College of Natural Sciences and Mathematics
Annual Student Research Symposium

May 8, 2002
2:30-3:30
First Floor Lobby
Main Hall

TITLES

LIFE SCIENCES

Water flow receptors in a marine slug
Jeffry Blackwell
Faculty Mentor: J.A. Murray

Do alanine transport activated apical membrane potassium channels regulate enterocyte volume?
Thomas Edwards
Faculty Mentor: Dr. Mike Moran

Structural and Behavioural Adaptations of the Corallivore *Coralliophila abbreviata* (Lamarck) for Effective Feeding on Scleractinian Corals
Reia Guppy
Faculty Mentor: Paul Hamilton

Do milkweed glues or poisons trigger vein severance by
monarch caterpillars?
Matthew Helmus
Faculty Mentors: David Dussourd, Patricia Draves and Katherine Larson

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Robert Keeton
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The role of intracellular acidification in apoptotic progression
Nelly Norrel
Faculty Mentor: Steven W. Runge

Role of a single neuron in turning while crawling in the marine slug *Tritonia diomedea*
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MATHEMATICAL AND PHYSICAL SCIENCES

Modeling Polymerization
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TUI Graphics Library
Jeremy Goldberg, Jason Cullum, Daniel Pollock
Faculty Mentor: Wayne Brown

Time independent Schrödinger potentials
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Faculty Mentors: Danny Arrigo and Fred Hickling

Exact Solutions to Approximate Equations
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Calcogen Selectivity by Nickel Controls Coordination
Geometries in Model Biochemical Systems
David L. Nutt
Faculty Mentor: Patrick J. Desrochers

Numerical Solution of Helmholtz Equation
Eugene Rathfon
Faculty Mentor: Guy Bernard

SCIENCE AND MATHEMATICS EDUCATION

Literature as a Manipulative in a Secondary Level Mathematics Curriculum
Matthew Dalke
Faculty Mentor: Carolyn Pinchback

Improving mathematics education in Arkansas Large-scale assessment can be an agent of change
Audri McCready
Faculty Mentors: Linda K. Griffith and Jean J. McGehee

ABSTRACTS

LIFE SCIENCES

Water flow receptors in a marine slug

Jeffry Blackwell
Faculty Mentor: J.A. Murray

The purpose of this research is to identify the brain cells that are responsible for sensing water flow in the marine slug *Tritonia*. The *Tritonia* must rely on its ability to touch and smell in order to navigate because it is blind. The primary factor that influences their crawling direction is the direction of water flow (caused by tides in nature). The sensory cells that detect flow and determine flow direction have not been identified. Lateral Cerebral Nerve 2 (latCeN2) has been identified as the nerve that carries sensory axons to the brain from the flow receptors in the oral tentacles. Backfilling this nerve to the brain has resulted in the staining of a number of cells located throughout the brain. Most of the stained cells are concentrated in the cerebral ganglion where the nerve enters the brain. Medial and lateral CeN2 have been filled for comparison of the pattern of cell from each nerve. A map of the cells innervated by latCeN2 will be made to show the location of the stained cells. Intracellular recordings of the electrical activity of these cells will be made in a live animal to determine if these cells are the flow receptors.

Do alanine transport activated apical membrane potassium channels regulate enterocyte volume?

Thomas Edwards
Faculty Mentor: Dr. Mike Moran

Increases in intracellular osmolarity in intestinal epithelial cells (enterocytes) during periods of nutrient absorption increase cell volume by osmosis. In response, enterocyte upregulate apical membrane potassium channels during nutrient absorption to regulate enterocyte osmolarity and volume. These channels allow efflux of potassium ions down the concentration gradient. The flow of K^+ ions and accompanying anions is followed by water and causes a regulatory volume decrease (RVD). This is an adaptive cellular response because cells can only swell 2-3% before their membranes fracture. To test whether apical membrane potassium channels

