Using Formative Assessment to Increase Learning of Biochemistry in High School Biology

Sheri P. Backus

The College at Brockport, sbackus2@CAL-MUM.ORG

Follow this and additional works at: http://digitalcommons.brockport.edu/ehd_theses

Part of the Elementary and Middle and Secondary Education Administration Commons

To learn more about our programs visit: http://www.brockport.edu/ehd/

Repository Citation
http://digitalcommons.brockport.edu/ehd_theses/316
Using Formative Assessment to Increase Learning of Biochemistry in High School Biology

by

Sheri P. Backus
August 2006

A thesis submitted to the Department of Education and Human Development of the State University of New York College at Brockport in partial fulfillment of the requirements for the degree of Master of Science in Education.
Using Formative Assessment to Increase Learning of Biochemistry in High School Biology

by

Sheri P. Backus

APPROVED BY:

[Signature] Jill Zarazinski  6/21/06  Date

[Signature] Director, Graduate Programs  6/21/06  Date
Dedication

I would like to dedicate this paper to Mike, Greg, Meghan and Sarah. Their love and support helped me run my race and their encouragement got me to the finish line. 😊
Table of Contents

Abstract ............................................................................................................................... iv
Chapter 1: Introduction. ....................................................................................................... 1
  Problem Statement ........................................................................................................... 1
  Significance of the Problem .......................................................................................... 2
  Purpose ............................................................................................................................ 3
  Rationale ......................................................................................................................... 4
  Definition of Terms ........................................................................................................ 5
  Summary ......................................................................................................................... 7
Chapter 2: Literature Review ............................................................................................. 8
  Formative Assessments Increase Success for Lower Achieving Students ................. 8
  Formative Assessments Increase Students’ Understanding ........................................ 12
  Formative Assessments Help Students Become Active Participants ....................... 20
Chapter 3: Applications and Evaluation ........................................................................... 25
  Introduction to Research ............................................................................................... 25
  Context ............................................................................................................................ 26
  Methods for Conducting Action Research ................................................................... 28
  Data Collection Sources .............................................................................................. 28
  Summary ......................................................................................................................... 31
Chapter 4: Results ............................................................................................................ 32
  Data Analysis and Interpretations ................................................................................ 32
Chapter 5: Conclusions and Recommendations ............................................................... 39
  Conclusion – What Was Learned .................................................................................. 39
  Future Plan .................................................................................................................... 41
  Recommendations ....................................................................................................... 41
  Summary ......................................................................................................................... 42
References ......................................................................................................................... 44
Appendices ......................................................................................................................... 49
  Organizer 1 ................................................................................................................... 50
  Organizer 2 ................................................................................................................... 51
  Quiz 1 ............................................................................................................................. 52
  Quiz 2 ............................................................................................................................. 53
  Checklist ......................................................................................................................... 54
  Institutional Review Board Approval Notification Letter ............................................. 56
  Parent/Guardian Permission Form .............................................................................. 57
  Student Permission Form ............................................................................................. 58
Lists of Illustrations

| Photograph 1 | ................................................................. | 32 |
| Photograph 2 | ................................................................. | 33 |
| Photograph 3 | ................................................................. | 33 |
| Photograph 4 | ................................................................. | 35 |
| Photograph 5 | ................................................................. | 35 |
| Photograph 6 | ................................................................. | 36 |
Abstract

This paper reports the outcome of a research project in regards to a biochemistry unit performed in a high school biology cooperative teaching classroom. As a result of difficulties with this topic in previous semesters, the author decided to use a variety of formative assessment teaching strategies with the intent of seeing if student learning, through active participation, would be enhanced. Along with increasing understanding, it was hoped these different assessment tools would improve the success rate of lower achieving students on the unit exam. The findings show that the use of graphic organizers, reflective journals, cooperative groups and open-book quizzes improved the learning of biochemistry and increased test scores on the unit exam for all students.
Chapter 1: Introduction

Why do people become teachers? Is it because they get summers off? Do they go into the profession for the money? What if the driving force is simply having the desire to help another person learn something? If the goal is the latter, then the focus of an effective teacher is to find ways to do just that. There is much support in educational research regarding the benefits of formative assessment and many experts in the field of teaching believe this type of assessment is the answer to helping students learn.

Problem Statement

Traditionally, summative assessment has been the focal point in the classroom. Teachers in the United States have been expected to lecture on a topic, give a test to their students, grade them and periodically send a report card home to parents. The summative grade on this report would be an indication of whether their child understood the material that was being taught. This is still common practice today. The problem with strictly using summative assessment is that instructors do not discover which students are having trouble understanding the material until the unit test or final exam. At this point it may be too late to give them help. If the goal as a teacher is to help students understand, how can this be done in a summative environment?
This past semester the majority of students in my Living Environment classes did not do well on their summative biochemistry exam. This test is the most difficult in this course, but this group of students did significantly worse than in years past. I realized it was time to pinpoint the problem. This particular unit contains a lot of information on macromolecules that needs to be understood before learning about the human body. The topic also contains many new words. The amount of information and the vocabulary is tough for the brightest students and so it is extremely intimidating to the average or lower than average achievers. I decided it was time to change my biochemistry lessons to include some new teaching strategies I hoped would help my classes understand the content better and remember unit vocabulary. I thought formative assessment might be the answer to my summative problem.

**Significance of the Problem**

Another factor influencing public schools and how teachers teach in the United States is the No Child Left Behind Act of 2001 (United States Department of Education, 2003). The act calls for every public school in the nation to raise its standards of learning in primary and secondary education. Each state will be required to periodically measure the progress made by its students in the form of a summative assessment. Schools and their teachers will be held accountable for the achievements of their students. It is my responsibility to teach my students some basic biochemistry so they can show competency in the area on their final state exam.
Not only is it important for my students do well in this area on their final exam but it is also imperative they understand how the human body works on a molecular level. My role as an effective Living Environment teacher is to provide my students with the knowledge in a physically and emotionally safe classroom. In order to do this, I need to possess the abilities to create a science classroom with an atmosphere conducive to learning – an atmosphere filled with mutual respect, caring and a feeling of safety in successes or failures. To be an outstanding teacher I not only need to know the content area but I also need to know how to deliver the material so students will come to understand it. I want to become proficient in pedagogy through the use of different tools or strategies so a diverse group of learners can master the information presented to them in science. Successful science teachers know students well enough to understand the barriers that may prevent some from grasping an idea. These teachers continually work to find strategies that work for their individual students with the goal of ensuring they learn. I need to recognize the barriers in regards to biochemistry and I want to find ways to get my students around them through formative assessment.

Purpose

The purpose of this research is to find ways to improve my Living Environment students' learning of biochemistry through formative assessment. In previous years, this has been the most difficult material for them to learn and they do not perform well on the unit test. I would like to develop ways to make biochemistry
more interesting and enjoyable for my pupils through formative assessment. This type of analysis provides instructional tools that actively involve all the students and make them more responsible for the knowledge that they gain. This should develop their organizational skills and through reflective practices help them understand and retain the material better.

