Millersville University
Department Earth Sciences

GEOPOD Project (GEOscience Probe of Discovery)

A Three-Year Project Funded by the
National Science Foundation (2009-2012)

GEOPOD Evaluation Report
Phase 1: GEOpod Design and Development

(September 1, 2009-June 30, 2010)

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Submitted
By

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GEOPOD Project (GEOScience Probe of Discovery)

I. INTRODUCTION

Project Background and Purpose

The GEOPOD Project (GEOScience Probe of Discovery) is a three-year project (2009-2012) funded by the National Science Foundation (NSF) and directed by faculty of Millersville University (MU) in Millersville, Pennsylvania. Dr. Gary Zoppetti, associate professor of Computer Science, serves at Principal Investigator (PI) for the project. Dr. Richard Clark and Dr. Sepi Yalda, both professors of Meteorology in the Department of Earth Sciences, serve as Co-Principal Investigators (Co-PIs); Dr. Clark also functions as chief contact for the project and the Project Director.

The purpose of the **GEOPOD** project is to develop and implement an interactive instructional software program, the ***GEOpod***[1], which provides instructors and students in the field of Meteorology with an intuitive and graphical interface in a 3-D gaming environment. The developers hope to provide users with a software program that allows them to probe authentic geophysical data and use virtual devices to collect data, record observations, and query information while guided by instructional design strategies that are customized for undergraduate learners.

The project significantly leverages the Unidata Program Center's open source Java-based visualization software, the Integrated Data Viewer (IDV), and its Internet Data Distribution (IDD) system and Local Data Manager (LDM), to import data in rendering a 3-D data environment which serves as an exploration platform for the

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[1] ***GEOPOD*** refers to the overall project and ***GEOpod*** refers to the interface.

GEOpod. Key features of the ***GEOpod*** include:

- the ***GEOpod*** interface;
- Customizable display panel with drag-and-drop capability for up to 19 user-selected meteorological variables;
- User guided navigation (with optional WII controller capability) or lock-on with smooth auto-pilot functionality allowing users to track an isosurface with high fidelity;
- Integration of Google map technology for both forward and reverse geocoding – users can fly to a specified location in ***GEOpod*** or ground-truth their location;
- Actuating particle imaging (snow crystals, liquid droplets) and vertical profiling (dropsonde) virtual devices;
- Auto-build and replay of IDV bundles;
- Web-based mission builder for user/instructor defined missions;
- Flight recorder for evaluation and assessment;
- Point-of-interest annotation; *and*
- Learning objectives and assessment.

The challenge in the ***GEOpod*** design is to use real data in a system of interoperability that works seamlessly with diverse integrated web and computer-based systems, such as the IDV-compatible interface. What distinguishes the ***GEOpod*** from other synthetic environments such as Virtual Thunderstorm (Gallus et al., 2005) is the use of authentic geophysical data (e.g., surface and upper air observations, satellite and weather radar imagery, and numerical model output) to construct the 3-D environment, and the nearly limitless possibilities for exploration and discovery afforded by the endless stream of geophysical data and products that are already available to colleges and universities via Unidata's IDD.

Rationale and Motivation for the GEOPOD Project

There is little doubt in academia or among the public at large about the importance of computer technology as a tool for learning, especially at the undergraduate and graduate level (How People Learn, 2000) in the 21st century. Across many disciplines, but notably in the geosciences, computer technology as a tool for access to data and Web-based resources, and computational problem solving, is the life-blood of the curriculum. Today, students in higher education have access to real-time and legacy datasets, sophisticated visualization applications, high-bandwidth networks, and high-speed computers. These students, the so-called "Millennials" or the Net Generation (NetGen'ers), have grown up with computers and are technologically savvy (Oblinger, 2004). They are accustomed to operating in a digital environment, communicating with cell phones, text messaging, and email—have computers at home and have access to multiple types of mobile devices equipped with wi-fi. By contrast, and despite huge investments in communication and computer hardware and software made by universities and schools, most formal teaching and learning still uses methods that would be familiar to a 19th century student: reading texts, listening to lectures, and participating in highly scripted laboratory exercises (Kelly, 2005).

Applied prudently and intelligently, technology holds great promise as a means to improve education and can be implemented without unrealistic increases in spending. Presnky (2003) has framed the significance of computer technology and simulations in terms of the fundamental characteristics of effective learning: Active engagement, participation in groups, frequent interaction and feedback, connections to real-world contexts, and learning by doing.

In recent years, the use of electronic games for experiential learning has generated considerable interest. Advocates suggest that gaming could increase student enthusiasm for educational materials, which could in turn increase time on task and lead ultimately to improved motivation and student performance (The Learning Federation Project, 2003). Educators have already begun introducing games into instruction (e.g. "Discover Babylon©, Civilization II™, SimCity™, and Immune Attack™), and will continue to benefit from commercial inroads into gaming in education so long as such applications are based on a sound understanding of which features of these systems are important for learning and why (Kelly, 2005).

It was the promise of this kind of interactive technology and the potential benefits for instructors and students in the field of Meteorology that provided the impetus for this **GEOPOD** project and the design of the ***GEOpod***. The ultimate goals of the **GEOPOD** project are: (1) to provide college educators in the field of Meteorology with a sound, technically accurate, and visually compelling interactive computer-based simulation and exploration environment for the classroom; (2) to provide an instructional design that complements the technology and will excite and motivate students to explore and discover the geophysical realm and deepen their interest in the field; and (3) to determine the efficacy of this technology-based approach for undergraduate teaching and learning.