contribute to RVD, we have combined intracellular recording techniques to monitor the apical membrane potential (V_a) and the electrical resistance method (ERM) to measure volume changes in *Aplysia* intestine. If upregulation of K^+ channels occurs during nutrient absorption, then K^+ channel blockers should abolish nutrient-induced RVD. Presently, we are testing several K^+ channel blockers for their ability to block the *Aplysia* enterocyte K^+ channels. So far, 1mM quinine shows some promise because it depolarizes V_a as expected for a blocker of plasma membrane K^+ channels. We will then use the ERM to determine whether or not apical membrane potassium channels are involved in regulation of enterocyte volume. First, we will assess alanine-induced changes in enterocyte volume with ERM. Second, we will repeat the experiment in the presence of the K^+ channel blocker. We predict that the K^+ channel blocker will abolish RVD.

Structural and Behavioural Adaptations of the Corallivore *Coralliophila abbreviata* (Lamarck) for Effective Feeding on Scleractinian Corals

Reia Guppy
Faculty Mentor: Paul Hamilton

The marine gastropod *Coralliophila abbreviata* Lamarck (1816) is known to feed on coral tissue, and has been classified as a significant predator in some studies. The goal of this project is to determine the adaptations that *Coralliophila* has for feeding on corals. Approaches have included field observations, food preference studies, and histological analyses of feeding structures with some details on how these structures operate biomechanically. *C. abbreviata* are found on the tissue boundaries of scleractinian corals, in small groups. The snails are able to detect coral when placed in a Y-maze ($n=24$, $p<0.001$), given a choice between coral and seawater. When the feeding apparatus of *C. abbreviata* was examined, no traces of a radular or stylet was found and the proboscis was highly muscular. Associated glands are relatively large and composed of serous cells indicating the presence of protein-secretory granules. The suggested mode of feeding includes a pumping action of the proboscis, with possible glandular secretions either for lubrication or enzyme secretions. Further analyses to examine the glandular secretions are being conducted.

Do milkweed glues or poisons trigger vein severance by monarch caterpillars?

Matthew Helmus
Faculty Mentors: David Dussourd, Patricia Draves and Katherine Larson

Larvae of the monarch butterfly (*Danaus plexippus*) only eat milkweeds (*Asclepiadaceae*), plants that are named for their milky latex. When a milkweed is punctured, sticky latex immediately flows out. Larvae attempting to feed may become

gummed up or trapped in congealing latex. Milkweed latex also contains heart poisons(cardenolides), which are toxic to most animals. Monarchs have evolved behaviors that circumvent the latex defense. Before eating a milkweed leaf, final instar larvae transect one or more veins, thereby severing the latex canals. Larvae then feed distal to the cuts where the milkweed plant no longer exudes latex. If a monarch encounters latex when feeding, it will return to chew further on its previous vein-cut. Although vein cutting clearly functions to reduce larval contact with latex, it is not yet known what characteristic of latex stimulates this behavior. I tested if stickiness and/or cardenolides cause monarchs to cut further on a previous vein-cut. Larvae tested with fresh *Asclepias curassavica* latex all returned to chew on their vein-cut, while larvae tested either with sticky polyethylene glycol or a cardenolide solution did not. When *A. curassavica* latex was centrifuged, the pellet fraction typically did not cause larvae to rechew, whereas the supernatant did. These data suggest that cardenolides and stickiness are not triggers for vein cutting, but that the supernatant fraction contains another chemical stimulant. The supernatant can now be fractionated further to test exactly what chemical elicits vein cutting.

Does L-alanine Stimulated Na^+ Absorption Stimulate the Delivery of IntracellularVesicles to the Apical Plasma Membrane in Seahare Intestine?

