"Incorporating Active Learning into Life Sciences Teaching: applying math and biology standards to the middle school curriculum"

A STEM THEC Race to the Top proposal.
by Tim McDowell, Aimee Govett and Tom Laughlin.

Abstract:

"Incorporating Active Learning into Life Sciences Teaching: applying math and biology standards to the middle school curriculum" (IALLST) is a partnership between East Tennessee State University and six regional school districts: Greene, Hawkins, Unicoi, and Washington Counties, and Bristol and Kingsport Cities. The IALLST project focuses on the STEM field of Life Sciences (Biology) and incorporates major elements of the Math Core Curriculum. It targets the middle school level (6-8th grades), where the need for improvement of pedagogy and content delivery is well documented. The IALLST project will be directed by ETSU PIs T. McDowell (Biological Sciences, content expert) and A. Govett (Curriculum & Instruction, pedagogy expert), with Co-PI T. Laughlin (Biological Sciences). The project will enlist 25 middle school teacher participants, in teams of at least one science and one math teacher from 12 schools. Teacher teams will interact for over 90 contact hours with the ETSU faculty over the 1 ½ year project to acquire, practice and share essential content and effective methods for biology and math instruction. Project activities include a one-day Summer 2012 STEM Institute, expert scientist visits to schools during the 2012-2013 academic year, a two-week Professional Development (PD) Workshop in Summer 2013, and Feedback Meetings in Fall 2013.

The IALLST project is designed to create Professional Learning Communities (PLCs) of teachers, educators and administrators to facilitate sustainable improvement in STEM education in participating school districts across the region and state. Teacher improvement will be documented by pre- and post-tests for content and for teacher attitudes and efficacy, and with videotapes of teachers before, during and after the PD Workshop. Sustainability of teacher improvement and reproducibility of the project's learning modules will be accomplished through multiple channels: a project web site will facilitate communication with PLCs; learning modules will be disseminated via web site, professional meetings and publications; and direct outreach will expand through project partners, including the ETSU Center for Science and Mathematics Education, the new ETSU STEM TNSIN Hub, and the Eastman Chemical Company, our STEM business partner.
**Demonstration of Need**

Most middle school science teachers have limited experience with math and biology in general, let alone the integration of the two disciplines via scientific investigations. Lack of content knowledge and investigation experience has been linked to teachers’ lack of self-confidence in teaching science and, in turn, lack of science integration of math and science in their middle school science classroom (Appleton, 2007). The 2000 National Survey of Science and Mathematics Education (Weiss, et al., 2001) revealed that fewer than one third (31%) of grades 5-8 science and math teachers’ undergraduate majors were in science, math or science/math education. The survey also showed that middle school teachers’ perception of their own preparedness reflected their limited math and science background: fewer than half reported that they felt very well qualified to teach areas such as experimental design or plant biology, and 49% of middle school science teachers did not feel well prepared to "use calculators/computers to collect and/or analyze data."

The ETSU Center of Excellence in Mathematics and Science Education routinely makes use of a Project Management Team (PMT) to track the specific needs of our service area. The PMT membership consists of K-12 math and science teachers, K-12 principals and system-wide administrators, and higher education faculty in education and arts and sciences. Among needs reported most often by teachers and district administrators from targeted districts are the following: enhanced science content; integrating math and science, especially the biological sciences; embedded inquiry; an enhanced repertory of instructional strategies to meet student needs; and professional development aligned to the Tennessee science standards and to the Tennessee Common Core Mathematics standards. Representatives of the PMT have met with school administrators in each of the targeted districts to review and analyze students’ performance level summary reports as measured by TCAP. Based on documentation, a large percentage of students in grades 6-8 failed to score at the proficient level and above.

In our targeted districts: Bristol City Schools, Kingsport City Schools, Greene County Schools, Hawkins County Schools, Unicoi County Schools and Washington County Schools – several schools demonstrated a need to improve test scores in mathematics and science. It is their goal for all students to achieve gains and for the poorer performing students to achieve the most gain. A major concern of teachers is preparing students to perform well on the TCAP test. For example, most teachers contacted by the PMT expressed a need to learn more effective instructional strategies for preparing students for this assessment.