Project Scope and Duration

The **GEOPOD** project consists of three phases over a three year period (2009-2012): **Phase 1: Design and Development of the GEOpod** (September 1, 2009- June 30,2010) consists of the design and development of the ***GEOpod*** technology, development of a student assessment instrument, and pilot testing of the assessment instrument. **Phase II: Testing and Rollout of the GEOpod** (July 1, 2010-June 30, 2011) involves the continued development and rollout of the GEOpod technology, implementation of the Usability Study, and testing of all of the comparison groups on the GEOpod assessment instrument. Phase III: Implementation and Assessment (July 1, 2011-June 30, 2012) consists of refinement of the ***GEOpod*** technology, training of faculty who will implement the GEOpod in their courses, implementation of the GEOpod technology and curriculum in selected Meteorology classes at Millersville University, and assessment to of learning for students who were instructed using the GEOpod in their courses. The specific goals and objectives of the **GEOPOD** project during all three phases of the project are the following.

Phase I:

- Develop the ***GEOpod*** technology including the platform and modules or missions for instructional use;
- Develop an appropriate assessment to determine the extent to which students increase learning outcomes as a result of instruction using the ***GEOpod*** in their courses; and
- Pilot test all assessment instruments.

Phase II:

- Refine the GEOpod technology;
- Conduct a usability test to determine the technological soundness of the ***GEOpod*** and any navigational and instructional issues for students and instructors;
- Test all comparison groups using the GEOpod assessment;
- Exchange and explore ideas about the GEOpod with professors and students at a broad range of universities and science organizations nationally.

Phase III:

- Develop a ***GEOpod*** User's Guide for instructional use;
- Implement the ***GEOpod*** in Meteorology courses at Millersville University over a one-year period;
- Train professors in the fields of Meteorology at Millersville University in the use the ***GEOpod***;
- Determine the efficacy of the GEOPOD approach (e.g. the extent to which professors and students *use and value* the ***GEOpod*** and the instructional curriculum);
- Determine the extent to which the ***GEOpod*** enhances learning outcomes for undergraduate students;
- Determine the sustainability of the **GEOPOD** approach at Millersville and the extent to which this approach has a wider appeal to educators at various educational levels.
- Exchange and explore ideas and methodologies regarding technology-based teaching with professors and students at a broad range of universities and science organizations nationally.

The GEOpod modules are specifically targeted for instruction in meteorology courses at Millersville University. It is expected that the ***GEOpod*** will be used in instruction with approximately 200 sophomore through senior students enrolled in these courses during Phase II of the project.

II. EVALUATION DESIGN AND METHODOLOGY

Evaluation Goals and Objectives

The evaluation design for the **GEOPOD** project consists of both formative and summative methodologies intended to provide evidence of the success and challenges of developing and implementing the project, the extent to which instructors and students value and use the ***GEOpod*** modules, and an examination of student learning gains as a result of using the ***GEOpod*** modules in their courses.

Formative evaluation results for Phases I and II, which include the design, development and testing of the ***GEOpod***, will offer the project team an opportunity to determine those project elements that are working successfully and those elements that need to be altered to achieve greater success, especially the instructional design, functionality, and technical accuracy of the ***GEOpod*** system. Evaluation questions addressed during Phase I are the following:

- *To what extent was the project carried out in Phase I as originally designed?*
- *What progress has been made in Phase I in the development of the GEOpod platform?*
- *What tests of functionality, technical soundness, and user interactivity were conducted on the GEOpod and with what results?*
- *What student assessments were developed and tested during Phase I and with what results?*
- *To what degree were faculty trained in the use of the GEOpod platform in their courses?*
- *To what degree are the project and the GEOpod itself ready for implementation in Phase II which will launch in the spring term of 2011?*

The summative evaluation, which will be conducted during Phase III, consists of implementation and assessment activities. It is designed to provide evidence of student learning outcomes as a result of using the GEOpod technology in the classroom, the value and usefulness of the GEOpod modules in instruction, the extent to which this kind of technology can be sustained in instruction at Millersville University, and the degree to which it can be adopted and used at other universities. The specific research questions guiding the Phase II evaluation include:

- *To what extent were the **GEOpod** modules used and valued by instructors as a teaching tool at the university level?*
- *To what extent did instructors require additional technical assistance beyond the initial training with the GEOpod?*
- *To what extent were students able to successfully complete a series of GEOpod lessons or modules?*
- *To what extent were the **GEOpod** modules used and valued by students as a learning tool?*
- *To what extent did students experience content knowledge learning gains as a result of using the **GEOpod** in instruction?*
- *How can this kind of technology be sustained as a learning tool at Millersville University?*
- *To what extent does the GEOpod technology have wide appeal and potential for replication at other colleges, universities, and educational settings around the country?*

Data Collection for the Three Phases of the Project

This evaluator, in collaboration with the Millersville GEOPOD project staff designed the following instruments and protocols for data collection during Phases I and II of the project.

Phase I. In order to address the evaluation questions for Phase I **(September 1, 2009 – June 30, 2010)**, the following instruments and methodologies were designed for use in data collection:

- **Document Review**: A systematic content review of all meeting minutes, timelines, and other project documents to determine decisions, the direction of the project, and activities completed during Phase I.

- **On Site Visits Protocols:** Documents providing evidence of on-site meetings between the project staff/students working on the GEOpod technology and the evaluator.

- **Student Outcomes Assessment Pilot:** An assessment instrument developed in collaboration with the GEOPOD project team and piloted in Phase 1-to be used in determining the learning outcomes for students using the GEOpod in Phase II.