Robert Keeton
Faculty Mentor: Mike Moran

The major long-term objective of this project is to determine the mechanism(s) responsible for the alanine-stimulated increase in enterocyte plasma membrane potassium conductance (G_k). Stimulation of Na^+ absorption in *Aplysia* intestine with alanine increases enterocyte intracellular osmolarity and induces enterocyte swelling by either osmosis or by cotransporter-induced water entry, or both. In response, enterocytes increase apical membrane G_K, which stimulates K^+ and accompanying anion efflux from the cell. The loss of K^+ and anions from the cell is followed by that of water. Thus, cell volume is restored to near pre-nutrient levels. Recent studies of exocytosis and membrane capacitance in *Aplysia* intestine suggest that the alanine-induced increase in plasma membrane G_k results from exocytic insertion of K^+ channels into the apical membrane. If alanine increases apical membrane G_K by exocytic insertion of K^+ channels, intracellular vesicles carrying K^+ channels must translocate and fuse with the apical membrane. Hence, we should be able to label these vesicles with a biotinylated lectin that binds specific sugar residues on the cell surface. These have a high affinity for avidin conjugated fluorescent probes and enter cells by constitutive endocytosis. However, determining the appropriate lectin to use as a membrane marker and the procedure in which to apply the lectin has proven difficult. Using a specially designed chamber, we have screened several biotinylated lectins for their affinity to the apical surface of Apylsia enterocytes. Biotinylated wheat germ agglutinin, succinylated wheat germ agglutinin, and concanavalin A successfully label the apical surface of the *Aplysia*

enterocytes. Therefore, these lectins can be used to study vesicular trafficking in the Aplysia enterocytes.

The role of intracellular acidification in apoptotic progression

Nelly Norrel
Faculty Mentor: Steven W. Runge

Apoptosis, or programmed cell death, is an essential mechanism for the development and maintenance of multi-cellular organisms. In recent years, significant advances have been made toward achieving full understanding of the many steps in the biochemical pathways of apoptosis, but many aspects of this process are still poorly understood. Intracellular acidification is an event that occurs in many cell types during apoptosis, and acidifying the intracellular environment is sufficient to induce apoptosis. Unfortunately, the precise function and significance of intracellular acidification to the cell death process is still unknown. In this study, apoptosis is induced in cultured mouse fibroblast cells by various stimuli, including enzyme inhibitors and UV irradiation. At the same time, cells in duplicate cultures have their internal pH locked at 7.4 to prevent intracellular acidification when the cells are exposed to the apoptotic stimulus. If preventing internal acidification results in a significant decrease in the levels of apoptosis observed, then intracellular acidification is likely a required step for apoptosis. Gaining a full understanding of how intracellular acidification functions during apoptosis could lead to the development of new approaches for controlling the cell death process. It is possible that these new approaches will lead to novel treatment strategies for diseases (such as cancer) that involve abnormal cell numbers in the body. In future studies, a comparison of the results of cancer cells versus the mouse fibroblast cells may identify ways in which apoptosis can be used to differentiate cancer cells and normal cells.

Role of a single neuron in turning while crawling in the marine slug *Tritonia diomedea*

Roger Redondo
Faculty Mentor: James Murray

Tritonia diomedea crawls using its ciliated foot surface as a sole means of propulsion. Turning while crawling involves the raising of a small portion of the lateral foot margin ipsilateral to the side of the turn. The cilia in the lifted area can no longer contribute to the driving force that moves the animal and it is this consequent asymmetry in thrust force what turns the animal towards the lifted side. The details of this mechanism vary according to the angle of turning. Others in our laboratory are studying these differences in turning mechanisms.

Foot contractions are initiated by neurons located in the pedal ganglia of the brain. Pedal 3 (Pd3), a 250μm dark orange cell, has been shown to receive synaptic input from flow receptors (Murray 1992) and to be necessary for turning (Murray 1994). We have recorded video of this turning behavior in a freely-crawling slug on which two fine wires have been glued over the surface of the brain, above Pd 3. The slug was placed in a flume (i.e. stream channel) to induce their natural tendency to turn upstream. Cameras sent views of the left and right sides of the foot, and of the bottom of the foot to a video mixer. The composite video was recorded synchronously with the firing activity of the Pd 3 neurons for off-line analysis. We have investigated whether Pd3's activity is correlated with turns and whether Pd3 stimulation is sufficient to elicit turning in *Tritonia*.