Fewer than 30% of elementary and middle school teachers used hands-on activities in their most recent lesson (Division of Research, Evaluation, and Communication, NSF, 1996). If teachers use inquiry and problem focused laboratory activities, they are often of a verification nature rather than inquiry. Northeast Tennessee teacher survey results indicate that although 75% of teachers strongly agree that they like teaching, only 35% of teachers are well prepared to engage students in inquiry oriented activities. Moreover, the TIMSS Report (Third International Mathematics and Science Study) reveals that the nation is behind in science education. The TIMSS data reinforces the idea that standards do matter and influences what students have a chance or opportunity to learn.

Through teachers and administrators in participating districts, the proposed project will ensure that students are introduced to rich and challenging math and science content in their
classes. Like their wealthier peers, poor children will learn more challenging ideas when they are exposed to them (Porter, et al., 2003). Interdisciplinary math and science curricular materials contribute to this effect.


**PROJECT DESCRIPTION**

**Section I: Overview, Goals and Objectives**

**Overview:** The project proposed here, "Incorporating Active Learning into Life Sciences Teaching: applying math and biology standards to the middle school curriculum" (IALLST) is a partnership between East Tennessee State University and six regional school districts: Greene, Hawkins, Unicoi, and Washington Counties, and Bristol and Kingsport Cities. The IALLST project focuses on the STEM field of Life Sciences (Biology) and incorporates major elements of the Math Core Curriculum. It targets middle school science and math programs (6-8th grades), where the need for improvement of pedagogy and content delivery is indicated by low standardized test scores and confirmed by direct communications from teachers and administrators. The IALLST project will be directed by ETSU PIs T. McDowell (Biological Sciences), the content expert, and A. Govett (Curriculum and Instruction), the pedagogy expert, with Co-PI T. Laughlin (Biological Sciences). The project will enlist 25 middle school teacher participants, including teams of at least one science and one math teacher from 12 schools. These teacher teams will interact closely with the faculty leaders during the course of the 1 ½ year project to acquire, practice and share essential content and effective methods for biology and math instruction. The project will provide a total of 90 hours in professional development training. Project activities include a one-day Summer 2012 STEM Institute, expert scientist visits to schools during the 2012-2013 academic year, a two-week Professional Development (PD) Workshop in Summer 2013, and Feedback Meetings in Fall 2013.

The IALLST project is designed to create communities of teachers, educators and administrators to facilitate sustainable improvement in STEM teaching and learning in participating school districts across the region and state. Sustainability of teacher improvement and reproducibility of the project's Learning Modules will be accomplished through multiple channels: a web site for the project will facilitate ongoing communication among the teachers and project leaders; Learning Modules will be disseminated via web site, professional meetings and publications; and direct outreach will expand through the ETSU Center for Science and Mathematics Education, through the newly created ETSU Tennessee STEM Innovation Network Hub, and through Eastman Chemical Company, our STEM business partner.

**The goals of this project are:**

1. Improve teachers' content knowledge and pedagogical techniques in the areas of Life Sciences and Mathematics.
2. Train teachers in the use of classroom friendly, curriculum-focused Learning Modules which engage students in Embedded Inquiry to address biological questions.
3. Build Professional Learning Communities of teachers, administrators and university experts to develop, implement, assess and disseminate methods to improve science and math learning.
4. Provide project participants and participating schools appropriate science tools to implement project goals on a sustainable basis.

**The objectives of this project are as follows:**

1. Achieve a normalized gain of at least 30% from pre-workshop to post-workshop test scores for life science and math content among participating teachers. (See Appendices: content tests).
2. Document broad improvement in scores for teachers' attitudes toward the nature of science and teaching science, and in teachers' efficacy, as measured by pre- and post-workshop teacher attitude surveys. (See Appendices: Teacher attitude surveys)
3. Obtain a 10% value-added increment in school average normal curve equivalent (NCE) scores for science in grades 6, 7, and 8.

4. Accomplish a demonstrable enhancement in participating schools' classroom equipment and supplies, and in teachers’ and students’ regular use of these materials.

5. Disseminate practical and effective biology and math Learning Modules through the program web site, professional meetings, and other channels.

Section II: Required Program Components

Content Focus: The primary focus of this project is the STEM field of Life Sciences (Biology). The activities and Learning Modules to be demonstrated and practiced throughout this IALLST project use direct observation of living plant specimens to address key biological topics in the middle school life sciences curriculum. A secondary focus of this project is mathematics. The ability to conceptualize and work with very large and very small numbers, and to calculate sizes, volumes and ratios at all scales, is central to all STEM fields. Thus, elements of the Math Common Core curriculum are addressed through the application of mathematical methods to the biological data sets which students construct from their own measurements of cells, organelles, pollen and seeds. The content focus of this project is detailed in Table 1, which aligns our PD Workshop activities with state curriculum standards in both Life Sciences and Mathematics.

