choose something that would not help them learn the material, or it would not help them pass the test. They implied that because the outlines were the traditional choice, and previously teacher-mandated, that somehow it carried more weight as to its “worthiness.” When asked if they would like to end the differentiated homework, the overall response was “no,” as indicated by a show of hands. The control group is glad that the study is over, because many of them would like to have choice.

The control group will be given differentiated assignments along with the other classes for the remainder of the year. It will be interesting to see if this group demonstrates an increase in academic achievement and homework completion and grade by the end of the school year. This group can now serve as a baseline, because now I will have pre-and post-data to compare, whereas the initial study lacked this information. Some of the limitations are that at the semester break, many of the students' schedules change for one reason or another, and there is an influx and egress of students' from one class to another, some switching to different teachers based on class size, and so on.

A limitation of this study is that the students knew that they were participants in a research study being conducted by their teacher. Some students inquired whether they were being helpful to the study by turning in homework. Another difference between previous years and this year was that I had a rubric for every assignment. The rubric included information about how many points would be deducted if an assignment was late. Many students, who believe teachers won't accept late assignments even one day late, won't bother to try to complete an assignment if they miss the due date. Knowing that credit would still be issued, many students who may have skipped doing homework turned it in for reduced credit several days late. Another limitation to the study was the small size of the parent response to the survey. It is likely that parents whose students had strong reaction, either positive or negative to homework, were more inclined to respond to a survey. It is also possible that some of the parents did not have the time or inclination to fill out surveys, regardless of what their student responded.

The implication of the study is that differentiated assignments work. Even though it takes more time initially to create the homework menus and rubrics, it is more interesting, engaging, and sometimes fun for both teacher and students to complete and grade. Once these rubrics are made, it is very easy to grade homework efficiently and takes little time to do. One of the aspects for further discovery is to determine why some of the assignments were not selected by any of the students, and what would be a better alternative as a choice. Differentiating homework was a first step for this teacher in trying to address the needs of diverse learners in the classroom. Now that the benefits have been demonstrated, further research will determine how choice can be delivered in the classroom.

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APPENDICES

APPENDIX A
LETTER OF CONSENT

September, 20, 2004

Dear Parent/Guardian,

Your student is a member of one of four biology classes that I am teaching this year at Lincoln High School. This is my eighth year at Lincoln, and I am currently working on my Master's Degree in Education at Eastern Michigan University. My Master's thesis is centered around the role of homework, and the impact it has on academic success. The purpose of the study is to determine if differentiation, or offering choice of assignment, will impact homework completion rate and consequently, academic success. As a result of this inquiry, I will be conducting research in my classroom. I am requesting your permission for your student to participate in this study. The results of the study may be published electronically or in print.

The study will take place over the course of the first semester. I will be collecting data for every homework assignment in biology. It will start in mid-September and will end January, 2005, which coincides with the end of the first semester. I will analyze the data after this time, and will present it to my thesis committee in February or March of 2005. Every chapter that is covered in class will have a homework assignment. The determination as to whether a class is the control or experimental group has already been selected by a coin toss. **All students will be required to do homework.** Failure to consent does not abstain your child from doing homework, it just means their homework grades and assignments will not be included in the study. Students in the experimental group will have the option of completing the traditional homework assignments if they do not want to be part of the study. Students in the control group will not have the option of completing the differentiated homework.

I do not foresee any risk or discomfort for your student. There is a possibility that the experimental subjects will derive an increased benefit for learning over the control subjects. This is the intent of study, to determine if there is a benefit for differentiating homework.

All records will be confidential. Students will be identified by a randomly assigned number. If your student participates in a focus group and agrees to be interviewed, he/she will be identified by a pseudonym that he/she selects. Not all students will be interviewed. All interviews will be tape-recorded to enhance accuracy. All materials associated with this study will be kept under lock and key in the investigators office. At the completion of the study, the interview tapes will be erased. A separate consent form will be sent home if your student participates in the focus group.

If you have any questions regarding this research, I can be reached at 734-484-7000, ext. 7654. You may contact one or both of the co-chairs at the EMU Human Subjects committee if you have further questions: Dr. Patrick Melia and Dr. Steve Pernecky, 487-0379.

Participation is voluntary. Refusal to participate will involve no penalty or loss of benefits to which the subject is otherwise entitled. The subject may discontinue participation at any time. I appreciate your consideration for your child's participation in this endeavor

Sincerely,

Genevieve F. Bertsos

"I have read the letter of consent outlining the research proposal submitted by Mrs. G. Bertsos. My student **_________________________________ has permission** to take part in the research study described above. I understand my child may withdraw at any time, but that homework will still be required by my student. A copy of this form has been made available for my records."

Parent/Guardian (print name)_______________________________

Signature _______________________________Date ____________________________

My student________________________________ **Does NOT** have permission to participate in the research study described above.

Parent/Guardian (print name)___________________________

Signature_______________________________ Date ____________________________

APPENDIX B

Human Subjects Approval

EASTERN MICHIGAN UNIVERSITY

September 27, 2004

Genevieve Bertsos
School of Education

RE: "*Differentiating homework for Biology to enhance academic success*."

The Human Subjects Institutional Review Board (IRB) of Eastern Michigan University has granted approval to your proposal: "Differentiating homework for Biology to enhance academic success".

After careful review of your application, the IRB determined that the rights and welfare of the individual subjects involved in this research are carefully guarded. Additionally, the methods used to obtain informed consent are appropriate, and the individuals are not at a risk.

You are reminded of your obligation to advise the IRB of any change in the protocol that might alter your research in any manner that differs from that upon which this approval is based. Approval of this project applies for one year from the date of this letter. If your data collection continues beyond the one-year period, you must apply for a renewal.

On behalf of the Human Subjects Committee, I wish you success in conducting your research.

Sincerely,

Patrick Melia

Dr. Patrick Melia
Administrative Co-Chair
Human Subjects Committee

CC: Dr. Steve Pernecky, Faculty Co-Chair
Dr. Deborah Harmon

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APPENDIX C
Traditional Biology Homework Assignment
Chapter Outlines and Study Guides
2004

Chapter One-The Science of Life

- 1.1 Themes in Biology
- 1.2 The World of Biology
- 1.3 Scientific Methods
- 1.4 Microscopy and Measurement

* Related topic response-Find a newspaper, magazine, or internet article that pertains to one of the concepts in chapter one. Give a brief description of the article, where you saw it, and how it relates to this chapter. You can also report on a movie, cartoon, video, etc, anything that relates to the topic we are discussing. Name the video, when or where you watched it, and how the topic related.
Study Guide handout-Chapter one

Chapter Two-Chemistry

- 2.1 Composition of Matter
- 2.2 Energy
- 2.3 Solutions

* Related topic response
Study Guide handout-Chapter Two

Chapter Three-Biochemistry

- 3.1 Water
- 3.2 Carbon Compounds
- 3.3 Molecules of Life

*Related topic response
Study Guide handout-Chapter Three

Chapter Four-Structure and Function of the Cell

- 4.1 Introduction to the Cell
- 4.2 Parts of the Eukaryotic Cell
- 4.3 Multicellular Organization