The Role of Microtubules in Intracellular Vesicular Trafficking and the Regulation of Apoptosis in Cultured Cells

Dana Strassle
Faculty Mentor: Steven W. Runge

The Na^+/H^+ exchanger (NHE) is an integral membrane protein that regulates intracellular pH by exchanging one intracellular H^+ for one extracellular Na^+. Cells respond to intracellular acidification by trafficking NHE in vesicles from the cytoplasm to the plasma membrane in an attempt to maintain normal intracellular pH. This study concentrates on the involvement of microtubules in trafficking vesicles from the cytoplasm to the plasma membrane where they, and the proteins they carry, are inserted by exocytosis. Human breast cancer cells were incubated in acidified media at pH of 7.4, 6.75 and 6.25 and the proton ionophore, carbonyl cyanide m-chlorophenylhydrazone (CCCP). Treatments involved incubation of cells with acidified media and subsequent addition of the anti-microtubule agent, Taxol, and incubation of cells in media of normal pH containing Taxol followed by subsequent incubation in acidified media. The percent of apoptotic verses percent adherent cells was measured in each experiment after 12 hours of incubation, 24 hours and 48 hours. Breast cancer cells incubated at pH 7.4 exhibited the highest percent apoptosis. These results were opposite of what was expected. Previous experiments with embryonic mouse fibroblast cells showed and increase in the percent of apoptotic cells with decreasing pH. Subsequent incubation of the breast cancer cells in media of normal pH, 7.4, with CCCP revealed an increase in percent apoptosis in the absence of other apoptotic triggers. It was concluded that CCCP is toxic to breast cancer cells and will be replaced in future experiments with another proton ionophore, nigericin. Development of anti-cancer treatments has not focused on the role microtubules play in vesicular trafficking, but rather on their role during cell division. Vesicular trafficking is dependent upon microtubules and other cytoskeletal components. An examination of this mechanism and its use by cancer cells, during regulation of intracellular pH in an acidic environment, may ultimately lead to the identification of novel chemotherapy targets for cancer in the future.

MATHEMATICAL AND PHYSICAL SCIENCES

Modeling Polymerization

Trey Bass
Faculty Mentors: Richard Tarkka and Danny Arrigo

Polymerization is the process of small molecules combining to form long, complex chains. Polymers are everywhere: Teflon® on cooking pots and pans; Nylons on stringed instruments; Polyesters in clothing. Finding exact solutions to the differential equations that describe polymerization kinetics is very challenging because the equations tend to be highly coupled and non-linear. Numerical methods are usually used instead. In this work, the mathematical technique of symmetry analysis is used to reduce a complex set of kinetic equations to simple, solvable ones. Exact solutions are obtained. The results are depicted graphically.

Impact of Bridge Construction on the Water Quality of Tucker Creek

Brent Baker, David Johnson, Matt Schroeder,
Dillon Smith, and Carrie Spicer
Mentor: Jeffrey Draves

To improve the follow of north/south traffic in the city of Conway, an extension of Country Club Rd. is under construction. When completed, the extension will connect Country Club Rd. with Dave Ward Dr. The extension takes the road through Salem Park and over Tucker Creek. The work presented here is a preliminary study of the impact this construction activity has on water quality of Tucker Creek. In particular, significantly higher loadings of metals and nitrates have been identified in the Creek. The higher loadings may be due to enhanced run-off and/or exposure to new layers of soil, but direct impact of construction materials cannot be ruled out.