Active Learning: Active learning is the central element and predominant modality of the IALLST project. Educators have long recommended that children should be active learners, constructing science understanding through hands-on/minds-on inquiry experiences. Students should engage in science investigations wherein they ask questions, collect and make sense of data, and come to conclusions that are supported by evidence (NRC, 2007). Students should investigate “authentic questions generated from student experiences” (NRDC, 2001).

There are distinct advantages in combining biological and mathematical investigation to teach fundamental curriculum content. Using the microscope to view fresh material is exciting to students, yet requires minimal equipment beyond the microscope. Mathematics is immediately relevant: how large is a leaf cell, a pollen grain? Proportions are used to determine the field of view under low, medium and high magnification, and areas or volumes of the cuboid leaf cells are calculated using millimeters and microns. Because the Elodea leaf is just two cell layers thick it can be viewed microscopically in whole mount - a small leaf in water under a cover slip. Because the regular sized rectangular cells are larger on the lower layer, each layer provides population sample data, directly observed and measured by students, and readily collected for use in statistical analyses (Sundberg, 1984). The IALLST project strives to present active learning approaches using simple yet real, live biological materials. This approach enables teachers and students to conduct these activities in their own classrooms. The IALLST workshops will provide teachers both the training and the materials to do this.

Table 1. Summer 2013 PD Workshop Schedule Aligned with State Standards

<table>
<thead>
<tr>
<th>Day and Topic</th>
<th>Curriculum Standards</th>
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<tbody>
<tr>
<td><strong>Week 1</strong></td>
<td></td>
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<tr>
<td><strong>Monday</strong></td>
<td><strong>Life Science – Cells</strong></td>
</tr>
<tr>
<td>Using microscopes: Measure cell sizes and volumes at microscopic scales</td>
<td>GLE 0707.1.1 Make observations and describe cells.</td>
</tr>
<tr>
<td></td>
<td><strong>Math Core Ratios...</strong></td>
</tr>
<tr>
<td></td>
<td>6.RP.3 &amp; 3d. Use ratio and rate... manipulate and transform</td>
</tr>
<tr>
<td>Day</td>
<td>Activity</td>
</tr>
<tr>
<td>-----------</td>
<td>--------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Tuesday</td>
<td>Scientific experiment with cell sizes and chloroplast densities</td>
</tr>
<tr>
<td></td>
<td>Organizing and analyzing data</td>
</tr>
<tr>
<td></td>
<td>Data analysis: testing for significant differences</td>
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<td></td>
</tr>
<tr>
<td>Wednesday</td>
<td>Photosynthesis and respiration: leaf cells and tissues</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Thursday</td>
<td>Classification of organisms: Review</td>
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</tbody>
</table>

**Week 2**

| Monday    | Asexual and sexual reproduction in plants                                | GLE 0707.4.1 ...fundamental features of ...reproduction.                       |                                      |                                     |
|           |                                                                          | GLE 0707.4.2 ...sexual reproduction in flowering plants.                      |                                      |                                     |
| Tuesday   | Pollen experiment: sizes vs species collect and analyze data            | GLE 0807.5.3 ...adaptations within a population...                            |                                      |                                     |
|           |                                                                          | GLE 0807.5.4 ...variation within a population...                              |                                      |                                     |
|           |                                                                          | **Math Core - Statistics and Probability**                                     |                                      |                                     |
|           |                                                                          | 6.SP.1&2, 7.SP.1 statistical question...population ...sample...                 |                                      |                                     |
| Wednesday | Seeds experiment data analysis                                           | 6.SP.1&2, 7.SP.1 statistical question...population ...sample...                 |                                      |                                     |
| Thursday  | Teacher presentations of Learning Modules - Discussion, review, and post-workshop survey | **Math Core - Statistics and Probability**                                    |                                      |                                     |

**Coherence:** In this IALLST project Biology and Math content are united with empirical, hands-on pedagogical methods through demonstration, practice and repetition of various lab-classroom investigations relating to plants. A common theme to all these activities is the need for teachers and students to become comfortable working at a range of scales, from microscopic to astronomical, and with very large and very small numbers. Using their own measurements, students more readily learn the use of scientific notation, and come to relate to the extremely large and small numbers which provide a conceptual keystone to all of the STEM fields. Through active engagement of teachers (and through them, students) in observation-based investigations, key concepts of scale and core skills of quantitative reasoning can be acquired and shared.

