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ABSTRACT

Problem-based learning (PBL) has great potential for inspiring K-12 learning. KaAMS (Kids as Airborne Mission Scientists), an example of PBL, was designed to help teachers inspire middle school students to learning science, math, technology, and geography. The children participate as scientists investigating environmental problems using NASA (National Aeronautics Space Administration) aeronautics and airborne remote sensing data. The general PBL process, characteristics, and impacts on science education and K-12 students served as the theoretical foundation for designing the Web-based KaAMS PBL lesson plans. The conceptual framework of KaAMS, including KaAMS the PBL model and general characteristics of KaAMS learning process emerged from this literature. Twelve lesson plans were developed and tested in the classroom. Formative evaluation results are presented. The paper concludes that through their high quality materials, NASA can make an impact on science in the classroom, which in combination with KaAMS strategies can change teaching practice and impress middle school students with the importance of and strategies for conducting "good science." (Contains 12 references.) (Author/MES)

Designing Web-Based Science Lesson Plans that Use Problem-Based Learning to Inspire Middle School Kids: KaAMS (Kids as Airborne Mission Scientists)

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Running Head: KaAMS Problem Based Learning

Designing Web-Based Science Lesson Plans that Use Problem-Based Learning to Inspire Middle School Kids: KaAMS (Kids as Airborne Mission Scientists)

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Abstract

Problem-based learning (PBL) has great potential for inspiring K-12 learning. KaAMS (Kids as Airborne Mission Scientists), an example of PBL, was designed to help teachers inspire middle school students to learn science, math, technology and geography. The kids participate as scientists investigating environmental problems using NASA aeronautics and airborne remote sensing data. The general PBL process, characteristics, and impacts on science education and K-12 students served as the theoretical foundation for designing the web-based KaAMS PBL lesson plans. The conceptual framework of KaAMS, including KaAMS the problem-based learning model and general characteristics of KaAMS learning process emerged from this literature. Twelve lessons plans were developed and tested in the classroom. Formative evaluation results are presented.

Introduction

Kids can be motivated and inspired by making direct contributions to solving real scientific problems. Can teachers be inspired too? Through a PBL approach, KaAMS, a NASA funded project guides teachers to take middle school children on live and past NASA airborne missions to collect data to study two environmental problems. The ultimate goal of the project was to inspire kids to learn and develop a career interest in science, math, technology and geography by their participating as scientists in activities punctuated by "bursts" of interactive events culminating in the analysis of data from NASA airborne missions. The goal is realized by providing a variety of learning resources to teachers to use with middle school children.

The KaAMS conceptual model (see figure 1) was designed to represent a holistic framework for the project. The relationships among the varied components (e.g., NASA resources, Web-Enhanced Learning Strategies Interface, NASA Mission, web-based PBL learning processes, characteristics of middle school kids, and National Science, Math, Technology and Geography Standards) are shown in this figure. In the center portion, the four phases of the KaAMS PBL process include the problem scenario, propose ideas, conduct the mission, and propose solutions. These phases were selected based on a review of both the problem based learning literature and the scientific process.

Based on this conceptual model of KaAMS, four PBL modules addressing two different environmental problems-active lava flows and the health of the coral reefs in

Hawaii were developed. The modules consisted of new *lesson plans* that could be used flexibly by many teachers, and tap into *existing* NASA and other web resources. The goal was to harness those resources that exist rather than create totally new ones.