Phases II and III. During Phase II (July 1, 2010-June 30, 2011) and Phase III (July 1, 2011-June 30, 2012) the following instruments will be designed to collect project level data in order to understand how the instructors use and value the ***GEOpod*** technology in the classroom, determine the significance of any gains in student learning that were realized as a result of using the ***GEOpod***, and to determine the sustainability and transportability of this kind of technology to other university settings.

- **Instructor Logs:** Web-based instruments for instructors to record their weekly use of the GEOpod in instruction, the curriculum materials used student reactions to the technology, and any challenges or benefits they experienced in using the technology. This weekly log will also act as a monitoring tool, allowing project staff to track any challenges instructors are having in using the technology in order to provide additional instructions and guidance.

- **Web-based Surveys**: Surveys designed for students and instructors that request their opinions of the impact of the GEOpod on their teaching and learning as well as their perceptions of any improvements in classroom atmosphere and instructional quality that were realized as a result of using the technology and curriculum.

- **Student Outcomes Assessment.** Implementation of the assessment instrument developed in Phase I to determine student gains in content knowledge as a result of instruction using the GEOpod. This is a pre/posttest that will be administered to students at the beginning and end of courses each semester during Phase II.

- **Focus Group Protocols:** These protocols will be used in two settings of randomly selected students and professors to gather more in-depth information about the use and value of the ***GEOpod*** in the classroom.

- ***GEOpod* Usability Study Protocol:** A protocol to test the soundness of the GEOpod technology platform and the human interactivity component.

Organization of the Phase I Report

This report represents the results of the GEOPOD project activities from Phase I of the study (September 1, 2009-June 30, 2010) using data from the following sources: document reviews; evaluator site visits; and results of the pilot of the assessment test. Section III describes the key activities of the project during Phase I, including project management, development of the GEOpod technology, development and testing of all evaluation instruments, including the student assessment instrument. Section IV presents the data on the results of the pilot test of the student assessment. Section V details the conclusions and recommendations from the evaluator's perspective and offers suggestions for adjustments to the project in Phase II.

III. Key Activities of the GEOPOD Project in Phase I (September 1, 2009 – June 30, 2010)

GEOPOD Project Management

As mentioned earlier, the GEOPOD project is managed by Drs. Richard Clark and Sepi Yalda (Co-PIs) in collaboration with Dr. Gary Zoppetti (PI) who oversees the development of the GEOpod modules with three Millersville students in the Department of Computer Science. Drs. Clark and Yalda also teach some of the courses that will be involved in the GEOPOD project during Phase III. Together they manage the day-to-day activities of the grant and coordinate evaluation efforts and activities with the external evaluator for the project.

Outcomes of Key Activities in Phase I

Formal Project Meetings. The project team met with the external evaluator three times during Phase I (October, 2009; January and June, 2010) to develop evaluation activities and timelines for the project, review the progress of the ***GEOpod*** development, and to design and pilot the student assessment instrument and the ***GEOpod*** usability study. During the October 2009 meeting, the project team revisited the goals and objectives of the project based on the revised budget imposed by NSF. The revised budget resulted in a reduced number of students and classes that could be involved in the project and eliminated some planned conference travel for staff involved in the project and related faculty development. Also, due to the cut in funding, the plan to include an Expert Panel to review the project and provide guidance for the development of the GEOpod was eliminated. In its place, Dr. Clark suggested that the project team demonstrate the project at several professional meteorological meetings and request feedback on the GEOpod at that time from those professionals in attendance. Those presentations have been tentatively scheduled for Unidata meetings in December 2010 and June 2012.

The following section reviews key decisions that were made in Phase I of the project and details project activities that were carried out during this time period.

Targeted Students and Courses for the GEOPOD project. During the first project meeting in October 2009, the GEOPOD project team decided on seven meteorology courses at MU that would be the target courses for this project. These courses enroll predominately sophomore to senior level students majoring in Meteorology. (See Table 1). It is expected that approximately 200 students will be enrolled in these classes during Phase III of the project and receive instruction using the ***GEOpod***. Those students who receive instruction using the GEOpod will comprise the Treatment group for this project.

To ensure robustness of the study and to support or negate the assumption that student learning gains could be linked to instruction with the ***GEOpod***, the project team decided that students who will be enrolled in *some* of these same courses (listed in Table 1) during fall of 2010 would serve as a Comparison[2] group. The students who will be enrolled in ESCI 241, *Introduction to Meteorology*, ESCI 341 *Atmospheric Thermodynamics*, ESCI 342 *Atmospheric Dynamics I,* and ESCI 444 *Mesoscale Meteorology* will receive instruction in their courses before the ***GEOpod*** is fully developed and available for course instruction—thus making them candidates as a comparison group in Phase II.

Table 1: Meteorology Courses involved in the GEOPOD Project

Course Number	Course Title	Course Description
ESCI 241	**Introduction to Meteorology**	Atmospheric structure and motions; physics of weather processes; weather and motion systems. 3 hours lecture, 2 hours lab.
ESCI 340	**Physical Meteorology**	Distribution of meteorological variables in the atmosphere; governing principles in atmospheric science (gas laws, hydrostatic equilibrium, diffusion, conservation of energy, mass, and momentum); radiative transfer, cloud processes and atmospheric electrification. 3 hours lecture.