Period Variability in Late Helium-Flash Object V838 Monocerotis

Ryan Brooks and Leigh Ann Reynolds
Faculty Mentor: Scott Austin

N.J. Brown (IAUC 7785) discovered a newly brightened stellar object on 2002 Jan. 6.6 UT at a visual magnitude of 10.0 in the constellation Monoceros. This peculiar variable star, later designated as V838 Monocerotis, brightened more dramatically a second time around 2002 Feb. 2 reaching a maximum visual magnitude of around 6.5. The photometric and spectroscopic behavior over the subsequent months identify V838 Mon as one of only a few late helium-flash objects ever observed. On five occasions between 2002 Feb. 8 UT and 2002 April 2 UT we did time-series differential-photometry of V838 Mon with the UCA Observatory's 11-inch telescope to look for short period variability (time resolution of 10 minutes) that might reveal a binary system or other interesting behavior in such a rare stellar event. Our lightcurves do not show any periodic variability that would indicate a binary system nor non-periodic flickering above the 0.1 magnitude level. For the night of 2002 Feb 8 UT our visual lightcurve has a decline rate of about 0.023 visual magnitudes per hour.

Modeling and Statistical Analysis of fipple Impedance in the Ocarina

Loi Clampit
Faculty mentor: David Peterson

Although the ocarina is a small, fairly simple instrument, there are several aspects that remain a mystery. Many uncertainties reside in the fipple. The fipple is the air splitter, or the whistle, in the instrument. Since the fipple is the sound producing part of the instrument, it is imperative to further understanding of the ocarina and its sound. The problem is clearly geometrical, but the solution is very difficult. Through my research, I have developed a model that explains the frequency output of the ocarina taking into account the fipple in addition to the standard finger holes. After developing a theoretical model, I set up a lab to collect data from the ocarina. Using a fast Fourier transformer, SRS, and varying the input pressure, I composed resonance curves for all possible fingering combinations. Using Quadratic regressions, I formed a table of resonance peaks for the ocarina. This table was later used in statistical analysis of the theoretical model. This is very significant because it is new information regarding the resonance of the ocarina. It will also allow the instrument designers to make more accurate ocarinas with properly sized holes.

Vibrational Analysis of 1,2-Dichlorotetrafluoroethane

G.T. Dobbs, J. M. Moix, K.L. Reynolds, J.R. Rucker,
S.E. Sparks, D.C. St. John
Faculty Mentors: J.A. Draves and P.F. Krause

High resolution, mid-infrared spectra were obtained for the gas phase of 1,2-dichlorotetrafluoroethane using a Nicolet 560 Fourier Transform Infrared Spectrophotometer. Normal mode analysis was attempted using a number of computational models including PM3, Gaussian, and Spartan. Combining molecular coordinates from assumed structures and a structural energy minimization, the molecule was determined to be a near-prolate top based on Ray's Asymmetry Parameter. From this information, the barrier to rotation, and the experimental band positions, it was concluded that the sample was a mixture of trans (C_{2h}) and gauche (C_2) 1,2-dichlorotetrafluororethane. Vibrational assignments were attempted, as were determinations for fundamental band origins and anharmonicity constants.

Schrödingers equation and potentials used to model α-decay

Chad Fendt
Faculty Mentors: Danny Arrigo, Fred Hickling,
Rahul Mehta, and Gaylon Ross

Darboux Transformations have been successful in linking the solutions of complex differential equations with solutions of much simpler equations. Of particular interest is its ability to transform solutions of the Schrödinger free-particle equation into solutions for Schrödinger equations with complex potentials. Recently the free-particle equation has been linked to a Schrödinger equation with a potential that resembles the potential used in nuclear physics to model α -decay. Using an analogy to Fourier series, we will obtain solutions associated with various initial probability distributions. Using these solutions we develop a new method of approximating the half-lives of atoms.

The Darboux transformation of the variable wave speed equation.

Bryan Gipson and Garth Johnson
Faculty Mentors: Danny Arrigo and Fred Hickling

A third order Darboux transformation is constructed for a modified form of the variable speed wave equation, $u_{tt} = u_{xx} + f(x)u$. The Darboux transformation allows for the solutions of the modified wave equation to be linked to the solutions of the standard wave equation with constant wave speed. The construction of the Darboux transformation creates a nonlinear fourth order partial differential equation (PDE) for the function $f(x)$,

which is solvable by reducing it to a linear fourth order PDE. Solving for $f(x)$ generates new classes of solvable wave equations. Finally, these forms are converted into the wave speeds for the standard variable speed wave equation by solving a nonlinear second order integral equation.