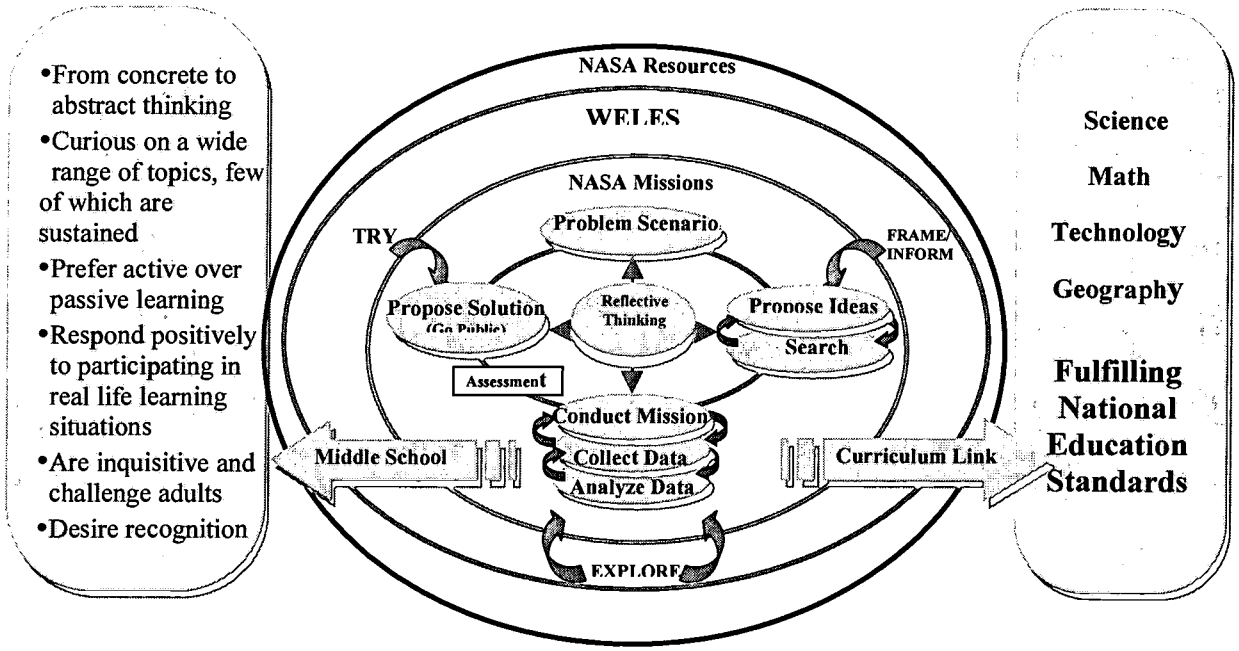


Figure 1. The KaAMS Model

Conceptual Framework of KaAMS Model

Foundation and Components of KaAMS Model

Conceptually, the KaAMS framework, as shown in Figure 1, is built upon the premise and foundation that among all NASA web resources from all aspects of the agency, a multitude of resources can be used in the classroom. These resources are filtered through a second-level premise, which is the Web-Enhanced Learning Strategies (WELES) interface (Koszalka, Grabowski, & McCarthy, 2000). This interface helps to sift through the available resources for elements and composite sites that are appropriate for use by middle school teachers and students. These resources are then used in four parts of a lesson plan—frame/inform/explore/try. The third premise is that teachers can use real web resources from real NASA missions in a problem based lesson format. Finally, these three levels of resources are harvested as part of the KaAMS PBL lesson plans.

Students are presented with an environmental problem for which NASA had collected airborne data on a previous mission. They begin a series of problem-solving lessons from which they develop content and applied knowledge by participating in problem solving activities. Through a series of framing and informing activities, students search for additional information on the problem, develop an understanding of the

science of the problem, and propose a solutions for conducting a mission that will provide remote sensing data to solve the problem. Students become involved in "bursts" of activities to conduct a mission, collect and analyze data. Finally, students summarize their findings in several different ways and "go public" to share what they have learned with classmate and/or other outside their classroom. One important note is that the students participate in reflective activities throughout the entire process.

Links to Middle School Kids

Also evident in the design were the following key characteristics we found about middle school students (This We Believe, 2000).

- Moving from concrete to abstract thinking
- Curious on a wide range of topics, few of which are sustained
- Prefer active over passive learning
- Respond positively to participating in real life learning situations
- Are inquisitive and challenge adults
- Desire recognition

Each of the problem-based learning modules involves students in active, concrete activity bursts during which the students reflect on their learning.