The IALLST professional development activities coincide closely with the needs expressed by participating school systems. Letters from each participating LEA are provided in Appendices. Integral to this project are opportunities for discussion among all participants, and feedback to the project leaders. Through the development of Professional Learning Communities including teacher teams, school administrators, and experts in pedagogy and STEM content, the project can adjust its activities and its teacher support to more precisely meet the needs of each Professional Learning Community (PLC).

**Continuous Learning:** The IALLST project will provide a total of at least 90 contact hours to all teacher participants through a series of activities conducted at ETSU, at the teachers' schools, and through on-going on-line interactions and support over the course of one and one-half years (Table 2). Moreover, the PLCs created through this project will extend teachers access to training and support beyond the limits of the project. These PLCs will facilitate a continuing conversation among all partners - teachers, faculty, STEM learning centers and business partners.
Table 2: Contact Hours for teacher participant PLCs and faculty leaders in IALLST

<table>
<thead>
<tr>
<th>Prof. Dev.</th>
<th>Activities</th>
<th>Contact Hrs</th>
<th>Contact Type</th>
<th>Contact Hours</th>
</tr>
</thead>
</table>
| Summer 2012 STEM institute 1 day- 5 hours | - McDowell, Govett and Laughlin meet with science and math teachers at Culp Center on ETSU campus  
- Demonstrations and discussions of workshop Learning Modules  
- Discussions and surveys on teacher and classroom needs | July 18, 2012 | Face-to-face | 5 |
| Expert Scientist school visits 6 hours each 2 visits/PLC | - McDowell and Laughlin meet with PLCs and their students in individual schools  
- Engage PLCs and students in Active Learning Modules | Fall 2012 Spring 2013 | Face-to-face | 12 |
| Summer 2012 PD Workshop 8 days 7.5 hours /day | - McDowell and Laughlin meet with participants at Brown Hall on ETSU campus  
- Teachers learn and practice inquiry-based activities w/ biology and math curriculum content and innovative, hands-on methodologies | July 15-26, 2013 | Face-to-face | 60 |
| Feedback meetings 5 hours each | - McDowell and Laughlin meet participants with at Brown Hall on ETSU campus (teachers attend one of two meetings)  
- Feedback from teachers on Active Learning Modules | Fall 2013 | Face-to-face | 5 |
| Web site | - Virtual interactive Professional Learning Communities (PLCs) | 2012 on | Virtual | 8 |

Professional Learning Communities: Professional Learning Communities have been shown to foster continuous improvement and facilitate positive change for teachers and their students. The IALLST project will create PLCs of science and math teacher teams at each participating school system, and link them with faculty experts in pedagogy and STEM content at ETSU. These PLCs will grow to include other teachers and administrators at the schools, and will link through ETSU to STEM partners across the region and state, as described in "partnership" below. The PLCs will be in conversation with the IALLST project leaders and with other science and math teachers through the project's interactive web site, which will also provide access to resources such as teaching activities, links for in-depth and grade-appropriate content, and PD opportunities.

Section III: Program Activities and Timeline

The IALLST project includes a variety of professional development activities conducted over a 1½ year period. A detailed timeline is provided in Table 3. The project, if funded, would begin in April 2012, with preparations for the Summer 2012 STEM Institute. This conference will be open to all regional middle grades science and math teachers, and will include Learning Module demonstrations, discussions and surveys (Program given in Appendices). Teacher teams will be recruited in summer 2012, and will host school visits by expert scientists during the 2012-13 academic year. The Summer 2013 PD Workshop will give teacher teams practice with a variety of inquiry-based activities with strong biology and math curriculum content and innovative, hands-on methodologies. Teacher teams will attend Feedback Meetings in Fall 2013 to report on their use of the Learning Modules in their classroom. Teacher improvement will be documented by pre- and post-tests for content and for teacher attitudes and efficacy, and with videotapes of teachers before, during and after the PD Workshop.