TUI Graphics Library

Jeremy Goldberg, Jason Cullum, Daniel Pollock
Faculty Mentor: Wayne Brown

TUI (Three-dimensional User Interface) is a set of software functions that allows a programmer to present a graphical interface between a user and an application. The interface can consist of 2D and/or 3D elements. TUI attempts to be both easy to use and powerful. One set of functions allows a programmer to create an interface quickly and easily with reasonable default values. Another set of functions gives the programmer complete control over every aspect of the interface elements.

An important feature of the library is its use of relationships between graphical elements. The programmer can set the position, rotation, size, and attributes of an interface element in relation to any other element. This allows the programmer to easily place elements in the interface environment. This also maintains the relative relationships of graphical elements as the user manipulates their virtual environment.

An addition goal of the project was to allow implementation on a variety of systems and environments. The TUI library is able to achieve device and Operating System independence through the use of OpenGL, GLUT (OpenGL Library Utility Toolkit), and ANSI C. The software is well designed and stable, allowing it to be easily modified to satisfy the needs of custom software implementations.

Time independent Schrödinger potentials

Brandon S. Lindley
Faculty Mentors: Danny Arrigo and Fred Hickling

It is known that solutions to the free particle Schrödinger equation can be used to solve a class of Schrödinger equation with a non-zero potential using a Darboux transformation. This tranformation produces not only the potential, but also a solution to the equation for this particular potential. It will be shown that for first order Darboux transformations, separable solutions of the free particle Schrödinger equation must be used to generate time-independent potentials**.**

Exact Solutions to Approximate Equations

Casey Milford and Brandon Willis
Faculty Mentors: Danny Arrigo and Fred Hickling

Most current techniques used to approximate solutions to partial differential equations (PDEs) start with a given equation and provide an approximate solution using a variety of techniques. An alternate scheme for approximating solutions to an equation is to find an approximate equation for which exact solutions are known. We will use this alternate scheme to find solutions to Schrodinger's equation.

Until recently, there have been very few potentials for which exact solutions of Schrödinger's equation were known. Given the recent extension to this class of potentials, we have created and implemented an algorithm that approximates any given potential, $V(x)$, by intelligently manipulating members of the recently extended class of potentials. This will eliminate most of the error currently associated with approximate PDE solutions, by providing an approximate equation for which exact solutions are known.

Calcogen Selectivity by Nickel Controls Coordination Geometries in Model Biochemical Systems

David L. Nutt
Faculty Mentor: Patrick J. Desrochers

Cysteine, selenocysteine, and thioethers are essential calcogen(O, S, Se) amino acids and substrates in three of the four known classes of nickel enzymes. Complementary theoretical and experimental results show that nickel's discrimination between calcogen amino acids determines its coordination geometries in model biochemical systems. Kinetically stable trigonal bipyramidal geometries are obtained for sulfur and selenium amino acid residues (Cys); comparable oxygen forms (Ser) yield square pyramidal geometries (**Tp*Ni(E,N)** where E = O, S, and Se.) Trigonal bipyramidal geometries observed for sulfur and selenium spectroscopically match structurally characterized complexes involving cysteine and its ethyl ester. Optimal pi overlap stabilizes Tp*Ni(S,N) and Tp*Ni(Se,N). Alkylation or oxidation of these complexes reduces this pi overlap, resulting in loss of the trigonal bipyramidal geometry. Alkylation, but not oxidation, is reversible, and oxidation of the selenium form is considerably faster than its sulfur derivative. The square pyramidal geometry obtained for oxygen is confirmed by comparative spectroscopic measurements with Tp*Ni(acac) and published nickel-acac complexes. Oxygen's diminished pi overlap with nickel prevents ethanolamine from stabilizing the trigonal bipyramidal geometry. These results help define the role of cysteine (both S and Se forms) in nickel-hydrogenase and carbon monoxide dehydrogenase enzymes as well as the cysteine-targeted toxicity of this metal.