[2] Comparison groups will be used in this study instead of strict controls groups because control groups in the social sciences and education are fraught with problems that are difficult to overcome. First, a true control group is difficult to construct as control groups require randomization and matches on types of students in classes on a number of variables (e.g. gender, grades, background knowledge, college standing, etc.); class enrollment by *type of student* cannot be required for obvious logistical reasons. Second, control groups are notoriously difficult to acquire in educational research as educators are naturally reluctant to *exclude* one set of students from potentially promising educational interventions while including others.

ESCI 341	**Atmospheric Thermodynamics**	First and second principles of thermodynamics, water-air systems, equilibrium of small droplets and crystals, thermodynamic processes in the atmosphere, atmospheric statics, vertical stability, and aerological diagrams. 3 hours lecture.
ESCI 342	**Atmospheric Dynamics I**	Meteorological coordinate systems; equations of motion; geostrophic, gradient and thermal winds; kinematics; circulation, vorticity and divergence theorems. 3 hours lecture.
ESCI 343	**Atmospheric Dynamics II**	Diagnostics equations, viscosity and turbulence; energy equations and transformations; numerical weather prediction; general circulation. 3 hours lecture.
ESCI 441	**Synoptic Meteorology**	Weather forecasting concepts with focus on numerical weather prediction; forecasting of severe convective storms; current weather discussion. 2 hrs. Lecture, 4 hrs. lab
ESCI 444	**Mesoscale Meteorology**	Primary circulations at scales between individual convective cells and large cyclones; jet streaks, gravity waves, mesoscale convective complexes, squall lines, dry lines. 3 hrs. lecture.

Assessment of Student Outcomes. In order to determine the extent to which students demonstrate gains in content knowledge as a result of instruction using the ***GEOpod***, the project team in collaboration with this evaluator, designed a pre/posttest measure of student learning that would be administered to all students in both the Treatment and Comparison conditions. This assessment instrument consists of 19 items that are a combination of check-off, fill-in-the-blank, and multiple choice items. Four (4) items address student demographics (e.g. course enrolled, college level, major, gender); two (2) items address students' experience with 3-D gaming and computerized navigational systems and students' experience with applied research or practical experience in the field of meteorology. Thirteen (13) multiple-choice questions address content related to the four GEOpod modules and content taught in the meteorology courses, such as basic kinematics of fluids, relationship between thermodynamic and kinematic fluids, cloud microphysics, and the nature of ageostrophic wind.

In order to determine test validity and address any issues with the particular test questions, the GEOPOD assessment was reviewed by selected faculty for face validity and piloted with a group of students who were enrolled in four Meteorology courses in the spring of 2010. (See Table 2). The results of this pilot test are discussed in Section IV.

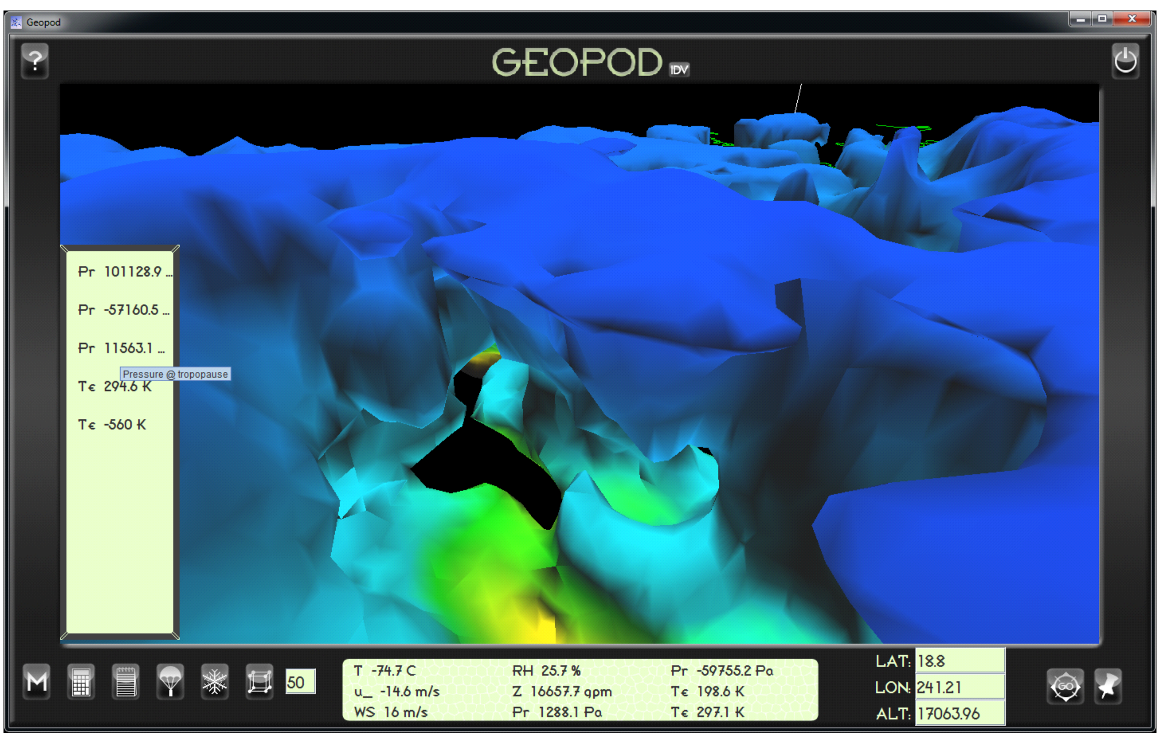
Testing the Comparison Group in Fall Term, 2010. During fall term of 2010, the GEOPOD pre/posttest test will be administered through the college's new online learning platform, **Desire to Learn (D2L).** Only Comparison Group classes will participate in the pre/posttest in fall, 2010:

- ESCI 241, *Introduction to Meteorology*,
- ESCI 341 *Atmospheric Thermodynamics*,
- ESCI 342 *Atmospheric Dynamics I, and*
- ESCI 444 *Mesoscale Meteorology*

The pre-test will be administered during the first two weeks of fall term, August 30-September 10, 2010. No test scores will be accepted after September 10th. The posttest will be administered during the final two weeks of the term, December 6 through 17th. Students will get course credit (to be determined by the instructor) for completing both the pre and posttest. Results of the Comparison and Treatment group outcomes will be analyzed and reported in the PHASE II evaluation report.