*Related topic response
Study Guide handout-Chapter Four

Chapter Twenty Four-Bacteria

- 24.1 Bacterial Evolution and Classification
- 24.2 Biology of Bacteria
- 24.3 Bacteria and Humans

*Related topic response
Study Guide handout-Chapter 24

Chapter Twenty Five-Viruses

25.1 Structure

25.2 Viral Replication

25.3 Viruses and Human Disease

*Related topic response

Study Guide handout-Chapter 25

Chapter Five-Homeostasis and Transport

5.1 Passive Transport

5.2 Active Transport

*Related topic response

Study Guide handout-Chapter 5

Chapter Six and Thirty One-Photosynthesis and Plant Structure

6.1 Capturing the Light

6.2 The Calvin Cycle

31.4 Leaves

*Related topic response

Study Guide handout-Chapter 6 and 31.4

APPENDIX D
Homework Menu's
Biology Chapter Two
Chemistry-Composition of Matter, Energy, Solutions

Chapter Outline AND study guide. *Blooms-knowledge and comprehension MI-verbal/linguistic; Intrapersonal	Design a power point presentation using the vocabulary terms on page 48. Use a minimum of 5 terms from each section. Synthesize a compound starting with the atom for section 1. There are 3 sections. Blooms-synthesis MI-spatial	Make a video about chemical bonds and solutions. Do as a game show, skit, newscast, or commercial-advertisement. Be creative, have fun. May do in a group or individually. Use terms on page 48, a minimum of 5 terms from each section. Blooms-synthesis MI-bodily/kinesthetic and Interpersonal
Tape or videotape a "conversation" about chapter 2 with your parents. Your conversation must include 4-5 terms from each section. as well as a basic explanation about the key points from the chapter. Blooms-comprehension MI-Interpersonal **See footnote	Make a 3 D model of 2 elements forming a compound. Attach a 5 x 7 card that explains the type of bond it has formed, and the name of the compound formed. ALSO must do study guide if you select this assignment. 24 pts. Blooms-application MI-bodily-kinesthetic	Design and sing a song about chemical bonds and solutions based on Nelly and Justin Timberlake's song "Work it." Song must be rapped or sung in class. Use vocab terms on pg 48. Minimum of 15 terms Blooms-synthesis MI-musical **See footnote
Make a story board or comic strip that teaches the changes in states of matter, and chemical bonding. Use vocab terms on pg. 48 Blooms-comprehension MI-verbal-linguistic; Spatial	Design a board game for 4 people using the terms from ch. 2.Make the objective of the game "building molecules" with the "winner" making the most molecules. Minimum of 15 terms, 5 from each section Blooms-application MI-spatial;bodily-kinesthetic	Write an original story involving bonding and solutions. Minimum 2 pages typed, 12 font, double-spaced. Use terms page 48, 5 terms each section. Blooms-synthesis MI-verbal-linguistic Intrapersonal.

Key
*Bloom's- refers to levels of Blooms taxonomy; knowledge, comprehension, application analysis synthesis, evaluation
*MI-refers to Gardner's Multiple Intelligence; verbal-linguistic, math-logic, spatial, bodily-kinesthetic, musical, interpersonal, intrapersonal, naturalist.
**Homework suggestion found on website
http://help4teachers.com/ScottChemicalbonds.htm

Chapter Three
Biochemistry-Water, Carbon Compounds, and the Molecules of Life

Directions: Select 1 of the following homework assignments to complete. The final due date is ___________________. You make work individually or with a partner. If you work with a partner, you must turn in a work sheet ahead of time explaining what part of the assignment for which you are responsible.

1. Chapter Outline AND study guide. Blooms-knowledge and comprehension MI-verbal/linguistic Intrapersonal All learners	2. Design a power point presentation that demonstrates how monomers become polymers; glucose, amino acids, fatty acids, nucleic acids. Include the properties of water and carbon in the presentation. Blooms- Analysis; MI-verbal linguistic	3. Design and conduct an investigation that will identify the nutrient content of a select group of foods. (cottage cheese, crackers, vegetable oil, etc. Write up a formal lab report. See me for materials, and a time to conduct it before or after school. Blooms-Analysis MI-math-logic
4. Write a story or make a comic strip, using as the main characters "Protein, Carbohydrate, and Lipid, and Water." Discuss the 3 of them doing their job. (Blooms-Synthesis MI-spatial, verbal-linguistic)	5. Make a poster that shows how carbon, oxygen, hydrogen, and nitrogen becomes an organic compound, and the organic compound becomes a polymer, and then becomes part of the human anatomy. Needs to be a tri-fold to show 3 organic compounds. Blooms-synthesis MI-Spatial	6. Debate the pro's and con's of breast vs. bottle feeding from a cultural, and nutritional and economical point of view. (Blooms-evaluation MI-interpersonal; math-logical You may work with a partner and present to the class.
7. Make a food pyramid that reflects the recommended daily allowance (RDA). Can be a model or poster. Include a 5x 7 card that describes the model. Label the poster. Blooms-Comprehension; MI-Spatial;	8. Create an ad campaign (brochure, jingle, song, video) that advocates the advantage of drinking water and milk instead of carbonated beverages. Discuss the protein, sugar and fat in your campaign. (Blooms-Synthesis; MI-math-logical, musical, interpersonal, depending on choice of presentation.	9. Make a model that represents the orderly transition of elements (carbon, hydrogen, oxygen, nitrogen) to monomers (simple sugars, amino acids, fatty acids) to polymers (starch, protein, lipids, DNA.) (Think of the child's toy of a box, in a box, in another box.) Blooms-Application MI-Spatial, bodily-kinesthetic.

Chapter Four
Structure and Function of the Cell

1. Chapter outline AND study guide. Blooms-knowledge and comprehension. MI-verbal/linguistic	2. Write a short story where the main characters are a bacterial cell (prokaryote), a plant cell, and an animal cell (both eukaryote.) Each cell is trying to convince the others that the type of cell is more desirable than the others. Use vocabulary on pg. 89. Minimum of 20 terms. Discuss the differences, adv. and disadvantages of each type. Blooms-synthesis MI-intrapersonal	3. Make a power point presentation that compares and contrasts prokaryotic cells and eukaryotic cells, and plant cells from animal cells. Include vocab on pg 89. Minimum of 20 terms. Blooms-analysis MI.-verbal linguistic
4. Make a diorama of an eukaryotic and a prokaryotic cell. Use the vocab terms on pg. 89 to label and describe the function of each organelle. Use a 5X7 card to write description. Minimum of 20 definitions. Blooms-application MI-spatial	5. Create a Jeopardy Game for chapter 4. Use each section for the 3 different categories. Put the questions on 3 x 5 cards. Minimum of 20 questions. Blooms-application MI-verbal/linguistic	6. Make a poster that compares and contrasts a plant cell with an animal cell. Label. Describe function of organelles on a 5x7 card. Blooms-analysis MI-spatial
7. Make a comic strip or story board that depicts 3 neighbors ("Prokaryote", "Plant cell" and "Animal Cell") trying to convince "newcomers" to join their "club" so they can do the same "activities" Blooms-application MI-Spatial; verbal /linguistic	8. Create an ad campaign for all of the organelles. Assume you are selling it to aliens who wish to visit earth. What good will it do them? Why do they need it? Why is it the best organelle to have? Present as a poster, video tape, jingle, etc. Blooms-synthesis MI-Musical, spatial	9. Group project. (or individual) Present a kinesthetic model of 9 organelles of the cell, showing the jobs they carry out. (Max of 3 people in group) If individual, perform 6. Blooms-Application MI-bodily/kinesthetic