*Rationale*

Can formative assessment tools improve student learning in a unit on biochemistry? This particular subject is a topic tenth grade students have a difficult time with yet is something they need knowledge of in order to understand how and why organisms work the way they do. This particular unit involves abstract thinking and the memorization of many new terms. Not only are the words new to the students, they are also very long. I do not go into great depth with the biochemistry material but my students need to learn and understand the macromolecules needed by cells, particularly human cells, to survive. They have to understand their function, how they are obtained, why they are needed and basic structure and composition. In my biochemistry unit, I also briefly cover, the processes of photosynthesis and cellular respiration. In past classes I have reviewed with them daily the new terminology and have felt they understood the material. Yet when they took their biochemistry final exam the class average was much lower than on other unit tests. The lower achievers in my classes had a more difficult time.
Reflecting upon these results I wondered if I misread their level of understanding before the exam or if the problem lies in the chapter test itself. The test may be worded in such a way that it creates confusion for my students. There are indeed a lot of terms and material to memorize so it might become disorganized in their minds when they take the test. I am sure for some there is also test anxiety. Whatever the issue, I knew I had to make a change.

I am anticipating the results from this action research will be helpful to me when I teach biochemistry in the future. In a broader sense, the information gained through the literature review on formative assessment will enhance my effectiveness as a science instructor by providing me with information and ideas in regards to the delivery of all my lessons. The problems I encountered in my biochemistry unit are dilemmas faced by many science teachers. Science is an area filled with a lot of information and a vocabulary of its own. Not all students are able to learn in a teacher-centered classroom and by memorizing facts. My attempt here is to make the science classroom more centered on my students and as a result they will understand and learn the chemistry of life.

**Definition of Terms**

Generally, teachers see assessment as separate from teaching. They see it used only as a way of finding out what a student knows (summative) and not a means of becoming more effective as an instructor (formative). They do not see it being used to increase understanding that will benefit themselves and their students (Torrance &
Assessments that are formative in nature can be integrated into lessons by a teacher to increase all their pupils’ learning (Hunt & Pellegrino, 2002). They occur on a daily basis informing and involving the student in their learning.

Formative and summative assessments used in conjunction can augment instruction and aid in the transfer of knowledge while being used to judge whether students understand the objectives set forth by instructors, the state and the federal governments. Further, assessments can be used by the school district to judge whether its teachers are being effective and can be used by the state governments to discover whether the school districts are being effective in teaching the state standards. These tools also can be used as a source for understanding and for professional accountability.

Little was known about how people learn when the educational system was first begun in this country. Initially the role of the school was to teach children to read, write and do arithmetic through repetition and memorization of fact. Today’s school systems are expected to teach students to think, express themselves and use the knowledge they have acquired (Bransford, Brown & Cocking, 2000). Advances in cognitive psychology have increased the educator’s understanding of how children learn. Research has shown that formative assessment is a strategy that can be used to reach the new mission of society’s expectations for learning (Bell & Cowie, 2001; Black & Wiliam, 1998; Black, Harrison, Lee, Marshall & Wiliam, 2004; Carlson, Humphrey, & Reinhardt, 2003; Hall & Burke, 2003; Priestley & Sime, 2005).
Summary

How can teachers in a society that is driven by summative assessments improve student learning through the use of formative assessment? The objective of this paper and research is to find ways to help students in a high school biology class be active participants and learn the subject of biochemistry. Formative and summative assessments will be compared, but the main focus will be on the former. This is an attempt to change from a more traditional, teacher centered learning environment to one where students take responsibility for their learning and actively participate. It is thought that as a result of these actions, the lower achieving students will score higher on a biochemistry unit test. More specifically, the following questions will be addressed:

1. Will formative assessments increase the success of lower achieving students on a summative biochemistry unit test?

2. Will formative assessments increase students’ understanding of biochemistry?

3. Will formative assessments help students become more active participants during biochemistry lessons?
Formative Assessments Increase Success for Lower Achieving Students

Traditionally, science lessons taught in the United States have been teacher centered. A typical classroom shows an instructor up in front of its class lecturing on a subject. Teachers did the teaching and the students listened. After a unit had been taught the students were tested or assessed to see who understood the material. Assessments were of the summative type. Those that learned quickly did very well on these tests and proceeded on. The students that did not score well or rank high eventually lost interest or confidence and many gave up (Stiggins, 2005). Assessment was used solely to quantitate knowledge, rank students and measure whether a student should receive certification. The school’s role was to see that students had the opportunity to learn and it was not their problem if a child gave up and quit (Stiggins, 2005).

There is a new mission in the United States. It has become the responsibility of the schools to not only provide an opportunity for children to learn but to make sure all students learn. No longer is it strictly an issue for a child if they are having difficulty in school. The school now shares the concern and they have an obligation to see that every child learns and does not give up. Because the goal has changed, so must our schools and our teachers. The traditional form of instruction is limiting and restricts the success of students who rank at the bottom. The educational system in this country is obligated to find ways to help lower level students learn. The schools
and educators have to change the way they teach in order to reach all children. With different learning goals come different strategies on how to achieve them (Bransford et al., 2000). Formative assessments may be a way to meet the goals of a summative world.

Carlson et al. (2003) compared assessments to growing plants. They pointed out that by pulling plants out of the ground to see if their roots are growing stops plant development. The same could be said about pupils in a classroom. Teachers need to check for growth in their students without constantly checking their roots. Experienced gardeners of assessment know how to enhance and recognize growth in all their seedlings without uprooting them.

An assessment is considered a “judgment of students’ work” (Taras, 2005, p. 467). Black and Wiliam (2003) say that assessments not only can be used to measure or judge learning but also have been known and recognized to support it. There are two major types of assessment: summative and formative. According to Bransford et al. (2000), summative assessment is used to measure what a student has learned and is generally given at the end of a unit. On the other hand, formative assessment is used during classroom time as feedback to the teacher so that he or she can change the teaching and improve student learning. Summative assessment is done for ranking and accountability (Torrance & Pryor, 1998). Formative assessment is done on a daily basis as a form of reflection so that the instructor can modify their lesson for the following day. Summative assessment is an assessment of learning and formative assessment is used for learning (Threlfall, 2005).
Traditionally, summative tests have been used to evaluate students for the purpose of grading them. It was named for its function to sum things up (Torrance & Pryor, 1998). This type of assessment has been used as the deciding factor on whether students should be certified or allowed to move forward in the educational process. The lower achieving pupils encountered failure and many times did not advance.

Evaluations geared to sum up the performance of a student do not provide immediate feedback to the learner, yet are often the basis for decisions in regard to a student (Sadler, 1989). This type of assessment also impacts district and State educational policies. Taras (2005) sees that summative assessments are judgments made covering everything to a certain point. Hunt and Pellegrino (2002) say this about summative evaluations: “Assessment in education is commonly used to certify the amount that individual students have learned and to provide an accountability measure for students and educational systems as a whole” (p. 73).