Links to National Standards

To maintain the link to the National Standards, we have completed an analysis of the NSTA/NRC standards and the AAAS Project 2061 Benchmarks to target in the KaAMS Project. Each lesson plan links to the specific national education standards that might be satisfied by completing the lesson activities

Flexibility of KaAMS Learning process

Since flexibility is very important to maximize the usability of this site, we have designed the site for the teacher. The framework is constructed so that the teacher is in control of how much and what types of the available activities that his or her students actually see. He or she can start from Phase 1 and proceed to Phase 4, or he or she can just go the activities of Phase 3, for example.

Understandings from Problem-Based Learning

The conceptual framework of the problem-based learning model for KaAMS is based on the perspectives from the problem-based learning literature. Problem-based learning as an instructional model is associated with the new learning-centered paradigm (e.g., Reigeluth, 1999). PBL, in general, encourages the students to develop deep understanding within a knowledge domain and problem solving skills by engaging them in the learning process and activities to solve real world, authentic problems (Duffy & Cunningham, 1996; Hmelo & Evensen, 2000). According to PBL researchers (Barrows, 1986, 1992; Hmelo & Evensen, 2000; Savery & Duffy, 1995; Schwartz, et al, 1999), PBL

include the following six key characteristics. Real world problem as the learning context: real-world problems with a motivational context drive students' learning. A real world problem is used as a focus or stimulus for the student to get involved in learning activity. Student generated learning goals: given a problem space, students generate their own learning goals by questioning what they know, what they don't know but need to know, and how to know it. Student access to multiple learning resources: multiple learning resources include print, electronic and humans. With access to rich and varied information, students are able to develop a deep understanding about the content related to the problem so that they may apply that knowledge to the problem at hand. Students as active problem solvers—experimenting, gathering data, reflecting, collaborating and communicating: students as active problem solvers work with their peers, teachers, and experts to share their different perspectives. By engaging students, they must exhibit problem solving skills, reflective thinking skills, and collaboration and communication skills. While being engaged in the process, students can assume the roles of various participants involved. Finally, teacher as coach or facilitator: teachers play a role as coaches or facilitators that support students' learning and problem solving activity, rather than directly teaching entirely what students should know and how students should solve a problem.

The PBL learning process, cycles students through the following five learning stages (Barrows, 1986, 1992; West, 1992): *students are presented with a problem, students develop a plan-- generate what they know and what they need to know and list possible actions, students collect information, analyze data and present and share* solutions.

- *Students are presented with a problem*—A real world problem is presented to students, and students get clarification about the problem.
- *Students develop a plan:* Generate what they know and what they need to know, and list possible actions—Students actively define problems and generate what they know and what they need to know based on their prior knowledge and experience. They are encouraged to identify learning issues or knowledge necessary to construct an understanding about how to solve problems. Students then discuss and generate strategies and activities for solving the problem.
- *Collect information—the student engages in gathering information from available learning resources ranging from print-based materials, electronic and human resources (e.g., peer, teacher, and expert).*
- *Analyze data*-- after gathering the information, they analyze and evaluate information in terms of what is most useful or what is not useful to solve the problem. They discuss and negotiate their perspectives about alternative solutions with peers, their teacher, and experts
- *Present and share solutions*— finally, students propose their solutions, share them with their peers and experts who might provide different perspectives to the solutions, and revise their solution based on feedback from their peers or experts.

PBL has been implemented in diverse content domains such as medical education,

business education, social education, and science education. Many researchers have investigated the effectiveness of PBL, especially in medical education. According to Hmelo and Evensen (2000), the results of PBL research in medical education have showed that students who engaged in PBL were able to solve problems and transfer their learning better than students who studied under a conventional learning approach. However, there have been few PBL research studies focused on middle or high school science education. In one study, West (1992) addressed the benefits of PBL used in secondary school science classrooms. He concluded that PBL could be an effective instructional strategy or technique to stimulate students' science interest, enhance knowledge construction and problem solving skills, and integrate science with other knowledge domain.

Through the PBL literature, as described above, some design considerations and strategies were incorporated into the KaAMS learning process. The following section illustrates these design considerations and strategies.