Chapter Five-Homeostasis and Transport
Passive Transport and Active Transport

Due Date______________________

1. Chapter Outline and Study Guide. Blooms-knowledge and comprehension. MI-verbal/linguistic	2. Using the scientific method, design an experiment using potato slices to demonstrate a hypotonic, hypertonic, and isotonic solution, and then carry it out. Write up your observations in a lab report. You can do this experiment at home, or after school. Blooms-synthesis MI-verbal/linguistic, bodily kinesthetic, math-logic	3. Write and perform a skit that demonstrates how the sodium-potassium pump works. Major characters in the play should include Na+ and K+ ions, the protein pump, ATP, and phosphate groups. Blooms-synthesis MI-bodily-kinesthetic and verbal/linguistic
4. Make a comic strip or story board that tells the story of passive diffusion, osmosis, and active transport. Include phagocytosis in the story line. Blooms-comprehension MI-spatial;	5. Write a short story about 4 characters whose jobs are passive diffusion, osmosis, active transport and facilitated diffusion. Blooms- MI-verbal/linguistic	6. Research and write a 2-3 page paper on kidney dialysis. Describe how it works. 12 font, double space. 1" margins. Blooms-synthesis MI-verbal/linguistic
7. Make a crossword puzzle out of the vocabulary terms on page 105. . Use 20 terms. Make on graph paper. Include the answer key on separate page. Be sure to number the blocks. Across and down. Blooms-comprehension MI-spatial	8. Present a newscast (video or in person) describing an event such as a flood. Explain what happens to the characters "sugar" "protein", "sodium", and "potassium", when the osmosis crew comes and throws a semi-permeable net around the area. Who gets through the net? Use the vocab terms to help tell the story. Blooms-synthesis MI-verbal/linguistic	9. Make a tri-fold poster. Compare and contrast passive diffusion, active transport, and ion channels. Blooms-analysis MI-spatial,

Chapter Six-Photosynthesis
and Chapter 22.1 Energy Flow
Capturing the Energy in Light,
The Calvin Cycle

1.Chapter 6 Outline and Chapter 22.1 Energy Flow Study guide-Ch. 6.1 and 6.2 and 22.1 Blooms-comprehension MI-verbal/linguistic	2. Construct a model of a photosystem, including the thylakoid membrane and the electron transport chain. Use vocab. terms pg. 121.to help determine what to include. Label all components. Blooms-application MI-spatial, bodily-kinesthetic	3. Create a skit that demonstrates how the light is captured in photosynthesis and converted into ATP. Also include the Calvin Cycle in the skit. This can be a group project. Blooms-synthesis MI-bodily kinesthetic; interpersonal
4. Make a power point presentation about chapter 6. Use the vocab terms to help explain the light reaction and the Calvin Cycle. Minimum of 10 slides. Bloom's-synthesis MI-spatial	5. Make a poster that shows where and how the leaves captures sunlight. Include both light rx and Calvin cycle in description. Blooms-comprehension MI-spatial;	6. Pretend you are a carbon in a molecule of carbon dioxide. In a narrative, describe the journey you are taken on as you enter a leaf and get converted into a molecule of glucose. Describe what happens to your "friends" the oxygen molecules. Blooms-synthesis MI-verbal linguistic
7. Create a "game show" ("Who wants to be a millionaire?") using the vocab terms from chapter 6 and chapter 22.1 minimum of 20 terms. MI-verbal/linguistic Bloom's-synthesis	8. Create a poem or rap song that describes the energy flow through an ecosystem. Start with photosynthesis. MI-musical Use vocab terms from ch. 6 and 22.1	9. Design and conduct an experiment at home or school to determine what effect different colored cellophane will have on plant growth. Use scientific method. Conclusion should include analysis pertaining to what you know about the role of light in photosynthesis. MI- spatial naturalist

APPENDIX E

Rubric Examples

Name______________________________ Rubric for Power Point
Date___________________________
Hour_____________________

Category	Exemplary	Proficient	Basic	Needs work
Content	Reflects essential information; logically arranged; exceeds vocabulary minimum requirement. 10 points	Reflects most of the essential information. Meets minimum vocabulary requirement. 8 points	Contains extraneous information; is not logically arranged. Less than minimum vocabulary requirement. 6 points	Less than 2/3 of vocabulary requirement. Essential information missing. 4 points
Due date	On time 3 points	1 date late 2 points	2 days late 1 point	2 or more days late 0 points
Design/text	Clean design; high visual appeal; color used effectively. Effective use of text/picture ratio. Sound and animation included. 4 points	Design is fairly clean with a few exceptions; uses color effectively. Too much text/picture ratio. 3 points	Cluttered design; low in visual appeal. 2 points	Low in visual appeal. Too much text, color not used effectively. 1 points
Text	Fonts are easy to read. Use of italics, bold; no errors in grammar, capitalization and spelling. 4 points	Sometimes the fonts are easy to read; little or no editing required for grammar, spelling, punctuation, etc. 3 points	Overall readability is difficult with lengthy paragraphs. Spelling, grammar, punctuation distract or impair readability. 2 pt	Text extremely difficult to read small font size, poor use of subheadings. Errors in spelling, capitalization, punctuation and grammar. 1 points

___/20 points

1. How much time did you spend on this assignment?
2. Why did you pick this assignment? (no choice, easy, interesting, challenging, geared toward my learning style, etc.) ____

____

3. What was your attitude toward this assignment? Use the ranking scale below.
1-terrible 2-not so bad 3-indifferent 4-it's okay 5-great
4. Explain why you rated it the way you circled it above: What did youlike or dislike about the assignment?____

____

Name________________________ Rubric for Chapter Outlines
Date________________________ Biology
Hour_____________

Category	Exemplary	Proficient	Basic	Needs work
Outline concepts	All sections included. All major concepts included. 10 points	All sections included, Some concepts not included. "sketchy outline" 8 points	Part of sections missing. Sections completed include all concepts 6 points	1 or more section missing. Some concepts missing. 4 points
Due date	On time 3 points	1 day late 2 points	2 days late 1 point	2 or more days late 0 points
Text	Legible, easy to read. Is in outline format 3 points	Legible, easy to read. Outline format attempted. 2 points	Legible. Not in outline format. 1 point	Not legible. Is not in outline format. 0 points
Related questions or topics.	Included a question and answer at end of outline. Included source and documentation/elab-oration. Or, pertinent article summary and source. 4 points	Included question and answer at end of outline. No documentation or elaboration 2 points	Vague reference to question. Not a critical thinking question. 1 point	No reference to question. Had question;wrong answer. 0 point