Originally the purpose of formative assessment was simply to increase the feedback to the instructor as to whether students understood the material being taught before the end of the unit or end of year test. Students that routinely had difficulty needed more frequent interaction with the instructor to check for comprehension. Subsequent lesson plans could be adjusted to accommodate the needs of the class. This meant giving more quizzes or tests that could be scored quickly. They were summative assessments given more frequently. Even today some experts advocate a formative assessment strategy that is not much different from summative. Gonzalez (2005), Herman & Baker (2005) and Olson (2005) suggest more frequent computer
generated tests. These tests give same-day feedback as to whether students understand. This is a tool that can be helpful but limiting. Black et al. (2004) believe in using the results of a unit test to check for weak areas. Identifying these areas will aid in future delivery of a lesson, especially to the weaker populations in a class.

Formative assessments have become more than simply using summative tests more frequently. They have evolved into something that influences instructional strategies in order to help all students reach understanding through active engagement in the process. As a result of this new teaching method, formative assessment has also become a learning experience for the teacher. It guides instructional practices with student comprehension being the focal point (Threlfall, 2005).

The purposes of summative and formative seem bipolar yet when used together they compliment each other. Summative evaluations satisfy the need in this country for accountability while formative assessments can be used to maximize all students learning. This type of ongoing assessment provides methods for improving understanding while addressing the diverse abilities and learning styles of students (Black & Wiliam, 1998, 2003, 2005; Bell & Cowie, 2001; Sadler, 1989; Stiggins, 2005; Torrance & Pryor, 1998). Black et al. (2004) reminds us that in order to reach the new goals of education, summative assessments are not the only answer. They need the aid of formative assessments. Threlfall (2005) agrees and says that one of the key features or purposes of formative assessment is to help every pupil improve and succeed in any type of classroom.
The best way to start using formative evaluations is to find easy, uncomplicated ideas. Teachers need to start out simple and after becoming comfortable move to more complex ideas (Priestley & Sime, 2005). Formative assessments are many things. Any instructional approach that increases student understanding can be classified as this type of assessment. The plan of attack can be simple or highly creative.

**Formative Assessments Increase Students’ Understanding**

Anyone who has taught has performed some type of formative assessment. This type of evaluation was practiced before it was even acknowledged and named. Whatever the setting, the instructor checks the learner for understanding. It is a natural part of the interaction between teacher and pupil. Whether in a classroom, on a stage, on a playing field, in a dance studio or on a bicycle, instructors, directors, coaches, and parents always look for evidence that their students understand.

Although we haven’t traditionally seen it in this light, assessment plays an indispensable role in fulfilling our calling. Used with skill, assessment can motivate the unmotivated, restore the desire to learn, and encourage students to keep learning, and it can actually create - not simply measure - increased achievement. (Stiggins, Arter, Chappuis & Chappuis, 2004, p. 3)

The educational system has become the focus of attention in the United States. There is increased interest on how students learn and how they compare to students in other countries. Assessment results are the basis for comparison. Consequently, the
purposes of evaluation and how they may be used are at the center of discussions between the policymakers and the educators (Wininger & Norman, 2005). Do they promote learning and understanding? Do they improve the performance of students or merely measure how much they know? Black and Wiliam (1998) found that assessments, specifically formative assessment, do improve the performance of students and make teachers more effective. These types of interactions should identify the needs of the students and define how lessons should be taught.

Processes for evaluation are central to good teaching and learning. In addition, assessments can be powerful because they provide feedback to the teacher. They can be the basis for a bond between the educator and students (Wiggins, 1998). Torrance and Pryor (1998) write that assessments play a crucial social role in the classroom and they can have a negative or positive impact on the future education of a student. These evaluations give clues to the instructor as to whether the students in their classroom understand the material being taught. The clues can be gathered through effective classroom questioning, discussions, laboratory reports, quizzes, tests, journals, research projects and behaviors. All forms of assessment must be appropriate to the students in the classroom. They should accommodate any learning style so as to give a clear and fair indication of a student’s knowledge.

Black et al. (2004) have defined formative assessment:

Assessment for learning is any assessment for which the first priority in its design and practice is to serve the purpose of promoting students’ learning. It thus differs from assessment designed primarily to serve the purposes of
accountability, or of ranking or of certifying competence. An assessment activity can help learning if it provides information that teachers and their students can use as feedback in assessing themselves and one another and in modifying the teaching and learning activities in which they are engaged. Such assessment becomes *formative assessment* when the evidence is actually used to adapt the teaching work to meet learning needs (p. 10).

As a society, we are faced with changing the way our students are taught because the national mission has changed (Stiggins, 2005). Many educational experts and policymakers believe all students can achieve and must meet specific standards. If teachers are to motivate the lower achieving students, the traditional method of using summative assessments will not work by itself (Black et al., 2004). In order for students to believe in their success, the tools for understanding and the atmosphere in the classroom have to change to accommodate different learning styles. Professional educators are convinced that formative assessment will be a part of the solution (Black & Wiliam, 1998, 2003, 2005; Bell & Cowie, 2001; Sadler, 1989; Stiggins, 2005; Torrance & Pryor, 1998).

Formative assessment was named for its function. This assessment is to be used to inform the pupil whether he or she understands the material taught. This type of evaluation is taken during a unit or through an entire course with the intent of improving learning (Torrance & Pryor, 1998). The instructor can use formative evaluation to recognize if students understand the material presented. Also it provides more frequent evidence so the teacher can make adjustments in their lesson delivery.
on a day-to-day or week-to-week basis (Stiggins, 2005). Black and Wiliam (2003) also found formative assessment supports learning and highlights how students think.

Of the two types of assessment, summative and formative, the latter can be the more complicated and time consuming. The novice teacher will probably practice more summative judgments to assess what their students have learned. Threlfall (2005) and Bell and Cowie (2001) believe that as the educator becomes more efficient in pedagogy and understanding how children learn, instruction will improve. They state the more experienced teacher is better at using formative assessment because they know where a class may have difficulty with a particular topic. Knowing where the misconceptions may be and having alternative approaches for learning is a part of formative assessment. This type of information is not generally evident to a young instructor. The mature educator finds an approach, or alternate plan, which will lead to understanding. When formative observations lead to different pedagogy strategies, Threlfall (2005) names this contingent assessment.

Torrance and Pryor (1998) see formative assessment as a learning tool and further divide it into two categories: convergent and divergent. In convergent assessments the learner takes what they know to find the best single answer. The teacher uses this type of assessment to see whether the student understands a predetermined objective. In divergent assessments the student is expected to use what they know to create multiple solutions to a problem. The teacher is looking to see what the child knows.

Formative assessment draws on the constructivist ideas whose basis is in psychology (Black & Wiliam, 2003; Hall & Burke, 2003). The teacher builds upon
the learner’s prior knowledge through a series of steps. At each step the instructor evaluates as to whether students are learning. This type of classroom assessment aims to give aid in developing the learner (Rushton, 2005). Hall and Burke (2003) say it has been recognized that real understanding occurs when the learners are able to decipher meaning for themselves. The teacher’s role in the classroom is to be a guide between the idea and the student, allowing the student more possession. This type of assessment involves both the teacher and the student interacting and is used to provide feedback to the instructor. This cycle aids with the understanding of the individual (Bell & Cowie, 2001). Day-to-day evaluations give teachers clues on how to respond. A lesson plan can be altered to accommodate difficulties of the students. Formative assessment puts the student at the center of their learning and should develop their meta-cognition skills (Black & Wiliam 2003; Harlen & James, 1997).