Incorporating PBL and the Scientific Process into KaAMS

The PBL learning process defined from the literature and the scientific process used by NASA scientists for solving environmental problems are similar, making the creation of PBL lesson plans for middle school kids using NASA missions a natural development. This cross over also made explaining the learning process to content experts very easy.

First, the PBL process was streamlined into four learning phases in the conceptual model that naturally match the evolution of a lesson plan—frame, inform, explore and try from the Web-Enhanced Learning Environment strategies framework (Grabowski, Koszalka, & McCarthy, 1999). See figure 1. KaAMS phase 1 is to present the scenario. At this point in the process, learning is framed by the context of the problem. Students obtain clarification about the problem and what their task is. During phase 2, students propose ideas and search for information. This is the inform phase. Students create a plan of study and review background information that will help them clarify issues surrounding the problem so that they can plan for conducting a NASA mission that will generate data to help them solve the problem. The third and fourth PBL phases were combined into one, conducting the mission. During this learning phase, students explore by collecting and analyzing actual NASA data. In the last phase, the students try out their knowledge by proposing solutions in a public forum (Go public) (Schwartz, Lin, Brophy and Bransford, 1999).

The scientific process follows the same path, but with a purpose of solving a real problem, versus having learning as its primary goal. In this process, scientists identify the problem, research ideas and develop a plan for investigation, collect and analyze data and report their findings. The phases of the PBL process from the literature, the learning phases of KaAMS, and the scientific process are mapped together in Table 1.

The last column exemplifies how these phases were actualized in the KaAMS project.

Table 1. Mapping KaAMS onto PBL and the Scientific Process

PBL Process	Scientific Process	KaAMS	Design Examples
Problem Presentation and Clarification	Identify Problem	Problem Scenario	• Two problems—finding lava flows for the Pacific Disaster Center, and determining if the coral reef need protection for a real Congressional Executive Order
Plan Development -what they know -what they need to know -list actions	Research ideas and Develop plan for investigation	Propose Ideas/Search for Information	• Activity Sheets as Who, What, When, Where, Why and How questions to determine what the students know • Students complete reflection journals • Find information using existing NASA web resources • Participate in activity bursts to explore new concepts
Collect Information	Collect Data	Conduct Mission and Collect Data	• Students think critically about which aircraft can run their mission and select from several possibilities • Students plan the actual mission and compare it to the actual NASA mission
Analyze Information	Analyze Data	Analyze Data	• Students use actual data from the live missions to draw conclusions • Students use guidelines from NASA scientists for interpretation of their data
Present Solutions	Report Findings	Propose Solution: (Go Public)	• Write a report to the Pacific Disaster Center, • Make recommendations to the President in response to his executive order

Example of KaAMS "Active Lava Flows in Hawaii" Lesson Plans

Lesson Plans: Mission I – Active Lava Flows in Hawaii

This mission, Active Lava Flow in Hawaii, puts the students in the role of Airborne Remote Sensing scientists concerned with identifying where the lava flows are active on the Kilauea volcano. This mission consists of 12 lesson plans that are organized in four learning stages associated with the processes of PBL and scientific inquiry, as described above.

Figure 2 shows the main screen of this mission that includes a visual representation of its learning cycle to help teachers understand the relationships between lesson plans and where each fits within the entire learning process of KaAMS.