Development of the *GEOPod* Modules. During the fall, spring, and summer terms of 2009 and 2010, the ***GEOpod* technology** was developed by Dr. Gary Zoppetti with the assistance of three students in the Department of Computer Science at MU. Students Ky Waegel and Michael Root, both juniors majoring in Computer Science, began work on the ***GEOpod*** on September 1, 2009, working approximately 4 hours every week for about 15 weeks. During this time they learned about the project and the required technologies they would be working with, specifically Java 3D and IDV functionality and software architecture. During spring 2010, they began to implement the switch from a fixed to a movable camera that samples the atmosphere at its current location. They also put into operation a minimal heads-up display at this time. The intensive development work on the ***GEOpod*** technology began in the summer term of 2010. At this time Lindsey Crouse, a sophomore in the Computer Science department, joined the team and all team members spent between 25 and 32 hours per week on the project. Over the summer, Mike, Ky, and Lindsey built and refined the interface and implemented the sensor, dropsonde, and particle image devices. In addition, Lindsey developed the mission subsystem and the flight recorder. (See Figure 1 for a photo of the GEOpod technology).

Figure 1: A photo image depicting the GEOpod interface.



Note: The primary parameter area pictured in the bottom center of the photo displays atmosphere parameters such as temperature and wind speed. Buttons on the lower left, lower right, and upper left allow the user to activate devices, view a mission, and obtain help. An overflow display on the left shows parameters beyond the 9 primary parameters. Seen through the HUD is an isosurface of relative humidity (a surface where the relative humidity is constant). The advanced user can select more parameters then the nine (9) that the primary display area shows. The overflow display (on the left) will become active when the user accesses it. All parameters have a tooltip that shows their full name (rather than a common abbreviation) when the user hovers over it.

Drs. Clark and Yalda determined the following target content for the first four modules that would serve as the initial focus of the GEOpod:

- Basic kinematics of fluids
- Relationship between thermodynamic and kinematic fluids
- Cloud microphysics
- Nature of ageostrophic wind

During the June 2010 site visit, Dr. Zoppetti's students, Ky and Mike, demonstrated one of the ***GEOpod*** modules or "missions" they had designed. The students described the task of developing the GEOpod modules as "daunting," but they continue to make good progress and should have some "missions" ready for demonstration and pilot purposes in the fall, 2010. Informal feedback from professors and students indicate that the graphics and the interactive aspects of the modules are very "impressive."

Usability Test for the *GEOpod*. In order to provide evidence of the structural integrity, user-friendliness, interactivity, and content appropriateness of the GEOpod, the project team is involved in designing a Usability Study of the technology. The Usability Study will examine elements of the ***GEOpod*** design, functionality, and usefulness, such as the following:

- Time it takes to finish the case, module, or mission;

- User navigational issues (Log major functions and sequences);
- 3-4 questions for students regarding their experience with the GEOpod and possibly some content questions;
- Perceptions of the GEOpod system's value and usefulness;
- Perceptions of potential impact on students' learning of content; *and*
- Feedback on what students liked about the system and what they would like to see changed.

Dr. Zoppetti will collaborate with professor Blaise Liffick in the Department of Computer Science to develop procedures and protocols for the Usability Study of the *GEOpod*. Dr. Liffick will engage his students who are enrolled in an upper level human computer interaction class to implement the Usability Study and to develop a case study of the results. The GEOpod missions or modules will be tested with a small stratified, random sample of students who are taking Meteorology courses in the fall term, 2010. The results of the Usability Study are review in Section IV.

Instructor Training in the Use of the GEOpod. In late fall term, 2010 or very early in spring term, 2011, MU instructors who will be providing classroom instruction with the ***GEOpod*** in Phase II of the project will be briefed on the ***GEOpod*** technology and introduced to a sample curriculum to use in instruction with the ***GEOpod***. Along with providing training on the ***GEOpod***, the instructors will be briefed on outcomes of the Usability Study, the results of the assessment pilot, and additional evaluation activities planned for the project and their role in providing data. Dr. Sepi Yalda is also drafting a User's Guide that will be used at this training to assist professors in implementing the ***GEOpod*** in the classroom. Training is critical to the adoption of the project and the full, correct, and systematic utilization of the ***GEOpod*** in the classroom across courses.

The results of the two major evaluation activities (the GEOPOD Pilot Test and the ***GEOpod*** Usability Study) implemented during Phase I are discussed in Section IV. Conclusions of activities conducted in Phase I and recommendations for Phase II activities are discussed in Section V.