Black et al. (2004) say there is evidence which shows using and improving formative assessment can increase understanding. They also mention its ability to raise learning in all students including the lower achieving students.

A thorough understanding of what formative assessment is is essential to using it in the classroom. Threlfall (2005) says this type of assessment is necessary in the teaching and learning process and should involve students in their learning by sharing expectations with them and providing them with feedback. This same author says formative assessment is committed to helping all students improve and it actively engages teachers and pupils through reflection and review of student progress. The Centre for Educational Research and Innovation (CERI) (2005) see
education and formative assessment as a global issue and have found the key elements of this type of evaluation to be a classroom atmosphere that emphasizes interactions and involvement of students in their learning goals through the use of varied approaches which meet the needs of all students while checking for understanding and tracking progress. From these key features by Threlfall and CERI it is evident there is a link between student learning and student participation in the educational experience. This issue will be addressed later in this paper.

There are many examples of formative assessment practices in the literature that are believed to increase students’ understanding and which could be helpful in a science classroom. McTighe and O’Connor (2005) suggest that the teacher use formal and informal assessments such as oral questioning, ungraded quizzes, instructional observations, portfolios, rubrics, and concept maps. Hunt and Pellegrino (2002) believe that formative assessment needs to take place while the student learns and can be augmented through interactive computer technology programs.

Wininger and Norman (2005) propose using practice tests, seatwork and group activities in addition to oral questioning and quizzes to check for student understanding. They explain further that formative assessment also involves observations of student attitudes, facial expressions, body language and student questions.

Carlson et al. (2003) recommend teachers to sit, listen and note observations of their students as they work, while at other times share new information sparking a discussion through higher order questions that seek understanding not memorization.
This same group of authors says self-assessment, observations, video and audiotapes, photographs, samples of student science writing and products of student science can all be used as evidence of learning. In addition to these examples of formative assessment, Black et al. (2004) suggested using journals to check for understanding and to provide written feedback. They also found written comments on tests rather than grades increased student learning.

Evidence that formative assessment practices, such as these, enhance learning and increase involvement of the student can be found in research reported by Torrance and Pryor (2001). This study’s focus was to develop this type of evaluation in primary classrooms. Teachers in this research concluded that divergent assessment was a more powerful tool when it came to learning but argued, due to time constraints, convergent evaluations were still needed. In an earlier work, Torrance and Pryor (1998) found formative assessment could stimulate further learning if the student understands the conditions of the task. Hall and Burke (2003) concluded that learning would not be maximized without formative assessment becoming a part of pedagogy. They are certain that schools need to educate and assess for the benefit of the learner and not for accountability.

In 1993, Steinbrink and Jones found that students, at all levels and in all subjects, improved their learning when they used the formative strategy of cooperative learning groups. This was especially true of the lower-achieving students. They also found that this type of assessment was more enjoyable to the learner. A study conducted by Hattie and Jaeger in 1998 concluded that student learning
increases in formative (classroom) assessment. More specifically they found that understanding is a direct result of teachers setting goals and providing feedback to their individual students.

Formative assessment not only facilitates student understanding but may also prove to be a learning experience for the teacher, professionally. Through this process the instructor must reflect on his/her teaching strategies and from this comes growth and development (Dekker & Feijs, 2005). Carlson et al., (2003) “highlight learnings from the Continuous Assessment in Science Project (CASP) from 1995-1997 and a professional development materials grant: Strengthening Science Inquiry, Assessment and Teaching, 1998 through 2002, both funded by the National Science Foundation.” (p. xii) In their book they found that formative assessment, or continuous assessment, fits naturally in a science classroom and it increases not only the learning of the student but also the instructor. It helps to inform and to form practice. Dekker and Feijs (2005) found assessing was an important part of learning and teachers developed favorable attitudes toward formative assessment once they were exposed to it. This is where professional support it necessary for its success because these same authors found that instructors will not use formative assessment until they feel comfortable with it.

As pointed out by the CERI (2005), improving the way we educate our children is as much an issue in other countries as it is in the United States and assessment is integral to that. Globally, governments are setting standards to which all children should attain. To measure whether the standards are reached there is
summative assessment. To reach the standards there is formative assessment, the assessments that on a day-to-day basis help students learn.

Since research is indicating that formative assessment has the ability to increase understanding in all students and the mission in education is to be sure ‘no child is left behind’, it seems only natural that the classroom environment should use more of it. The standards set by the educational system in the United States fall in line with the purpose of formative assessment: student learning.

**Formative Assessments Help Students Become Active Participants**

There should be a natural progression toward the use of formative assessment in the science classroom (Carlson et al., 2003). One of the main objectives in a biology class is to enable our students to problem solve independently or in teams. There is a shift toward lessons based on inquiry and away from simple memorization of fact. The standards require that students become actively involved in their education. Formative assessment claims to make students active participants in their education and by becoming involved this should also enhance their understanding of the subject. Student involvement is a large component of formative assessment. This type of assessment is intended to be student centered and not teacher.

An increase in student learning through formative assessment practices that actively involve the student were hypothesized in literary reviews and later found to be true in research by Black and Wiliam (1998, 2003, 2005) and Black et al. (2004). These authors are so certain as to the positive affects of formative assessment, as a
result of this research, that they have now turned their focus into finding ways of getting it into the classroom.

In 2001 Bell and Cowie said, “Formative assessment is dependent on teachers’ and students’ mutual engagement in a process which involves them in eliciting, interpreting and acting on assessment information” (p.12). A cycle of feedback, between instructor and pupil, is needed for success (Hall & Burke, 2003). Feedback is more than a slap on the back by the teacher (Wiggins, 1998). Constructive feedback explains what a student did correctly or incorrectly. The student is expected to think about their thinking (meta-cognition). They are allowed to reflect upon their work and then should be able to understand the difference. In order for feedback to work, it has to be explained clearly and specifically to the student. Feedback requires reflection on the part of the teacher as well. The teacher has to review what the student has accomplished and then needs to respond with the appropriate strategy. This type of descriptive interaction between teacher and pupil can be very productive when performed in an environment of trust and support (Wiggins, 1998). It can be very rewarding.

Sadler (1989) believes more learning will take place when there are clear goals for the student to follow and feedback from the teaching in the quest to reach those goals. The interaction between instructor and pupil should be a cycle. Bell and Cowie (2001) also see the process of formative assessment as being cyclic and interdependent. The cycle is not just between teacher and student but also happens within each of the participants. Both instructor and pupil should go through the
process of, “gathering information, interpreting, and taking action” (p.77)

independently. Periodically the teacher and student should interact to check for understanding.

Many educational experts believe the formative assessment cycle should also involve students working together to improve on their education. Some have found evidence supporting this belief and some have not. Torrance and Pryor (1998) found that the interaction of peers increases learning and this type of assessment will lead to positive outcomes if it becomes a normal part of the teacher’s pedagogy. Prins, Sluijmsmans, Kirschner & Strijbos (2005), investigating more specifically, peer assessment, found more studies need to be done before it can be decided on whether it will have an impact on learning.