___/20 points

1. How much time did you spend on this assignment?
2. Why did you pick this assignment? (no choice, easy, interesting, challenging, geared toward my learning style, etc.) ____
____
3. What was your attitude toward this assignment? Use the ranking scale below.
1-terrible 2-not so bad 3-indifferent 4-it's okay 5-great
4. Explain why you rated it the way you circled it above: What did youlike or dislike about the assignment?____
____

Biology
Rubric for game

Name______________________________
Hour______________________________

Category	Exemplary	Proficient	Basic	Needs work
Organization	Extremely well organized; enhances effectiveness of game. Logical format, easy to play. 3 points	Organized, but some ideas are unclear. 2 points	Somewhat disorganized, distracting to audience. 1points	Not well organized. Confusing to audience as to concepts being displayed. 0 point
Content	Completely accurate; includes all components of concepts. 10 points	Mostly accurate; a few inconsistencies or errors. 8 points	Somewhat accurate; more than a few inconsistencies or errors in information. Incomplete explanation 6 points	Completely inaccurate; the facts are misleading. Or incomplete information 4 points
Due date	On time 3 points	1 day late 2 points	2 days late 1 point	2 or more days late 0 points
Creativity/mechanics/ text	Was extremely clever and unique. Rules and directions explicit. Great variety of color/text. 4 points	Well done and interesting to audience. good variety of color; text easy to read; minor editing. Clean, minor problems with size, directions or rules. 3 points	Limited use of color/text. Problems with game board. Minor grammatical, spelling errors. Minor problem with directions and rules. 2 point	Major problems with game; rules/directions. Very little color/text balance. 1 points

___/20 points

1. How much time did you spend on this assignment?
2. Why did you pick this assignment? (no choice, easy, interesting, challenging, geared toward my learning style, etc.) ____
____

3. What was your attitude toward this assignment? Use the ranking scale below.
1-terrible 2-not so bad 3-indifferent 4-it's okay 5-great
4. Explain why you rated it the way you circled it above: What did youlike or dislike about the assignment?____
____

Name______________________ Biology

Date______________________ Rubric for Model

Hour________________

Category	Exemplary	Proficient	Basic	Needs work
Organization	Extremely well organized; 5 points	Organized, but some ideas are unclear, 4 points	Somewhat disorganized, distracting to audience. 3 points	Not well organized. Confusing to audience as to concepts being displayed. 1 point
Content	Completely accurate depiction of concept requirement. (6 points	Mostly accurate; a few inconsistencies or errors; Meets minimum requirement 5 points	Somewhat accurate; more than a few inconsistencies or errors in information. Less than minimum requiments. 4 points	Completely inaccurate; the facts are misleading. Or incomplete information 3 points
Due date	On time 3 points	1 day late 2 points	2 days late 1 point	2 or more days late 0 points
Creativity	Was extremely clever and presented with a unique approach that truly enchanced the model 3 points	Unique approach. Model is original. 2 points	Not very original. model does not capture interest of viewers. 1 point	Bland and predictable. Very little originality. 0 points
Mechanics/text	Well designed; professional looking; scale noted. Accurate depiction of what it is supposed to represent. Includes explanation on attached card, is labeled correctly. 3 points	Well done and interesting; some minor problems with materials; has attached card, but not complete 2 points	Limited use of color/text. Oversimplified; explanation incomplete. 1 point	Major problems with model; not well made. Very little color/text balance. 0 points

____/20 points

1. How much time did you spend on this assignment?
2. Why did you pick this assignment? (no choice, easy, interesting, challenging, geared toward my learning style, etc.) ____

____

3. What was your attitude toward this assignment? Use the ranking scale below.

1-terrible 2-not so bad 3-indifferent 4-it's okay 5-great

Rubric for Original Story

Name_________________________(revised)

Date____________________ Hour___________

Category	Exemplary	Proficient	Basic	Needs work
Arrangement of concepts	Main concept from each section easily identified; subconcepts branch appropriately from main idea 3 points	Main concepts easily I.D.'d; from each section. most subconcepts branch from main idea 2 points	Main concept clearly I.D'd; many sub-concepts branch from missing 1 points	Main concept not clearly identified. sub concepts missing. 0 point
Content	Reflects essential information; logically arranged; exceeds vocab minimum requirement. 10 points	Reflects mos of the essential information. Meets minimum vocab requirement 8 points	Contains extraneous information. is not logically arranged. Less than minimum vocab requirement. 6 points	Less than 2/3 of vocab requirement. Essential information missing. 4 points
Due date	On time 3 points	1 date late 2 points	2 days late 1 point	2 or more days late 0 points
Creativity/ text	Story was extremely clever and written with originality in a unique approach that truly enhanced the story. No errors in grammar, capitalization, punctuation, and spelling. 4 points	Story clever at times; thoughtfully and uniquely written. The text is clearly written with little or no editing required for grammar, punctuation and spelling 3 points	Added a few original touches to enhance the story, but did not incorporate it throughout. Spelling, punctuation, and grammar error distract or impair readability. 2 points	Little creative energy used writing this story; was bland and unimaginative. Errors in spelling, capitalization, punctuation, usage and grammar distract the reader; major editing and revision is required. 1 points

___/20points

1. How much time did you spend on this assignment?
2. Why did you pick this assignment? (no choice, easy, interesting, challenging, geared toward my learning style, etc.) ____

____

3. What was your attitude toward this assignment? Use the ranking scale below.

1-terrible 2-not so bad 3-indifferent 4-it's okay 5-great

4. Explain why you rated it the way you circled it above: What did youlike or dislike about the assignment?____

APPENDIX F

Name ___________________________	Likert Homework Survey
Date_____________________________	Pre and Post-Assessment
Hour (required)________	

Read the following statements carefully. Circle the category that relates to how you feel about the statement**: 1-strongly disagree**, **2-disagree, 3-neither agree, or disagree, 4-agree, 5-strongly agree.**

Circle one of the following that pertains to your gender: male female

1. Homework helps me learn the concepts we are studying in school.	1 2 3 4 5
2. I don't mind doing homework.	1 2 3 4 5
3. Homework is interesting.	1 2 3 4 5
4. I have some choice in selecting the type of homework for class.	1 2 3 4 5
5. I would like to have some choice in selecting the type of homework I have to do for my class.	1 2 3 4 5
6. The type of homework I am usually assigned is geared toward the way that I learn best.	1 2 3 4 5
7. I typically do my homework whether I like it or not.	1 2 3 4 5
8. I can usually complete my homework in the time allotted by my teacher.	1 2 3 4 5
9. Homework helps me prepare for the tests I am given in class.	1 2 3 4 5
10. Even if given a choice as to type of homework, I would still not do it.	1 2 3 4 5

APPENDIX G

Student Interview Questions-

1. Does the type of homework assigned to you in biology relate to the concepts being studied in the classroom?

2. Do you think that the types of homework assignments given in biology help you learn the concepts being taught in the classroom?