IV. Results of the Pilot Test of the Student Assessment Instrument and the Usability Study

Findings from Pilot Administration of the GEOPOD Assessment

In January 2010, the project team in collaboration with the project evaluator developed a pre/posttest measure for the GEOPOD project. The assessment consisted of 19 items and was designed to be given as a pre and post-test measure to both the Treatment and Comparison groups. Four items addressed student demographics (e.g. course enrolled, college level, major, gender) and two background items addressed students' experience with 3-D gaming and computerized navigational systems and students' experience with research methodologies and strategies in the sciences. Thirteen multiple-choice questions addressed content related to the four modules to be addressed in the GEOPOD project. Target concepts included: Basic kinematics of fluids, relationship between thermodynamic and kinematic fluids, cloud microphysics, and the nature of ageostrophic wind.

In order to determine test validity and any issues with the particular test questions, the GEOPOD assessment was reviewed by selected faculty for face validity and piloted with a group of students who were enrolled in the four courses listed in Table 2.

Table 2: Courses and Number of Students included in the pilot of the GEOPOD Assessment in spring term, 2010

Course Number	Course Title	Number of Students enrolled
ESCI 340	**Physical Meteorology**	**29**
ESCI 343	**Atmospheric Dynamics II**	**20**
ESCI 443	**Climate Dynamics**	**21**
ESCI 444	**Meso/Storm Scale Meteorology**	**19**
	Total	**89**

The assessment was administered on the Blackboard platform. The pilot test was not administered in class in a controlled environment; students were allowed to access and complete the assessment on their own time and were given course credit for taking the test. This was done to mirror the conditions under which the assessment would be given to students in Phase II.

Population included in the Pilot. Forty-three (43) students out of the 89 students enrolled in the four courses responded to the assessment on Blackboard, representing a 48% response rate. Three of the students who started the test failed to complete the test, answering fewer than 3 questions and, thus, were not included in the analysis. Forty (40) students, across the four courses, who completed the assessment, were included in this analysis.

Demographic Data. The majority of the students taking the GEOPOD assessment were upperclassmen (juniors and seniors) majoring in Meteorology; only ten percent of the students were sophomores and no freshman or graduate students were represented in the sample. (See Figure 1). Seventy three percent (73%) of the analyzed sample were males (29/40); twenty-seven percent (27%) were females (11/40), representing roughly the enrollment by gender in Meteorology courses at MU overall.

Experience with 3-D Gaming and Computerized Navigational Systems. In order to understand the potential impact of students' experience with 3-D gaming and computerized navigational systems that might impact their ability to work on the ***GEOpod*** system, students were asked to comment on their experience with common existing systems. The majority of students in the sample reported familiarity with Google Earth, Gempak/Garp, and IDV. **(See Figure 3).** Slightly less than half reported using Call of Duty (40%) and McIDAS use was reported by a quarter of the students (25%). Fewer than 20% reported using GIS, Microsoft Flight Simulator or World of War Craft. Thirteen percent reported no experience with 3-D Gaming or Computerized navigational systems.

The pattern of usage reflected by the females in the sample is somewhat different from the pattern of usage reported by the males in the sample. Except for Call of Duty (9%) and World of War Craft (0%), females ranked order of usage roughly similar to males, although use of 3-D and computerized systems reported was down overall among females. One-fourth of the females sampled reported no experience with 3-D gaming or computerized systems—this is higher than the sample overall. Understanding the kind of experience that students will bring to the GEOPOD project will be very helpful in assisting the developers in designing navigational systems and interpreting results of testing and instruction using the ***GEOpod*** system.

Figure 3. Rank Order of Student Experience with 3-D Gaming and Computerized Navigational Systems (N=40)

3-D Gaming/Computerized Navigational Systems	Number of Students with Experience	Experience by Gender	
		M (N=29)	F (N=11)
Google Earth	30 (75%)	24 (83%)	6 (54%)
GEMPAK/GARP	25 (63%)	22 (76%)	3 (27%)
IDV	20 (50%)	16 (55%)	4 (36%)
Call of Duty	16 (40%)	15 (52%)	1 (9%)
McIDAS	10 (25%)	8 (28%)	2 (18%)
GIS	7 (18%)	6 (21%)	1 (9%)
Microsoft Flight Simulator	6 (15%)	5 (17%)	1 (9%)
World of War Craft	5 (13%)	5 (17%)	0 (0%)
No Experience with 3-D Gaming	5 (13%)	2 (7%)	3 (27%)
Other (Not Specified)	7 (18%)	5 (17%)	2 (18%)

Undergraduate Applied Research Experience and Practical Field Experience. Students were asked to respond to a question (Question 6) related to the type of research experience in the sciences they had engaged in as an undergraduate student. A third of the students reported that they had experience in Data Analysis and Inquiry-Based Research and a quarter (25%) reported "Other" research experience that was not specified. However, an equal percentage of students (30%) also indicated that they had *no experience* in any scientific research. Students reported few instances of engagement with Observational Fieldwork (15%), Computational Analysis (15%) or Geophysical Simulations or Experiments (5%). The reporting by males and females follows roughly this same pattern.

Based on a discussion held at the June 22 GEOPOD team meeting where the team expressed lack of confidence with the student responses to this question, it was decided that the question and the response set would be revised to better reflect what undergraduate students might actually do to gain practical experience or engage in applied research. The question was subsequently revised by the evaluator to include such categories as broadcast internships and the use of websites and computer software packages with meteorology content. The response categories were also expanded to include examples. (See Figure 2 for a revision of Question 6).

Figure 2. Revised Wording for Question 6: Applied Research or Practice-Based Experience in the field of Meteorology.