Carlson et al. (2003) refer to formative assessment as continuous assessment indicating this is an on-going process and not just an end product. They believe this type of assessment helps with instruction as it monitors the growth of students, enhances student learning, produces deeper thinking, enables professional growth of the teacher through reflection and should fit naturally in a science classroom as it reflects the process of inquiry. This same group of authors mentions how formative assessment is sometimes referred to as naturalistic assessment. This particular name was given to it because a teacher may use it to observe pupils in an informal or natural setting.

Torrance and Pryor (1998) suggest that early in a child’s education, it is the “power relationships” (p.67) between teacher and student that structure formative
assessment and it is not only a process of social interactions between teacher and students but students and students. How assessment is conducted in the early years of a child can have a negative or positive affect on the future of their learning. Chappuis (2005) writes how teachers should set up the environment for learning but students should be in charge of it. She says children should be given clear goals and along with feedback from their instructor, be able to reach those goals. Sadler (1989) wrote that three conditions, occurring simultaneously, form the basis of formative judgments. He believes the learner must understand what is expected of them, have the chance to compare their performance to that expectation and then find a way to close the gap between the two.

Many of the examples of formative assessment strategies already listed in this paper would require input from the student. The ideas in this section were designed exclusively with the intent for student involvement.

Self-reflection through portfolios and journal writing are ideas for transferring the power of learning to the student, says Chappuis (2005). This same author suggests having students evaluate and revise anonymous samples of work. These types of feedback not only give the teacher an idea what the student understands but also allows the pupil a chance to refine their work. In 2004, Black et al. suggested self-assessments, peer assessments based on rubrics and having students prepare test questions as ideas of formative assessment that would involve the student.

Klecker (2003) writes how learners need to be participants in their education and not just observers. She found students respond favorably to being evaluated after
having the opportunity to discuss assessment questions in cooperative groups. This
type of format promotes peer interaction and a time for the teacher to hear what their
students are thinking. Prins et al. (2005) studied how peer assessment might be used
in a Computer Supported Collaborative Learning (CSCL) environment. Student
workbooks may be another strategy for involving classes in their education
(Wellington & Collier, 2002).

Whatever type of formative or continuous assessment, the method has to give
information regarding what the student understands and clear instructions on what
needs to be done for improvement (Rushton, 2005). The learner needs to become a
part of the process and take ownership. This creates independence and fosters
problem-solving skills that a student will have for a lifetime.
Introduction to Research

In the beginning, there was God. On the first day He created the heavens, the earth and the sea. He looked at His work and it was good. On the second day God fashioned biochemistry and marveled at how clever and magnificent it was. When the third day came, God created high school biology students to share in his joy of biochemistry. But the adolescents did not take part in the Lord’s excitement for the subject. Instead they whined and moaned and complained until God said, “Enough!” So on the fourth day God created the high school biology teacher and commanded her, “Go forth and teach my children about the chemistry of life. Fill them with the wonder of it for I have lost patience with my young people.”

On the fifth day, the teacher, filled with the wisdom of organic and inorganic compounds, taught the students the wonders of life through elements, bonding and electrons. At the end of the day, the blessed instructor tested her students for comprehension but found most of her class was not filled with the knowledge she had expected.

She got down on her knees and cried to the Lord, “God, creator of the heavens, the earth and all that inhabit it because of biochemistry, why have you done this to me? How can I make these young people see the gift you have given them? If you could not make them see its significance how shall I?”
God thought a long while and answered, “My child. I will provide you with a solution.” On the sixth day, God created formative assessment and gave it to the teacher. It seemed good and filled the instructor with hope. This teaching strategy actively engaged the students in their education and made them responsible for their own learning of biochemistry. God looked down and said, “This is good. I am pleased with formative assessment.”

The seventh day came and God decided that everyone needed a rest. So they did.

Context

This research was carried out in a rural high school in Upstate New York. The county in which this school resides had a median household income of $42,066 in the year 2000 and 10% of the population was below poverty level. In that same year, 19% of the county’s population held Bachelor’s degrees and 82% of its children graduated from high school. This particular school district currently employs 25 full-time teachers in the high school and has 377 students enrolled in grades 9-12. Of these students, 185 are male and 192 are female. In this population, 362 are white, 10 are African-American, two are Hispanic and two are Asian. Seven students from this school district’s high school are enrolled in alternative education programs and 37 children have Individualized Education Plans (IEP). From July 1, 2004 through June 30, 2005, nine students were involved in disruptive incidents not involving weapons.
and four were implicated in the use, possession, or sale of drugs or alcohol. The attendance rate in grades 9-12 is approximately 95%.

The classroom in which this research was conducted consisted of 14 students and the subject being taught was New York State’s The Living Environment (biology) curriculum. All of the students in this classroom were in tenth grade and fifteen or sixteen years old. This was a cooperative teaching (co-teach) classroom with one content specialty instructor and one special education teacher (cooperative teacher). Three of the students had IEPs and one had been registered under Section 504. The subject was taught in one semester block schedule where classes met 85 minutes every day for approximately 18 weeks. At the end of that time, students would take a state proficiency exam (Regents). This particular class met at the end of the school day and consisted of seven boys and seven girls.

I chose this class to conduct my research in because it was a co-teach class. Formative assessment has been found to increase the learning of all students, especially the lower achievers (Black & Wiliam, 1998, 2003, 2005; Bell & Cowie, 2001; Sadler, 1989; Stiggins, 2005; Torrance & Pryor, 1998). This particular class is a combination of academic talents. I wanted to see if using different assessment techniques would increase my students’ understanding of biochemistry by involving them in their learning and ultimately would improve their scores on the unit test.
Methods for Conducting Action Research

The problems I faced with this unit I felt I could address by using formative assessment techniques. The issues I wanted to tackle with my students were to increase the success of my lower achievers on the unit exam and increase understanding of the material for all students by having them become more active in their learning. Most of the formative methods that I decided to use with my co-teach class were qualitative in nature. They involved tools by which the students became responsible for organizing what they learned in class, cooperative learning groups and daily reflection through writing. I did use one quantitative formative assessment strategy. Since the research class was so diverse, I chose methods I felt would be good reinforcement techniques for any student along with creating tools that would be appropriate for the academically weaker or untraditional learner.

Data Collection Sources

Graphic Organizers – Students filled in two different organizers. The macromolecule organizer (see Appendix, Organizer 1) was concerned with information they received from lecture on nucleic acids, proteins, carbohydrates and lipids. This particular visual was designed to help the students arrange the terms, function and structure for each macromolecule group. The protein organizer (see Appendix, Organizer 2) was intended to sort the protein family and help, especially, with enzyme information from lecture. The intent of these collection sources was to provide help for the lower achievers, to improve everyone’s understanding and make...
the students become active participants. Another purpose for these visuals was to help the students when studying for the unit test.

Checklist (see Appendix, Checklist) - On the first day of this unit, students were given a list of things they had to know for the biochemistry section exam. At the end of each day, they were responsible for checking off on the list anything they had learned that day. This was used to encourage the class to become responsible for what they had learned and to also show them what needed to be studied for the unit test.