Table 3: Timeline for Incorporating Active Learning into Life Sciences Teaching (IALLST)

<table>
<thead>
<tr>
<th>Year</th>
<th>May</th>
<th>June</th>
</tr>
</thead>
</table>
| 2012 | - Attend Project Directors meeting  
- Begin teacher recruitment  
- Identify minority and private school teachers  
- Prepare and distribute recruitment brochure | - Hire graduate assistants  
- Complete on-line teacher survey  
- Hire web designer  
- Complete ETSU site logistics  
- Conduct on-line teacher survey | - Order Summer Institute supplies |
Section IV: Partnerships

Dr. Tim McDowell, Dr. Aimee Govett, and Dr. Tom Laughlin will be active in all parts of the proposed project. As Associate Professor of the ETSU Biological Sciences faculty and the ETSU Center of Excellence in Science and Mathematics Education, Dr. McDowell teaches various undergraduate and graduate botany and biology courses, directs the ETSU Arboretum and the J.C. Warden Herbarium, conducts THEC workshops, visits regional biology classrooms, and collaborates on many teacher training projects. He will provide biology content and demonstrate hands-on learning activities throughout the project and present project results at the 2013 National Science Teachers Association convention. Dr. Govett, Associate Professor in Curriculum and Instruction in the ETSU Clemmer College of Education and K-12 Science Education Specialist in the Center of Excellence in Mathematics and Science Education, teaches preservice science content courses and methods as well as diverse graduate courses for in-service teachers’ PD and has served as PI on various General Competition projects (TQI: Tennessee Higher Education Commission), and as Co-PI and Assessment Coordinator for many outside funded projects (NSF, US Department of Education, and Eisenhower PD Program Awards). She will be involved in summer conferences, academic year classroom visits, summer workshops, and academic year follow-up workshops and will coordinate the assessment and present project results at the 2014 International Association for Science Teacher Education conference. Dr. Laughlin, Associate Professor in Biological Sciences at ETSU, teaches and researches in vertebrate and population biology and is active in the development of biology pedagogical methods. Throughout the summer conferences, academic year classroom visits, summer workshops and academic year follow-up workshops, he will participate in both the planning and delivery of content, particularly with respect to the applied mathematics content of the project.

There is strong support from ETSU for STEM education. The ETSU Center of Excellence in Science and Math Education promotes diverse projects supporting regional STEM education. The ETSU School of Graduate Studies has agreed to waive the graduate tuition fees and provide 3 credit hours for teacher participants in the IALLST project. The Eastman Chemical Company is a STEM business partner for this IALLST project, and has long supported
regional science education. The newly created ETSU TSIN STEM Hub, under development in Kingsport, will provide additional opportunities and support for school teachers in STEM fields.
Significance and Evidence of Feasibility

Professional development that fosters the growth of Professional Learning Communities (PLCs) is a primary feature of this proposal. The significance of effective PLCs has been identified as integral to the communication of content knowledge in the middle school classroom and requires that professional development be integrated with local and state priorities while also being combined with continuous evaluation (Rhoton and Shane, 2006). Our project, which follows this research based approach to content teaching, will recruit teachers from committed LEA partners who will be engaged in conferences, workshops and a series of ongoing face-to-face and virtual activities to further improve STEM education at the Middle School level. Letters of commitment and support from the six LEAs participating in this project are attached (see Appendices).

Other best practices research on professional development indicates effective professional development experiences should: foster collegiality and collaboration, promote experimentation and risk-taking, involve participants in discussions about as many aspects of the professional development experience as possible; provide time to participate, reflect on, and practice what is learned; provide leadership and sustained support; supply appropriate rewards and incentives; have designs that reflect knowledge based on learning and change; integrate individual, school, and district goals; and integrate both organizationally and instructionally with other staff development and change efforts (Loucks-Horsley, 1997).

All of our activities are designed with Tennessee State Standards in Life Sciences and the Math Core as goals for ultimate learning outcomes of students in classrooms. One main goal of this project is to give Middle School teachers’ confidence in their content knowledge in order to improve student content knowledge in biology and mathematics. Students will be more likely to pursue a career in STEM areas if it is taught in a way that reflects real scientific. Moreover, due to more challenging revised state standards and the significant changes in state testing that are reflected in school and teacher evaluations, we propose several integrated biology/mathematics activities that are the basis of this project.