Numerical Solution of Helmholtz Equation

Eugene Rathfon
Faculty Mentor: Guy Bernard

The Helmholtz equation is a differential equation that describes the steady vibrations of phenomena modeled by the wave equation, e.g. sound propagation in air. Applications of this equation arise in acoustics, seismology, sonar and radio transmission, to name just a few. This research project (in progress) deals with the one dimensional Helmholtz equation $u_{xx} + k^2(x)\, u = f(x)$ where $-R < x < R$ denotes the position in one dimensional space, u(x) the amplitude of the vibrations (to be determined) and k(x) describes a property of the medium e.g. speed of sound in air.

In the many applications of Helmholtz equation of interest in engineering, the wave number k(x) is not constant. In this case, analytical methods to solve these equations do not exist and engineers must resort to computer generated approximations of their solutions. The objective of this research is to devise a numerical method capable of approximating the solution of Helmholtz equation in the difficult case where $R >> 2\ /k(x)$. The numerical method will consist of a finite difference method in combination with a multigrid solver which will be constructed specifically to circumvent the difficulties of this problem.

SCIENCE AND MATHEMATICS EDUCATION

Literature as a Manipulative in a Secondary Level Mathematics Curriculum

Matthew Dalke
Faculty Mentor: Carolyn Pinchback

This research is designed to test qualitatively the effectiveness of using literature in a secondary mathematics curriculum. Much has been done at the elementary level already with integrating mathematics and literature, one example being a study conducted by Pamela Halpern. In her article "Communicating the Mathematics in Children's Trade Books Using Mathematical Annotations" for the NCTM 1996 yearbook, Halpern states that in her study using a sample of 209 children in grades one through three, 81.8% of the students preferred books with mathematical annotations as opposed to those books without the annotations. Such reasons as to why they liked the annotated books better were "The mathematical annotations made reading the book more enjoyable" and "The mathematical annotations made the book 'easier to understand' and communicated the mathematics more clearly." And if this would work at the lower levels, why would it not work at the secondary level? Literature can be used to take the mathematical concepts taught in high school that are often thought of as abstract and obscure and show how they can be applied to an everyday situation. Currently we are looking at utilizing the short story "How Much Land Does a Man Need" by Leo Tolstoy to teach algebra, geometry, and trigonometry at the secondary level. I have already created my own adaptation of this story that will be given to the students in each of the classes. Also, I will be looking at adapting a portion of the story *Gulliver's Travels* by Jonathan Swift to use.

Improving mathematics education in Arkansas
Large-scale assessment can be an agent of change

Audri McCready
Faculty Mentors: Linda K. Griffith and Jean J. McGehee

Two issues in the forefront of mathematics education are state testing/accountability programs and effective professional development. When the testing extends beyond norm-referenced tests to criterion-referenced tests and emphasizes curriculum alignment with testing, then the assessment becomes a positive agent of change in teaching practices and student achievement. In Arkansas criterion referenced tests, the Benchmark Exams, are given in grades 4, 6 and 8. Drs. Griffith and McGehee have designed a professional development model based on content knowledge acquisition, classroom coaching, and

curriculum alignment. The data collected in the Professional Development and Curriculum Alignment Project (PDCA) is used to determine the following:

1. Long-term trends in student achievement based on Benchmark test data in grades 4,6, and 8
2. Annual growth in student achievement based on a pre/post test
3. Impact on teacher knowledge and practice based on classroom observations and teacher/scholar interactions

As a graduate assistant I have collected and analyzed the following data for this program:

- Benchmark data for grades 4, 6 and 8.
- Pre/post tests based on released Benchmark items for each of the grades 3-8 to demonstrate annual growth in student achievement.

While PDCA has extended to several school districts in the state, this presentation focuses on two school districts in northeast Arkansas. Eighth grade trend data and ethnographic data on one sixth-grade teacher show significant increases in student achievement and impact on teacher practice. In 2002-2003, I will continue to analyze test data and will assist with videotapes and observations in the classroom.