Journals – Students were given their own journals that were to be kept in the classroom. At the end of each class, they were given time to write answers to one or more higher order questions that revolved around that day’s class objectives. I reviewed the entries on a daily basis and wrote comments back to my students. The intent of this exercise was to see if the students understood the material after each lesson, particularly the weaker students. This method puts the student at the center of their learning and encourages them to explain the new material with the intent that they will do better on the unit exam.

Cooperative Learning Groups – In this exercise I paired up students by picking their names (on sticks) from a cup and had them work as a team to create an experiment that would prove plants not only perform photosynthesis but also carry on cellular respiration. I had them write the formulas for cellular respiration and photosynthesis in their journals. I gave the students a list of materials they would need for this project and I gave them time in class to brainstorm. Each group reported back to the rest of the class how they would conduct this experiment. After hearing all
the ideas we then decided how to proceed and carried out the experiment, as a class. This exercise was intended to increase understanding by reinforcing the processes of photosynthesis and cellular respiration and made the students active participants. This was intended to improve their scores on their unit test as well.

Quizzes (see Appendix, Quiz 1 and Quiz 2) – At two different points during the biochemistry unit, students were given a five-question quiz. Students were allowed to use their notes and textbooks when taking these quizzes but they could not ask anyone else for help. The purpose of this exercise was to get the students accustomed to the type of questions they would find on their unit test and to take the information they learned in class and see if they could apply it to a test. I allowed them to use reference material because I wanted them to work out the solutions to the questions without the pressure of having to memorize the material. If they could come to the correct answers, then I knew they understood the material even if it may not yet be memorized. This particular technique was also used to indicate to the students the areas in which they may be weak.

Unit Test – This was the only true quantitative method used in this research. I used this as an instrument to tell me if the students understood the material and to help me decide if the changes I had made in this unit were beneficial, especially to the lower achievers.
Summary

By actively engaging my students in their education through graphic organizers, checklists, journal entries, cooperative learning groups and open-book quizzes I attempted to increase their comprehension of biochemistry and to raise the unit exam scores for my students with learning difficulties.
Chapter 4: Results

Data Analysis and Interpretation

Graphic Organizers – Most of the students were able to fill in the organizers with little help from the resource teacher or myself. Some students did want assistance from us because they were afraid of putting the incorrect information on them. Two IEP students wanted help because they did not want to be bothered looking up the information. At the end of the unit the students had to write in their journals, without discussions with other classmates, what they thought of the different data collection sources. All 14 students wrote favorably about the macromolecule organizer (Photograph 1). One student wrote, “The macromolecule graphic organizer helped me on my test.” My IEP students gave favorable comments such as, “Should use it because it made it easier to remember and you could always look back to it.”

Photograph 1

In regards to the protein organizer, a second IEP student wrote it was a good idea and should be used again because it helped with organizing information. My cooperative teacher had this to say:
The organizers give the students more of a visual, which helps them remember information. It also categorizes information in their minds. Organizers are definitely a benefit to learning. It is the best way for students with disabilities to make connections.

Checklist (Photograph 2) – There were mixed reviews concerning the checklist. Six students liked them and wrote things such as, “You knew what to study.” Two other students expressed similar answers in that the list allowed them to see, as they went through it, what they knew and what they did not yet know. One student suggested using it as a study guide for the unit test and as you went through the list, check off the topics as you reviewed them. Eight members of the class found them useless. One student felt she already knew it all and did not need to use it and another said, “The checklist didn’t really help me because I like to re-read all of my notes whether I know it or not.”

Photograph 2

Photograph 3

Journals (Photograph 3) – On a daily basis the students were expected to work independently on this strategy using only their notes and textbook for assistance. About half of the class did this assignment without asking for assistance for the duration of the research. The other half of the class asked for some guidance to get them started either from my co-teacher, a fellow student or myself. My cooperative
teacher felt many in the class had the fear of being wrong and wanted to be “spoon-fed”. I agreed with her so on Day 6 of this unit, when it came time for them to write, we separated the class out allowing them to take their notes and textbooks with them but they were not allowed to ask us or another classmate for help. We were looking for more independence and were trying to build confidence in their thinking processes. I found their journal writing did not suffer because of this. In fact, I knew then their work was truly their own.

Overall, I found the journal writing very interesting and the students answered the objective questions well. I found two of my IEP students always hurried through it, became bored with it and one of them never wrote in complete sentences. Another student comes from a home where English is not spoken so he does have some difficulty with vocabulary and understanding science material. In the beginning of this unit he would wait for someone to assist him on this assignment. Near the end of the unit we required him to use his notes and to work on his own. He did well and I believe this was a step in the right direction for developing his confidence and independence to think things through.

I found most of the students responded to the comments I made to them in their journals. I noticed all the students reading the daily comments I wrote to them. All but two students would reply to the comments I wrote that required a response. These were the same IEP classmates that always hurried through this assignment. I found it very helpful that the other teacher in the room did journal entries also. We
wrote comments back and forth to each other as to how we felt things were going, how things could be improved and made adjustments as we went along.

Cooperative Learning Groups (Photograph 4) – This teaching strategy received a favorable response from the class. Ten of my students enjoyed this and one student wrote, “Helped me understand how they (photosynthesis and cellular respiration) worked.” My student with the English vocabulary difficulties really liked this part of the unit. Only one student simply did not like this activity while a couple thought it was difficult and one of these individuals commented:

The plant experiment was hard for me because I didn’t really know what to do and I had trouble thinking about how to start the experiment.

On the same day we did this activity my special education teacher wrote in her journal (Photograph 5), in reference to the above student:

[He] would not answer your journal question in the fear of being wrong. I told him about four times to make a hypothesis. When I left him, I see he called you over to help him. Whatever happened to taking risks? I’m afraid that several of these kids will never reach their full potential until they allow themselves to take risks. What do you think? Maybe they know the answers but are afraid to be wrong.

Overall, I think this was very successful and I enjoyed watching the students work in teams to try and figure this out. None of them ever gave up. Two or three
were afraid to start and take a stab at it, but no one shut down or quit. Putting all their ideas together to create the experiment was fun and the class was very excited to see the results.

Quizzes (Photograph 6) – Most of the members of the class found the open-book quizzes helpful. One reason the students gave for liking this tool was they were able to find the answers to the questions they could not remember by using their notes or textbooks. Some also found it helpful because it prepared them for the final unit test by letting them know what to study. A journal response summed up how the majority of students felt in reference to the quizzes:

The quizzes were a good way to make us really think about the stuff we learned and gave us a little taste of the stuff we really needed to know.

Photograph 6

Three of my students stated the quizzes made them nervous and one simply said, “I didn’t like it because I don’t like taking any kind of quiz or test.” Some mentioned they liked the fact I did not grade these assessments.

I noticed how well the students were engaged while they worked on the quizzes. Each class member for one or all of the questions referred to their notes or textbooks. Each time, after taking the quizzes, we went over the answers. I found they had a more difficult time with the questions on the first quiz versus the second quiz.
By going over the quizzes I was able to explain and correct any misconceptions students had rather than discover these after the unit exam.