3. Do you think that there is enough variety in the types of homework assigned?

4. Based on what you have discovered about your own learning style, if you could choose the type of homework assignment that would help learn best, what would you choose to do?

5. Do you spend more or less time working on your biology homework compared to the other classes you are taking this semester?

6. If you were in the experimental group (you were allowed to choose the type of assignment to complete for homework), how did you feel about being able to select which homework assignment complete?

7. If you were in the traditional group (no choice) how did you feel about not being able to choose when you discovered that students in other class periods were able to choose?

8. Do you think you would have done better in class if you had been able to select they type of homework to complete?

Appendix H

ANOVA and T-test Results

ANOVA: Homework **Return Rate**-percent

The results of a ANOVA statistical test performed at 13:03 on 23-JAN-2005

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	3571.	3	1190.	1.725
error	6.2804E+04	91	690.1	
total	6.6375E+04	94		

The probability of this result, assuming the null hypothesis, is 0.167

Group A: Experimental GroupNumber of items= 24
0.000E+00 40.0 60.0 60.0 80.0 80.0 80.0 80.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 86.7
95% confidence interval for Mean: 76.01 thru 97.32
Standard Deviation = 24.8
High = 100. Low = 0.000E+00
Median = 100.
Average Absolute Deviation from

Group B: Experimental GroupNumber of items= 24
20.0 20.0 20.0 20.0 40.0 60.0 60.0 80.0 80.0 80.0 80.0 80.0 80.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 75.8
95% confidence interval for Mean: 65.18 thru 86.49
Standard Deviation = 30.1
High = 100. Low = 20.0
Median = 80.0
Average Absolute Deviation from Median = 22.5

Group C: Control Number of items= 24
0.000E+00 20.0 60.0 60.0 60.0 80.0 80.0 80.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 85.0
95% confidence interval for Mean: 74.35 thru 95.65
Standard Deviation = 27.2
High = 100. Low = 0.000E+00
Median = 100.
Average Absolute Deviation from Median = 15.0

Group D: Control Number of items= 23
0.000E+00 60.0 80.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 93.0
95% confidence interval for Mean: 82.16 thru 103.9
Standard Deviation = 22.2
High = 100. Low = 0.000E+00
Median = 100.
Average Absolute Deviation from Median 6.96

Student's *t*-Test: Results Homework **return rate** in percent.

t= -1.42
sdev= 26.4
degrees of freedom = 93

The probability of this result, assuming the null hypothesis, is 0.160

Group A: Experimental Group-differentiated homework Number of items= 48
0.000E+00 20.0 20.0 20.0 20.0 40.0 40.0 60.0 60.0 60.0 60.0 80.0 80.0 80.0 80.0 80.0 80.0 80.0 80.0 80.0 80.0 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 81.2
95% confidence interval for Mean: 73.67 thru 88.83
Standard Deviation = 27.8
Hi = 100. Low = 0.000E+00
Median = 100.
Average Absolute Deviation from Median = 18.8

Group B: Control Group-traditional homework Number of items= 47
0.000E+00 0.000E+00 20.0 60.0 60.0 60.0 60.0 80.0 80.0 80.0 80.0 100. 100. 100. 100. 100.

100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.
100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100. 100.

Mean = 88.9
95% confidence interval for Mean: 81.28 thru 96.59
Standard Deviation = 25.0
Hi = 100. Low = 0.000E+00
Median = 100.
Average Absolute Deviation from Median = 11.1

ANOVA **Homework grade** percent

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	4003.	3	1334.	2.098
error	5.7870E+04	91	635.9	
total	6.1873E+04	94		

The probability of this result, assuming the null hypothesis, is 0.106

Group A: Experimental (6th hr) Number of items= 24
8.00 13.0 16.0 18.0 29.0 34.0 43.0 50.0 61.0 66.0 68.0 70.0 71.0 73.0 74.0 75.0 75.0 83.0
86.0 87.0 88.0 88.0 95.0 95.0

Mean = 61.1
95% confidence interval for Mean: 50.86 thru 71.31
Standard Deviation = 27.7
High = 95.0 Low = 8.00
Median = 70.5
Average Absolute Deviation from Median = 21.4

Group B: Experimental (2nd) Number of items= 24
0.000E+00 26.0 46.0 47.0 62.0 63.0 67.0 68.0 77.0 77.0 85.0 87.0 87.0 88.0 88.0 88.0 88.0
89.0 90.0 90.0 91.0 93.0 96.0 98.0

Mean = 74.6
95% confidence interval for Mean: 64.40 thru 84.85
Standard Deviation = 24.1
High = 98.0 Low = 0.000E+00
Median = 87.0
Average Absolute Deviation from Median = 15.9

Group C: Control 3rd Number of items= 24
0.000E+00 14.0 27.0 39.0 44.0 49.0 53.0 59.0 63.0 71.0 73.0 76.0 78.0 81.0 81.0 83.0 84.0
84.0 87.0 89.0 92.0 92.0 95.0 96.0

Mean = 67.1
95% confidence interval for Mean: 56.86 thru 77.31
Standard Deviation = 26.4
High = 96.0 Low = 0.000E+00
Median = 77.0
Average Absolute Deviation from Median = 19.8

Group D: Control (5th) Number of items= 23
0.000E+00 33.0 64.0 68.0 69.0 73.0 73.0 79.0 80.0 80.0 84.0 84.0 85.0 85.0 87.0 88.0 88.0 88.0 92.0 92.0 96.0 100. 100.

Mean = 77.7
95% confidence interval for Mean: 67.29 thru 88.18
Standard Deviation = 22.1
High = 100. Low = 0.000E+00
Median = 84.0
Average Absolute Deviation from Median = 13.0

Student's *t*-Test: Results Homework grade (percent)

The results of an unpaired t-test performed at 10:14 on 16-FEB-2005

t=-0.843
sdev= 25.7
degrees of freedom = 93

The probability of this result, assuming the null hypothesis, is 0.402

Group A: Number of items= 48
0.000E+00 8.00 13.0 16.0 18.0 26.0 29.0 34.0 43.0 46.0 47.0 50.0 61.0 62.0 63.0 66.0 67.0 68.0 68.0 70.0 71.0 73.0 74.0 75.0 75.0 77.0 77.0 83.0 85.0 86.0 87.0 87.0 87.0 88.0 88.0 88.0 88.0 88.0 88.0 89.0 90.0 90.0 91.0 93.0 95.0 95.0 96.0 98.0

Mean = 67.9
95% confidence interval for Mean: 60.49 thru 75.22
Standard Deviation = 26.6
Hi = 98.0 Low = 0.000E+00
Median = 75.0
Average Absolute Deviation from Median = 20.0

Group B: Number of items= 47
0.000E+00 0.000E+00 14.0 27.0 33.0 39.0 44.0 49.0 53.0 59.0 63.0 64.0 68.0 69.0 71.0 73.0 73.0 73.0 76.0 78.0 79.0 80.0 80.0 81.0 81.0 83.0 84.0 84.0 84.0 84.0 85.0 85.0 87.0 87.0 88.0 88.0 88.0 89.0 92.0 92.0 92.0 92.0 95.0 96.0 96.0 100. 100.