The ETSU School of Graduate Studies is providing in-kind benefits by waiving the graduate credit and fees in order to offer the Teacher Participants three graduate credit hours in the form of a Professional Development Content Course that can be used toward an advanced degree or toward continuing education units. The feasibility of summer workshops of the type proposed for this project has been previously supported and shown to increase student achievement (Rhoton and McLean, 2008). The state standards based program objectives planned for the academic-year scientist visits to the classroom, the summer institutes and the follow-up activities will enhance the ability of teachers to present content knowledge in the middle school classroom. Our integrated pre-post-test evaluations will help us evaluate the effectiveness of the project as it proceeds. This project will also use a synergistic combination of the experience and expertise of the ETSU Center of Excellence in Science and Math Education, and the development of a project web site that will be used to publish our Learning Modules so as to further enhance the development of the proposed PLCs.
Evaluation

Our assessment plan will utilize mixed methods and approaches. We will use both quantitative and qualitative data to determine how well we are meeting our project goals and what we might do to improve our performance (formative assessment). As our project nears completion our assessment will focus on whether we have met our goals (summative assessment). All good assessment focuses on project goals, so they are restated here, with measureable objectives and actual measures:

<table>
<thead>
<tr>
<th>Goal</th>
<th>Measures</th>
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| To improve teachers' content knowledge and pedagogical techniques in the areas of Life Sciences and Mathematics. | Pre/post content tests developed by faculty (See Appendices)  
Pre/post survey of Teachers’ attitudes toward the nature of science and science teaching (See Appendices) |
| To train teachers in the use of classroom friendly, curriculum-focused Learning Modules which engage students in Embedded Inquiry to address biological questions that will improve their content knowledge. | Scored observation of Teacher/Participants giving presentations of demonstration lesson plans.  
Pre- and Post-Videos of Teacher implementation of Biology lesson  
Post- interview/focus group  
Teacher/Participants’ journal entries  
Analysis of State Standardized Test Scores |
| To build Professional Learning Communities of teachers, administrators and university experts to develop, implement, assess and disseminate methods to improve science and math learning. | Master Teacher Demonstration Lessons will be shared on interactive Web Page; Interactive Professional Learning Community |
| To provide project participants and participating schools appropriate science tools to implement project goals on a sustainable basis. | Assessment Survey: Needs and Preparedness (See Appendices) |

Modeling for Comprehension of Concepts: The Conceptual Content Tests will be administered to all teacher participants to assess whether the teachers have acquired the appropriate sets of skills, mathematical and biological content knowledge and pedagogical content knowledge necessary to initiate student problem/project based learning that is effective and results in maximum conceptual understanding as a result of this participating in this project. (See Appendices) Each class meeting will conclude with a short assignment: a data set to be analyzed (with appropriate methods) and interpreted to see if working with models improves student comprehension of the conceptual material. Dr. Laughlin and Dr. McDowell will model the active learning strategies and give feedback to the teachers on their assignments throughout the summer graduate level course. At the conclusion of the Professional Development Workshop (Summer 2013), the teacher participants will be producing and presenting a Master Teacher Demonstration Lesson that can be implemented, observed, and videotaped for analysis to be compared with a prior videoed lesson (created before the workshop and scientist visits to the classroom).
**Measuring Learning Outcomes:** Dr. Aimee Govett, from the Dept. of Curriculum & Instruction at ETSU, will serve as our Assessments Coordinator. She will (1) assist us in making sure that the teacher participants understand the expectations of the program, (2) monitor the construction of appropriate assessment instruments, (3) be responsible for analyzing measures of individual learning outcomes, and (4) help us monitor project evaluation progress.

**Assessment of Participants’ Experience:** In addition to measuring learning outcomes, Dr. Govett will conduct ‘exit interviews’ with all of the participants. These will be used primarily to gauge teachers’ perceptions of their own gains in confidence in the scientific process and preparation for teaching these integrated biological and mathematics concepts to middle grade students as modeled. Questions will be designed to assess which aspects of the program were most/least effective in increasing their confidence. Online journals will be kept by all teacher participants throughout the project and these will be analyzed to determine the changing of habits of mind in attitude and feelings of efficacy toward the nature of science, understanding of the main concepts, and the teaching of these concepts at the middle grades level.

**Program Evaluation:** One of our primary objectives is for our teacher participants to transcend the traditional classroom-student mentality and develop active learning models. To this end, we will analyze individual pre and post content and attitude scores and examine state test scores for individual schools (See Appendices). We will also observe and critique the teacher-created pre- and post- videos in order to analyze problem based learning and the use of biological and integrated mathematics modeling by the teachers.

**Disclosure of Other Tennessee Education Grants:**

None of the PIs or Co-PIs for this IALLST project have other current or pending education grants from the state of Tennessee.
Bibliography


National Staff Development Council (2001). National staff development council’s standards for staff development, revised: Advancing student learning through staff development. Oxford, OH.