Unit Test – Last semester I had two classes taking the Living Environment and the averages on this assessment for both were very low. The scores were so low I offered open-book test corrections. After test corrections, the average score in one class increased to 76% and the other rose to 70.5%. For both groups combined, after corrections, the scores ranged from 53% to 100% and out of 33 students 8 failed (below 65%), 19 scored below 75% and only 7 were at a mastery level (> 85%).

When I allow test corrections, I expect my students to fix their mistakes with the aid of their notes and books yet without my help. This form of assessment can be a good teaching tool but I was concerned of its necessity. I was curious as to what I could do differently to improve understanding in the future. Their troubles and anxiety over this unit led me to my action research.

The results from my research class this semester were astounding. The overall average for the class was 86.3% with a median grade of 89.5% and a mode grade of 97%. The scores ranged from 63% to 97% and the standard deviation was 10.6. The standard deviation was not very good but what impressed me was only two of my 14 students received scores below 75% and eight were at mastery level. There was no need for test corrections!

My student with the English vocabulary difficulties scored the 63% but I was very excited about this because on his two previous tests he had scored a 48% and 58%. This was not a failure for him but a success because I feel this is the most
difficult unit assessment I administer in my course. As for my resource students, one
with an IEP who had scored an 88% and 67% on two previous tests scored an 81% on
this exam. A second IEP student scored a 92% and an 87% on his previous tests and
scored a 94% on this test. The third IEP student scored an 88% and an 85% on his
previous tests and scored a 94% on this test. My student with a 504 plan scored an
88% and a 74% on her previous tests and scored an 88% on this test. If I could
somehow weigh in the level of difficulty of this test, I believe it would show the
impressiveness of these results.

The comments the students made in response to the question, “How could I
make the test better?” were very interesting. One student mentioned it was “too easy”
whereas two others thought it was “perfectly worded and executed” or “good
enough.” One classmate did not like that it was all multiple choice and another
suggested adding more “in-depth questions.” Another student wrote and told me I
could not make it better, unless I made it easier. The most amusing answer came from
one of my IEP students. How could I make the test better? “Give the answers before
the test.” ©
Conclusion – What Was Learned

I felt the organizers accomplished their goal of helping the lower achievers and students with different learning styles sort out the information being taught to them, thus improving their understanding. It actually proved to be effective for all my students while getting them to take part in their learning. In the end it did serve as an aid in studying for their unit test as well.

The intent of the checklist was to make the students responsible for knowing what they learned daily and what to study. The majority of the students did not use it as a daily tool and felt it was useless. I have to agree with them. If this is to be used as a tool to encourage students to become more active in their learning, its real potential lies in its usefulness as a study guide for the unit test.

I believe the journal entries, in response to daily objective questions, were a good reflective device on the day’s lecture and made me aware of who understood the material. The writing allowed the students to look back over what they had been taught that day. Many of my students never look over the notes I give them or they only look at them the night before a test. Requiring each member of the class to reflect upon what they were taught each day made them review the material one more time and participate in their learning. I believe this helped them learn and what they wrote indicated to me if they understood. Another benefit to this technique was it allowed for more individual attention, from myself, through written feedback. There
was one negative aspect to this tool. Even though this was a nice closure and reflective activity, it did require a lot of time from me after school in regards to reading the entries and commenting on them.

I loved the cooperative group activity and I wished there had been more time so each group could have set up the experiment according to their own procedure to see what kind of results they would have gotten. Working in teams to troubleshoot problems is what goes on in the world outside of school and I now realize my students need to do it more often. The more they do it, the more comfortable they will become with it. This activity was student centered, enjoyed by my lower achievers and I believe reinforced and increased the understanding of photosynthesis and cellular respiration for all my students, thereby helping everyone on their unit test.

The quizzes were successful because they required the students to work independently. As we went through the unit, the students became more comfortable working alone and using just their notes and textbooks to find the answers to the questions. I believe this is the reason the class was more successful on the second quiz. Going over the quizzes helped them with understanding and they liked having a quiz that was not graded. The emphasis was taken off the grade and put on the learning. These assessments were also good practice for the type of question they would see on their unit test.

The results from the unit test showed formative assessment strategies did increase the success of my lower achieving students and increased the understanding of all my students. More important to me than any test score, though, is knowing my
14 students have a good grasp of macromolecules, photosynthesis and cellular respiration. This class will get more out of their remaining units on the human body and ecology because they understand basic biochemistry and these energy processes. This information is the basis for why and how the body systems and the ecosystems work the way they do.

**Future Plan**

The next time I teach this unit will be during the fall semester and I plan to implement the formative assessment strategies the students responded positively to in this research. I will be responsible for delivery of the plan and the purchasing of any supplies (journals, green water plant) required of it. If I use this plan for professional development credit, I will need to present written results of my findings to my building principal. If I use an action plan similar to my research plan and not for professional development, I will not have to present my findings to my principal. I would be willing to present my results to other teachers within my school who may be interested.

**Recommendations**

Based on my research I have decided to use in my plan the graphic organizers, quizzes, cooperative group experiment and will continue the journal writing to objective questions. I intend to make changes to the journal activity in order to decrease the amount of time required of myself. I would like to have the students
write their reflections and then pair up with a classmate. In teams of two, the students will do peer assessments of the journal entries. This will involve the students more in their learning and should help them understand the material better as they will judge and correct each other’s work. Even though eight of my 14 students thought the checklist was useless, I think it would be a good idea to keep it available for students who may wish to use it for studying purposes. The unit test will stay relatively the same although I did like the suggestions of having more in-depth and fewer multiple-choice questions. I plan on changing this exam, though I will not be giving the answers out before the test. 😊

**Summary**

If the reason for teaching is to help a student learn, then finding ways of doing just that are a priority. In the literature it has been found formative assessment can achieve this while at the same time increase student participation in their learning. Low achievers also tend to have more successes in the educational process when instruction is student centered as a result of formative strategies (Black & Wiliam, 1998, 2003, 2005; Bell & Cowie, 2001; Sadler, 1989; Stiggins, 2005; Torrance & Pryor, 1998). I found these to be true also. As a result of formative assessment strategies, I felt my lower achieving students were more successful on their unit test and because my class became more active participants in their learning, the level of understanding in this unit improved.
Formative assessment is not something new. Effective teachers use it all the time. They just may not be aware of it. The reasons for education are changing and as a result of that the way schools instruct their students has to change. This will not be easy or well accepted if the changes do not fit with the structure of the school (Priestley & Sime, 2005). Time, schedules, budgets and teacher’s willingness to participate are a few barriers that have to be overcome. If these obstacles are addressed and conquered, formative assessment could be what is needed to achieve the science education standards in this country.
References


*Educational Assessment, 10*(1), 19-37.
Appendices
Pigments
Cell Structures
Hormones
Antigens & Antibodies

FUNCTION OF

BASIC UNIT

WHERE MADE IN CELL

FORMULA

Organizer 2
1) Two molecules of the type illustrated below are combined by dehydration synthesis.