Mean = 72.3
95% confidence interval for Mean: 64.86 thru 79.74
Standard Deviation = 24.7
Hi = 100. Low = 0.000E+00
Median = 81.0
Average Absolute Deviation from Median = 16.7

ANOVA Results-**1st and 2nd quarter** test scores combined.

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	1244.	3	414.6	1.734
error	2.1761E+04	91	239.1	
total	2.3005E+04	94		

The probability of this result, assuming the null hypothesis, is 0.166

Group A: Experimental group 2nd Number of items= 24
32.0 42.0 58.0 61.0 62.0 64.0 64.0 67.0 71.0 71.0 72.0 73.0 73.0 74.0 78.0 82.0 82.0 84.0 90.0 92.0 93.0 93.0 94.0 98.0

Mean = 73.8
95% confidence interval for Mean: 67.48 thru 80.02
Standard Deviation = 16.4
High = 98.0 Low = 32.0
Median = 73.0
Average Absolute Deviation from Median = 12.3

Group B: Experimental 6 Number of items= 24
42.0 47.0 48.0 51.0 51.0 58.0 59.0 60.0 60.0 62.0 69.0 70.0 71.0 71.0 72.0 72.0 75.0 76.0 78.0 78.0 81.0 85.0 93.0 99.0

Mean = 67.8
95% confidence interval for Mean: 61.56 thru 74.10
Standard Deviation = 14.5
High = 99.0 Low = 42.0
Median = 70.5
Average Absolute Deviation from Median = 11.4

Group C: Control 3 Number of items= 24
24.0 52.0 55.0 60.0 63.0 69.0 73.0 73.0 76.0 76.0 79.0 80.0 82.0 82.0 85.0 85.0 87.0 87.0 88.0 92.0 93.0 97.0 98.0 99.0

Mean = 77.3
95% confidence interval for Mean: 71.02 thru 83.56

Standard Deviation = 17.2
High = 99.0 Low = 24.0
Median = 81.0
Average Absolute Deviation from Median = 12.3

Group D: Control Number of items= 23
55.0 57.0 58.0 59.0 59.0 64.0 68.0 68.0 70.0 71.0 75.0 78.0 78.0 80.0 85.0 85.0 85.0 86.0 87.0 88.0 92.0 97.0 100.

Mean = 75.9
95% confidence interval for Mean: 69.46 thru 82.27
Standard Deviation = 13.4
High = 100. Low = 55.0
Median = 78.0
Average Absolute Deviation from Median = 11.3

Student's *t*-Test Results- **1st quarter and 2nd quarter test** scores combined percent

t= -1.83
sdev= 15.5
degrees of freedom = 93

The probability of this result, assuming the null hypothesis, is 0.070

Group A: Experimental group Number of items= 48
32.0 42.0 42.0 47.0 48.0 51.0 51.0 58.0 58.0 59.0 60.0 60.0 61.0 62.0 62.0 64.0 64.0 67.0 69.0 70.0 71.0 71.0 71.0 71.0 72.0 72.0 72.0 73.0 73.0 74.0 75.0 76.0 78.0 78.0 78.0 81.0 82.0 82.0 84.0 85.0 90.0 92.0 93.0 93.0 93.0 94.0 98.0 99.0

Mean = 70.8
95% confidence interval for Mean: 66.36 thru 75.22
Standard Deviation = 15.6
Hi = 99.0 Low = 32.0
Median = 71.5
Average Absolute Deviation from Median = 12.0

Group B: Control Number of items= 47
24.0 52.0 55.0 55.0 57.0 58.0 59.0 59.0 60.0 63.0 64.0 68.0 68.0 69.0 70.0 71.0 73.0 73.0 75.0 76.0 76.0 78.0 78.0 79.0 80.0 80.0 82.0 82.0 85.0 85.0 85.0 85.0 85.0 86.0 87.0 87.0 87.0 88.0 88.0 92.0 92.0 93.0 97.0 97.0 98.0 99.0 100.

Mean = 76.6
95% confidence interval for Mean: 72.12 thru 81.07

Standard Deviation = 15.3
Hi = 100. Low = 24.0
Median = 79.0
Average Absolute Deviation from Median = 11.9

ANOVA: Results **Final Grade** %

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	1309.	3	436.4	2.096
error	1.8949E+04	91	208.2	
total	2.0258E+04	94		

The probability of this result, assuming the null hypothesis, is 0.106

Group A:Experimental Number of items= 24
34.0 58.0 59.0 65.0 69.0 69.0 70.0 73.0 75.0 77.0 78.0 79.0 80.0 80.0 83.0 83.0 83.0 84.0 87.0 89.0 89.0 89.0 90.0 95.0

Mean = 76.6
95% confidence interval for Mean: 70.73 thru 82.43
Standard Deviation = 13.3
High = 95.0 Low = 34.0
Median = 79.5
Average Absolute Deviation from Median = 9.42

Group B: Experimental Group Number of items= 24
44.0 49.0 50.0 50.0 53.0 57.0 60.0 60.0 60.0 64.0 67.0 71.0 71.0 71.0 72.0 73.0 76.0 77.0 81.0 81.0 83.0 89.0 91.0 98.0

Mean = 68.7
95% confidence interval for Mean: 62.82 thru 74.52
Standard Deviation = 14.4
High = 98.0 Low = 44.0
Median = 71.0
Average Absolute Deviation from Median = 11.6

Group C: Control group Number of items= 24
18.0 55.0 61.0 68.0 69.0 71.0 74.0 74.0 77.0 77.0 79.0 79.0 81.0 83.0 83.0 83.0 84.0 84.0 88.0 90.0 92.0 95.0 97.0 97.0

Mean = 77.5
95% confidence interval for Mean: 71.61 thru 83.31
Standard Deviation = 16.5
High = 97.0 Low = 18.0

Median = 80.0
Average Absolute Deviation from Median = 10.6

Group D: Control Group Number of items= 23
48.0 60.0 62.0 63.0 65.0 67.0 68.0 73.0 73.0 75.0 76.0 76.0 79.0 81.0 85.0 87.0 87.0 89.0 89.0 90.0 91.0 99.0 99.0

Mean = 77.5
95% confidence interval for Mean: 71.50 thru 83.46
Standard Deviation = 13.2
High = 99.0 Low = 48.0
Median = 76.0
Average Absolute Deviation from Median = 10.7