6. Have you had any applied research or practice-based experience in the field of Meteorology or Oceanography either as part of your coursework or as an independent study outside of the classroom? (Check all that apply.)

a. **Observational Field Work (**e.g., using instruments to study the state of the earth's atmosphere either at the surface or aloft. Predicting and spotting severe storm events and interpreting real-time data.)

b. **Conducting Independent Study or Investigations** (e.g., reading and compiling information from scholarly research and juried articles related to a topic or research question in the field of Meteorology or Oceanography.)

c. **Conducting Computational Analysis and Numerical Modeling (**e.g., applying such basic equations of motion, atmospheric thermodynamics, gradient and geostrophic flow to phenomena in Meteorology and/or Oceanography. Using numerical modeling techniques and weather prediction models to study different aspects of weather patterns.)

d. **Conducting Geophysical Laboratory Experiments (**e.g., participating in hands-on experiments using water, balloons, beakers, tanks, and other laboratory equipment to study phenomena such as temperature and heat transfer, thermal equilibrium, density differences in cold and hot air, and pressure changes, etc.)

e. **Conducting Data Analysis** (e.g., compiling and/or analyzing sets of numerical data in the field of Meteorology or Oceanography. Interpreting statistical output and meteorological reports.)

f. **Using Web-Based or other Computer-Based Programs to Study Meteorological Data** (e.g., using the Integrated Data Viewer (IDV) from Unidata, a Java-based software framework, or other specialized software packages, such as Matlab, to analyze and visualize geosciences data.)

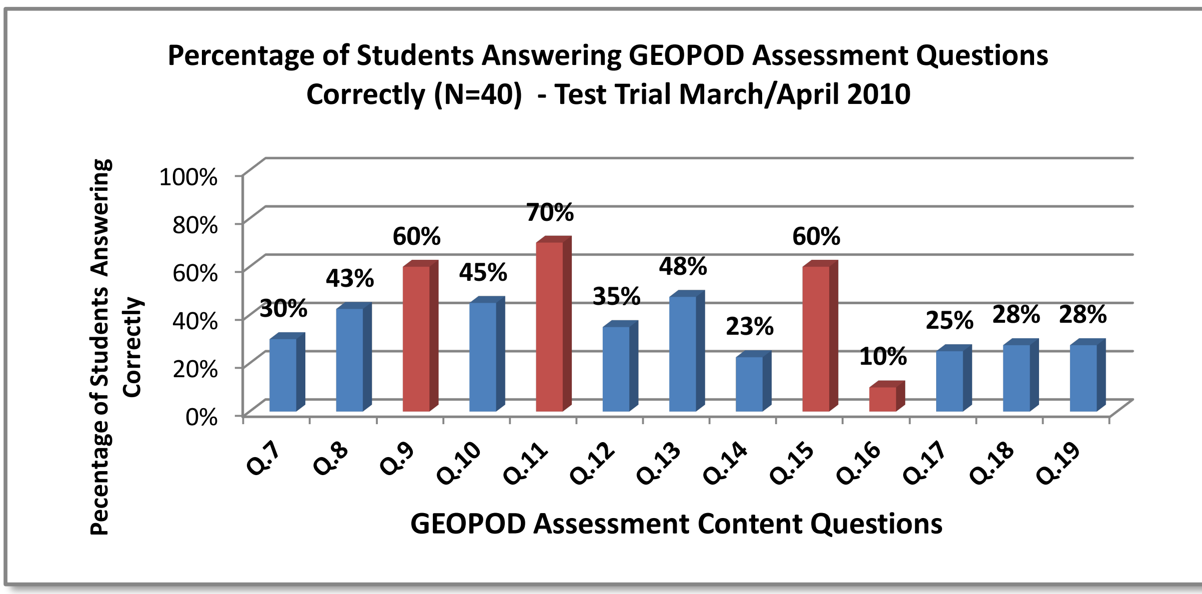
g. **Internships (**e.g., practical experience with the National Weather Service offices, government laboratories, private consulting firms, media and broadcasting stations, or educational institutions.**)**

h. **I have had no applied research experience in the field of Meteorology.**

i. **Other: (Please specify and give an example) ____________________________**

Analysis of Student Responses to Content Questions. Student responses to the thirteen (13) content-related questions on the GEOPOD assessment are displayed in **Figure 3**. As depicted in Figure 3, roughly one-quarter to a half of the students correctly answered nine of the content-related questions (e.g. Questions 7,8,10,12,13,14,17,18, and 19) depicted in *blue* on the Figure 4 graphic. This correct response rate to these items reflects what one might expect from a pretest given to students *before* engaging in the content related to the GEOPOD assessment and at the beginning of their course of instruction, as was the case with this group of students in the pilot. Overall, the correct median response rate for all students on all questions was 38%.

Figure 3. Student Responses to the GEOPOD Content Questions (N=40).



Students correctly answered questions 9, 11, and 15 (depicted in red on the Figure 4 graphic) at higher rate than expected (e.g. 60%, 70%, and 60% respectively). This reflects a higher response pattern than might be expected from students who have not been exposed to the GEOPOD material. This higher correct response rate suggests that these questions needed to be reviewed (**especially Question 11**) to see if the question stem or the response items could be adjusted for a greater difficulty level. Only 10% of the students (4) were able to able to correctly answer Q. 16, suggesting that there may be some problem with the stem question or the response set.