Combining these two molecules produces
A) a lipid  B) starch  C) a protein  D) maltose

2) Which molecules belong in area A?
A) amino acids  C) disaccharides
B) fats  D) nitrogenous bases

3) Groups A and B in the table below contain molecular formulas of compounds.

<table>
<thead>
<tr>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>C_6H_{12}O_6</td>
<td>NaCl</td>
</tr>
<tr>
<td>C_{12}H_{22}O_{11}</td>
<td>NH_3</td>
</tr>
</tbody>
</table>

How would the compounds in these groups be chemically classified?
A) group A - inorganic  C) group A - monosaccharides
group B - organic  group B - disaccharides
B) group A - disaccharides  D) group A - organic
group B - monosaccharides  group B - inorganic

4) In which type of molecule is the ratio of hydrogen to oxygen usually 2 to 1?
A) protein  B) lipid  C) glycerol  D) carbohydrate

5) Which substance is classified as an inorganic compound?
A) fat  B) glucose  C) protein  D) water

Quiz 1
1) Which types of molecules are used for the synthesis of a lipid?
   A) fatty acid and glycerol  
   B) monosaccharide and glycerol  
   C) amino acid and fatty acid  
   D) amino acid and monosaccharide

2) Which type of molecule is used for the synthesis of an enzyme?
   A) glycerol  
   B) monosaccharide  
   C) fatty acid  
   D) amino acid

3) Which food contains the highest percentage of the type of molecule represented by F?
   A) lettuce  
   B) bread  
   C) table sugar  
   D) butter

4) Which substance normally controls the rate of this reaction?
   A) an enzyme  
   B) a neurotransmitter  
   C) auxin  
   D) hormone

5) The general equation \( A + B \rightarrow AB + H_2O \) best represents the process of
   A) digestion  
   B) photosynthesis  
   C) anaerobic respiration  
   D) dehydration synthesis

Quiz 2
Biochemistry Unit
What I Have Learned and Need to Know for My Test

1. Macromolecules
   Nucleic Acids
   ____ Examples of
   ____ Subunits
   ____ Parts of nucleotide
   ____ Function

   Proteins
   ____ Where made in cell
   ____ Examples of
   ____ Subunits
   ____ Structure
   ____ Functions
     Enzymes
     ____ Where made
     ____ Subunits
     ____ Function
     ____ Spelling of
     ____ Reaction formula
     ____ 3 things that affect enzyme activity

   Carbohydrates
   ____ Elements in molecule
   ____ Ratio of H to O
   ____ Spelling of carbs.
   ____ Monosaccharide and examples
   ____ Disaccharide and examples
   ____ Polysaccharide and examples
   ____ Function
   ____ Structure

   Lipids
   ____ Composed of (made up of)
   ____ Examples
   ____ Function
   ____ Structure
   ____ Saturated fat
   ____ Unsaturated fat

Checklist (p. 1 of 2)
II. Biochemistry General Information
   ___ Main elements (atoms) in molecules
   ___ Inorganic molecules
   ___ Examples of inorganic molecules
   ___ Organic Molecules
   ___ Examples of organic molecules
   ___ pH notes
   ___ Dehydration synthesis
   ___ Hydrolysis
   ___ Stomata and guard cells
   ___ Transpiration
   ___ Autotroph
   ___ Heterotroph

III. Photosynthesis
   ___ Where it takes place in a cell
   ___ What type of organisms perform photosynthesis
   ___ Purpose
   ___ Formula

IV. Cellular Respiration
   ___ Where it takes place in a cell
   ___ What types of organisms perform cellular respiration
   ___ Purpose
   ___ Formula
   ___ 3 steps of
   ____ Aerobic
   ____ Anaerobic
   ____ Fermentation
   ____ ATP/ADP

Check List (p. 2 of 2)
To: Sheri Backus
From: Colleen Donaldson, Institutional Review Board Administrator
Date: April 4, 2006
Re: Project #: 2005-196

Project Title: Formative assessment to enhance understanding in a science class

Your proposal, “Formative assessment to enhance understanding in a science class” has been approved for one year from this date.

You must use only the approved consent form or informational letter and any applicable surveys or interview questions that have been approved by the IRB in conducting your project. If you desire to make any changes in these documents or the procedures that were approved by the IRB you must obtain approval from the IRB prior to implementing any changes.

If you wish to continue this project beyond one year, federal guidelines require IRB approval before the project can be approved for a second year. A reminder continuation letter will be sent to you in eleven months with the specific information that you will need to submit for continued approval of your project. Please note also that if the project initially required a full meeting of the IRB (Category III proposal) for the first review, then continuation of the project after one year will again require full IRB review.

Please contact Colleen Donaldson, IRB Administrator, Office of Academic Affairs, at immediately if:

- the project changes substantially,
- a subject is injured,
- the level of risk increases
- changes are needed in your consent document, survey or interview questions or other related materials.

Best wishes in conducting your research.

Institutional Review Board Approval Notification Letter
Dear Parent/Guardian,

This semester I am working on a project that will lead to the completion of my graduate work with the SUNY Brockport Department of Education and Human Development. As a part of that, I want to work on the delivery of my biochemistry unit. This topic is difficult for tenth grade students to learn and enjoy. I would like to develop ways to make this unit more interesting and more understandable for your child through formative assessment.

Formative assessment involves using different teaching strategies to make your child an active participant in their learning. The students will be organizing their material on a mind map, answering higher order questions and doing journal writing to reflect upon what they learned each day. The learning process will be the same for everyone in the class.

In order to do this project, I need your signature below. Your child does not have to be a part of this project and can withdraw at any time. Their grade will not be affected if you choose to not have them participate.

If you would like more information, please contact me at school. Thank you.

Sincerely,

Sheri P. Backus
Teacher, The Living Environment ©

I, ____________________________, have read and understand the above letter. I agree to allow my child to participate in Mrs. Backus’ formative assessment research. I also realize that my child may withdraw from participation at any point without penalty.

Student’s Name ____________________________

Principal Investigator: Sheri P. Backus  My Faculty Supervisor: Dr. Scott Robinson

Parent/Guardian Permission Form
Dear Student,

This semester I am working on a project that will lead to the completion of my graduate work with the SUNY Brockport Department of Education and Human Development. As a part of that, I want to work on the delivery of my biochemistry unit. This topic is difficult for tenth grade students to learn and enjoy. I would like to develop ways to make this unit more interesting and more understandable for you through formative assessment.

Formative assessment involves using different teaching strategies to make you an active participant in their learning. You will be organizing your material on a mind map, answering higher order questions and doing journal writing to reflect upon what you have learned each day. The learning process will be the same for everyone in the class.

In order to do this project, I need your signature below. You do not have to be a part of this project and can withdraw at any time. Your grade will not be affected if you choose to not participate.

If you would like more information, please come see me. Thank you.

Sincerely,

Mrs. Backus

Mrs. Backus,
The Living Environment 😊

I, ____________________________, have read and understand the above letter. I agree to participate in Mrs. Backus' formative assessment research. I also realize that I may withdraw from participation at any point without penalty.

Principal Investigator: Sheri P. Backus My Faculty Supervisor: Dr. Scott Robinson

Student Permission Form