Student's *t*-Test**:** Results **Final Grade (percent)**

The results of an unpaired t-test performed at 10:29 on 16-FEB-2005

t= -1.62
sdev= 14.6
degrees of freedom = 93

The probability of this result, assuming the null hypothesis, is 0.108

Group A: Experimental Number of items= 48
34.0 44.0 49.0 50.0 50.0 53.0 57.0 58.0 59.0 60.0 60.0 60.0 64.0 65.0 67.0 69.0 69.0 70.0 71.0 71.0 71.0 72.0 73.0 73.0 75.0 76.0 77.0 77.0 78.0 79.0 80.0 80.0 81.0 81.0 83.0 83.0 83.0 83.0 84.0 87.0 89.0 89.0 89.0 89.0 90.0 91.0 95.0 98.0

Mean = 72.6
95% confidence interval for Mean: 68.45 thru 76.80
Standard Deviation = 14.3
Hi = 98.0 Low = 34.0
Median = 74.0
Average Absolute Deviation from Median = 11.4

Group B: Control Number of items= 47
18.0 48.0 55.0 60.0 61.0 62.0 63.0 65.0 67.0 68.0 68.0 69.0 71.0 73.0 73.0 74.0 74.0 75.0 76.0 76.0 77.0 77.0 79.0 79.0 79.0 81.0 81.0 83.0 83.0 83.0 84.0 84.0 85.0 87.0 87.0 88.0 89.0 89.0 90.0 90.0 91.0 92.0 95.0 97.0 97.0 99.0 99.0

Mean = 77.5
95% confidence interval for Mean: 73.25 thru 81.68
Standard Deviation = 14.8
Hi = 99.0 Low = 18.0
Median = 79.0
Average Absolute Deviation from Median = 10.7

ANOVA: Entry GPA (cumulative grade point average as of September, 2004)

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	4.135	3	1.378	2.158
error	58.13	91	0.6388	
total	62.26	94		

The probability of this result, assuming the null hypothesis, is 0.098

Group A: Experimental Number of items= 24
0.970 1.00 1.60 1.80 2.20 2.30 2.40 2.40 2.50 2.50 2.50 2.50 2.60 3.00 3.00 3.10 3.20 3.40 3.40 3.50 3.60 3.60 3.60 3.90

Mean = 2.69
95% confidence interval for Mean: 2.366 thru 3.014
Standard Deviation = 0.801
High = 3.90 Low = 0.970
Median = 2.55
Average Absolute Deviation from Median = 0.635

Group B: Experimental Number of items= 24
0.970 1.00 1.50 1.50 1.50 1.70 2.00 2.10 2.10 2.20 2.20 2.20 2.30 2.40 2.60 2.70 2.70 2.90 2.90 3.00 3.50 3.80 3.80 4.00

Mean = 2.40
95% confidence interval for Mean: 2.075 thru 2.723
Standard Deviation = 0.838
High = 4.00 Low = 0.970
Median = 2.25
Average Absolute Deviation from Median = 0.651

Group C: Control Number of items= 24
1.10 1.70 1.90 2.00 2.10 2.10 2.50 2.60 2.60 2.90 2.90 3.00 3.00 3.00 3.00 3.10 3.30 3.40 3.50 3.90 3.90 4.00 4.00 4.00

Mean = 2.90
95% confidence interval for Mean: 2.572 thru 3.220
Standard Deviation = 0.796
High = 4.00 Low = 1.10
Median = 3.00
Average Absolute Deviation from Median = 0.613

Group D: Control Number of items= 23
1.00 2.10 2.20 2.20 2.20 2.30 2.40 2.50 2.50 2.60 3.00 3.00 3.00 3.20 3.20 3.30 3.50 3.60 3.70 3.80 3.80 4.00 4.00

Mean = 2.92
95% confidence interval for Mean: 2.586 thru 3.248
Standard Deviation = 0.758
High = 4.00 Low = 1.00
Median = 3.00
Average Absolute Deviation from Median = 0.613

Student's *t*-Test: Entry GPA Results

The results of an unpaired t-test performed at 18:46 7-Feb-2005

t= -2.10
sdev= 0.801
degrees of freedom = 93

The probability of this result, assuming the null hypothesis, is 0.039

Group A: Experimental groupNumber of items= 48
0.970 0.970 1.00 1.00 1.50 1.50 1.50 1.60 1.70 1.80 2.00 2.10 2.10 2.20 2.20 2.20 2.20 2.30 2.30 2.40 2.40 2.40 2.50 2.50 2.50 2.50 2.60 2.60 2.70 2.70 2.90 2.90 3.00 3.00 3.00 3.10 3.20 3.40 3.40 3.50 3.50 3.60 3.60 3.60 3.80 3.80 3.90 4.00

Mean = 2.54
95% confidence interval for Mean: 2.315 thru 2.774
Standard Deviation = 0.824
Hi = 4.00 Low = 0.970
Median = 2.50
Average Absolute Deviation from Median = 0.655

Group B: Control Number of items= 47
1.00 1.10 1.70 1.90 2.00 2.10 2.10 2.10 2.20 2.20 2.20 2.20 2.30 2.40 2.50 2.50 2.50 2.60

2.60 2.60 2.90 2.90 3.00 3.00 3.00 3.00 3.00 3.00 3.10 3.20 3.20 3.30 3.30 3.40 3.50 3.50
3.60 3.70 3.80 3.80 3.90 3.90 4.00 4.00 4.00 4.00 4.00

Mean = 2.89
95% confidence interval for Mean: 2.657 thru 3.121
Standard Deviation = 0.776
Hi = 4.00 Low = 1.00
Median = 3.00
Average Absolute Deviation from Median = 0.630

ANOVA: Results- Gender analysis Homework Scores

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	633.1	3	211.0	0.3150
error	6.0964E+04	91	669.9	
total	6.1597E+04	94		

The probability of this result, assuming the null hypothesis, is 0.81

Group A Female Control: Number of items= 26
0.000E+00 0.000E+00 27.0 39.0 44.0 64.0 68.0 69.0 73.0 79.0 80.0 83.0 84.0 84.0 85.0 85.0
87.0 87.0 88.0 88.0 88.0 89.0 92.0 92.0 95.0 100.

Mean =71.9
95% confidence interval for Mean: 61.84 thru 82.01
Standard Deviation = 27.4
High = 100. Low = 0.000E+00
Median = 84.0
Average Absolute Deviation from Median = 17.3

Group B Female Experimental: Number of items= 23
0.000E+00 8.00 18.0 34.0 46.0 61.0 67.0 70.0 75.0 77.0 83.0 86.0 87.0 87.0 87.0 88.0 88.0
88.0 88.0 89.0 90.0 95.0 96.0

Mean = 69.9
95% confidence interval for Mean: 59.19 thru 80.63
Standard Deviation = 28.7
High = 96.0 Low = 0.000E+00
Median = 86.0
Average Absolute Deviation from Median = 19.3

Group C Male Control: Number of items= 21
14.0 33.0 49.0 53.0 59.0 63.0 71.0 73.0 73.0 76.0 78.0 80.0 81.0 81.0 84.0 84.0 90.0 92.0
92.0 96.0 100.