These question items and response sets were discussed at the June 22nd team meeting and the following decisions were made:

- Co-PIs Clark and Yalda will change the response set in Q. 11 to alter the difficulty level.
- Q. 9 and 15 will remain the same as they have an *acceptable* average response rate. Also, Q. 9 and 15, while easier to answer, offer students a feeling of confidence and the motivation to continue with the rest of the exam (i.e. they aren't stumped by every question.)
- Both Co-PIs Clark and Yalda felt that Q. 16 was a good question with a good response set, so we decided to keep that question "as is" in the assessment as it is a good discriminator item.

Subsequent to the meeting, Dr. Clark revised Q. 11 in the assessment question set.

Response rates for male and female students were similar although these sample sizes are too small to do any statistical testing. As depicted in Table 4, median scores for male and female students were both 38%.

Table 4. Response Rates on GEOPOD test by Gender

Gender	Average Number of Items Answered Correctly	Median	Max	Min
Male (29)	4.88 (37%)	5 (38%)	7 (54%)	2 (15%)
Female (11)	5.45 (42%)	5 (38%)	9 (69%)	2 (15%)

Overall, the GEOPOD assessment, except for the questions noted and addressed, appears to be a good measure of pretest knowledge and should serve as a good pre and posttest measure of student learning for both Treatment and Comparison groups.

Findings from the Usability Study

The plans for the Usability Study are ongoing and the study will be carried out and reported on during Phase II of the project. This represents a change in the project timeline.

Section V: Conclusions and Reflections from Phase I Activities and Recommendations for Phase II

The previous sections of this report detailed results of the activities of the GEOPOD project team during Phase I (September 1, 2009-June 30, 2010). This section offers some observations and conclusions from the perspective of this evaluator and presents recommendations for Phases II and III of the project to support future efforts to strengthen teaching and student learning outcomes in the field of Meteorology and other science-related fields.

Conclusions

Conclusion 1: Successful Development of the *GEOpod* and the Student Assessment Instrument. The GEOPOD project team was very successful in completing the primary goals of the project in Phase I: (1) To develop the ***GEOpod*** technology including the platform and the modules or missions for instructional use; and (2) To develop and pilot test an appropriate assessment instrument to determine the extent to which students experience learning gains as a result of using the ***GEOpod*** in their courses.

The successful development of the ***GEOpod*** technology is due in no small part to the diligent efforts of Dr. Zoppetti and his team of student researchers who spent over 1,000 hours, cumulatively, in researching and developing the ***GEOpod***. It appears that the team will meet its goal to have the ***GEOpod*** technology ready for implementation in the classroom during spring or fall term 2011.

Drs. Clark and Yalda effectively designed and successfully pilot tested an assessment instrument that will be used to test Comparison groups in fall of 2010 and Treatment groups in Phase III of the project. This assessment instrument is critical to the project in that it will allow the team to determine, in part, the efficacy of the ***GEOpod*** technology used in instruction and the extent to which students realize learning gains as a result of using the ***GEOpod*** technology.

Three additional activities projected to be accomplished in Phase I have not (at the time of this draft) been completed: The GEOpod Usability Study, a timeline and plan for the training of the instructors to implement the GEOpod, and the development of the GEOpod User's Guide. These are ongoing activities that will be carried out in Phase II.

Conclusion II: Plans for Dissemination of Information on The *GEOpod*. Despite lack of funding to support the planned expert advisory panel for the project, Dr. Clark has developed plans to present the ***GEOpod*** technology at the Unidata meeting scheduled for December, 2010. This will be an excellent opportunity to not only display this technology to a field of professionals in Meteorology, but also to solicit feedback from the greater science community on the benefits and challenges of using this kind of technology in the undergraduate classroom and other venues. Suggestions for improvements and enhancements to the technology will also be solicited from science professionals at this meeting.

Recommendations

Recommendation 1: Training of Faculty and Other Collaborators. The necessity of training for faculty who will implement the ***GEOpod*** technology in the classroom at Millersville as well as those who may adopt this technology in other venues cannot be overstressed. Training is critical in implementing and sustaining any educational innovation for several reasons. First, the training and briefing sessions help faculty understand the project's goals from the viewpoint of the project designers and begin to "buy into" the concept and fully embrace it as their own. Second, during training, faculty begin to understand what is involved in fully implementing and using the technology in the classroom for maximum benefit to students. Third, training and access to follow up technical assistance allow faculty to feel comfortable in asking questions and modifying their instruction to include the ***GEOpod*** technology.

Successfully sustaining innovations in the classroom is dependent on the kind of initial training and follow-up technical assistance that faculty receive (Steven, 2004). Any expansion of the GEOPOD project to other collaborators at other universities and venues would need to include this same level and quality of support for instructors who wish to adapt this technology. It might be possible to utilize the skills of the first cohort of trained professors to assist in the support of any subsequent collaborators.

Recommendation 2. A Project Website. As the project becomes known outside the Millersville community, especially after the Unidata meeting in December, there will be, no doubt, inquiries about the project. It would be helpful to the science community to begin to post project developments on a project website, possibly showing the modules or missions, some suggestions for best practice in using the ***GEOpod***, and the User's Guide. Links to other technologies and related readings in the field, as well as the team's project documents could be posted. Having a project website to refer people to will lessen burden of answering project inquiries and provide valuable information to the field.

Recommendation 3. Expanding the Project to Other Venues. While it is early in the project, there is already evidence that the GEOpod technology will be useful at other universities and in other educational settings. It would be helpful for the project team to begin to explore other institutions that might be interested in adapting this technology for instruction and to bring them into the project as collaborators during Phase II. Since adapting this kind of project to another setting would require careful planning and resources, these efforts should be considered carefully at the beginning.

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