Mean = 72.5
95% confidence interval for Mean: 61.26 thru 83.70
Standard Deviation = 21.3
High = 100. Low = 14.0
Median = 78.0
Average Absolute Deviation from Median = 15.0

Group D Male Experimental: Number of items= 25
13.0 16.0 26.0 29.0 43.0 47.0 50.0 62.0 63.0 66.0 68.0 68.0 71.0 73.0 74.0 75.0 77.0 85.0 88.0 88.0 90.0 91.0 93.0 95.0 98.0

Mean = 66.0
95% confidence interval for Mean: 55.68 thru 76.24
Standard Deviation = 24.9
High =98.0 Low= 13.0
Median = 71.0
Average Absolute Deviation from Median = 19.0

ANOVA: Results1 & 2 quarter test scores (males/females)

Source of Variation	Sum of Squares	d.f.	Mean Squares	F
between	939.2	3	313.1	1.291
error	2.2066E+04	91	242.5	
total	2.3005E+04	94		

The probability of this result, assuming the null hypothesis, is 0.282

Group A: Exp malesNumber of items= 25
42.0 48.0 51.0 58.0 58.0 59.0 60.0 61.0 62.0 64.0 69.0 70.0 71.0 72.0 75.0 76.0 78.0 82.0 85.0 92.0 93.0 93.0 93.0 94.0 98.0

Mean = 72.2
95% confidence interval for Mean: 65.97 thru 78.35
Standard Deviation = 16.0
Hi = 98.0 Low = 42.0
Median = 71.0
Average Absolute Deviation from Median = 13.2

Group B: Control males Number of items= 19
52.0 59.0 60.0 63.0 64.0 70.0 71.0 73.0 76.0 76.0 79.0 80.0 87.0 88.0 88.0 97.0 97.0 98.0 99.0

Mean = 77.7
95% confidence interval for Mean: 70.64 thru 84.83
Standard Deviation = 14.5
Hi = 99.0 Low = 52.0
Median = 76.0
Average Absolute Deviation from Median = 11.8

Group C:Females Exp. Number of items= 23
32.0 42.0 47.0 51.0 60.0 62.0 64.0 67.0 71.0 71.0 71.0 72.0 72.0 73.0 73.0 74.0 78.0 78.0 81.0 82.0 84.0 90.0 99.0

Mean = 69.3
95% confidence interval for Mean: 62.85 thru 75.75
Standard Deviation = 15.4
Hi = 99.0 Low = 32.0
Median = 72.0
Average Absolute Deviation from Median = 10.7

Group D: Females control Number of items= 28
24.0 55.0 55.0 57.0 58.0 59.0 68.0 68.0 69.0 73.0 75.0 78.0 78.0 80.0 82.0 82.0 85.0 85.0 85.0 85.0 85.0 86.0 87.0 87.0 92.0 92.0 93.0 100.

Mean = 75.8
95% confidence interval for Mean: 69.98 thru 81.67
Standard Deviation = 16.1
Hi = 100. Low = 24.0
Median = 81.0
Average Absolute Deviation from Median = 11.8

APPENDIX I

Parent Letter and Survey

January 2005

Dear Parents,

My study on differentiating biology homework is going to end in two weeks, the end of the first semester. I want to thank you for allowing me to conduct this research with your students. It is only by conducting research that we can determine if different instructional strategies have benefits for academic achievement. I have gathered some interesting data so far, and will share the results with you after I have completed my thesis. However, there is still some data that I would like to collect, and for that I need some parental input. I would like to solicit you for information regarding your perception of your student's attitude toward the homework assignments in biology. For example, did they complain about it, seem excited, or in general, remain indifferent? Any information you can give me will be helpful in evaluating the worthiness of allowing choice for homework assignments.

I have attached a survey on the reverse side of this letter. You may fill it out anonymously so that you can be frank about your opinion. I will provide an envelope in the classroom so that your student can place it there without being identified. If you would like to talk to me in person, I will gladly sit down and discuss this study with you after school, or arrange another time to do so. My school number is 734-484-7000 ext. 7654. My prep period is from 11:45 am to 12:30pm. My e-mail address is bertsos@gw.lincoln.k12.mi.us. I am looking forward to hearing from you.

Sincerely,

Genevieve Bertsos
Biology teacher
Lincoln High School
7425 Willis Rd.
Ypsilanti, MI. 48197

Parent Survey
Biology-Differentiated Homework Study

1. Was your student in the control group (traditional homework-outlines and study guides) or the experimental group (choice of homework assignment)?

____

2. Did the homework assignments your student was required to complete create a hardship on family/student time? ________________.
Do you wish to elaborate?____

____

____

3. If your student was in the experimental group, did you perceive any attitudinal behavior from your student in regard to homework? ______. If so, could you elaborate?

4. If your student was in the control group, did you perceive any attitudinal behavior from your student in regard to homework? _______. If so, could you elaborate?

5. Do you think it is important for students to have some choice in regard to the type of homework they are required to complete? _______. Could you elaborate on your response?

6. Do you think homework is necessary for biology? _____. Why or why not?

7. Do you have any other comments or concerns regarding this study?

APPENDIX J

Experimental Group Homework Survey

Question	**Pre-assessment Strongly Agree/Agree**	**Post-assessment Strongly Agree/Agree**	**Change in Confidence (percentage points)**
1. Homework helps me learn the concepts we are studying in biology.	57%	59%	+2
2. I don't mind doing homework.	25%	36%	+11
3. Homework is interesting.	4%	10%	+6
4. I have some choice in selecting the type of homework for class.	57%	78%	+21
5. I would like to have some choice in selecting the type of homework I have to do for my class.	87%	74%	-13
6. The type of homework I am usually assigned is geared toward the way that I learn best.	18%	54%	+36
7. I typically complete my homework whether I like it or not.	72%	72%	0
8. I can usually complete my homework in the time allotted by my teacher.	63%	72%	+9
9. Homework helps me prepare for the tests I am given in class.	57%	69%	+12
10. Even if given a choice as to type of homework, I would still not do it.	4%	5%	+1
11. I spend time almost every day doing homework.	63%	67%	+4

Appendix K

Control Group Homework Survey

Question	**Pre-assessment Strongly Agree/Agree**	**Post-assessment Strongly Agree/Agree**	**Change in Confidence (percentage points)**
1. Homework helps me learn the concepts we are studying in biology.	64%	59%	-5
2. I don't mind doing homework.	23%	32%	+9
3. Homework is interesting.	6%	17%	+11
4. I have some choice in selecting the type of homework for class.	11%	7%	-4
5. I would like to have some choice in selecting the type of homework I have to do for my class.	73%	54%	-19
6. The type of homework I am usually assigned is geared toward the way that I learn best.	25%	22%	-3
7. I typically complete my homework whether I like it or not.	78%	66%	-12
8. I can usually complete my homework in the time allotted by my teacher.	43%	54%	+11
9. Homework helps me prepare for the tests I am given in class.	62%	44%	-18
10. Even if given a choice as to type of homework, I would still not do it.	3%	9%	+6
11. I spend time almost every day doing homework.	71%	59%	-12