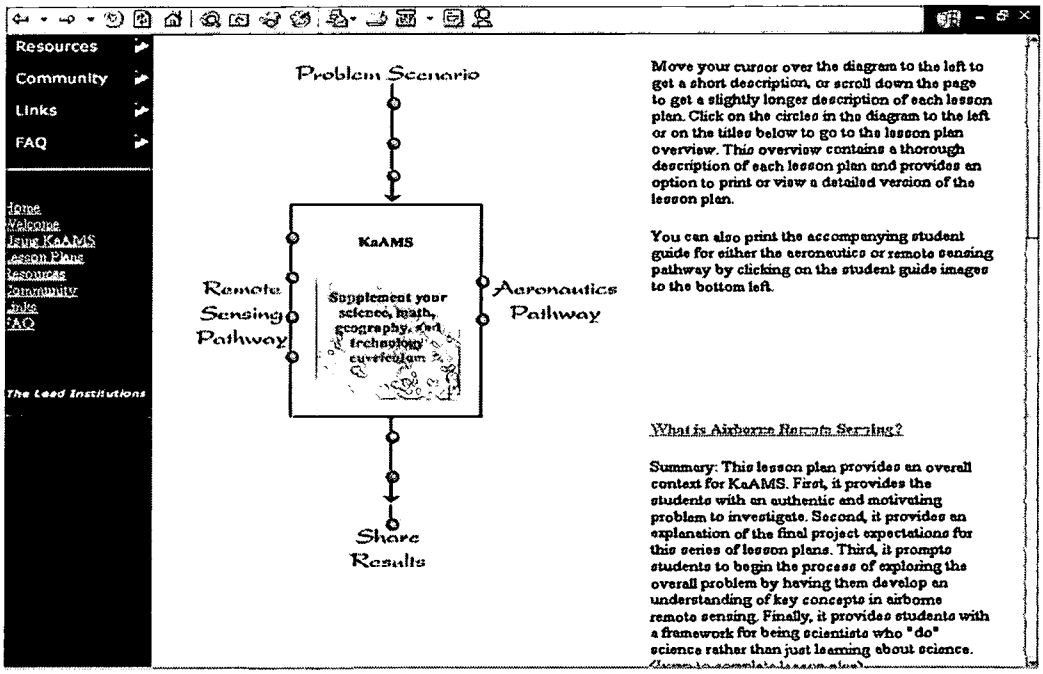
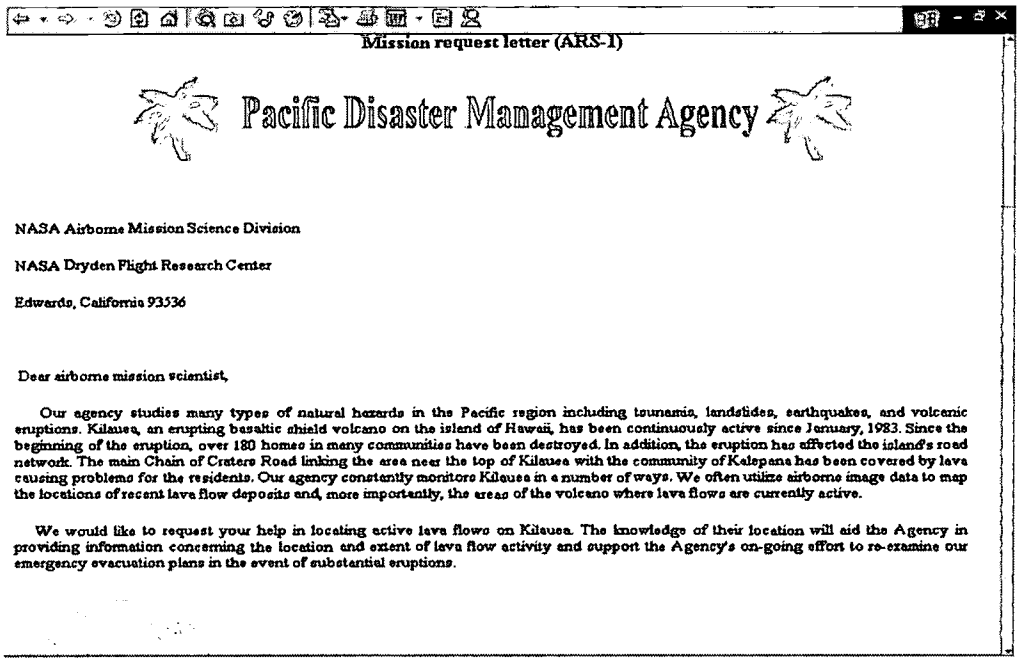


Figure 2. Main Screen of Mission I - Active Lava Flow in Hawaii

Learning Phase 1: Problem Scenario

To motivate students and promote their engage in an authentic problem, the problem scenario requests that students function as airborne mission scientists to investigate the location of active lava flows on the Kilauea volcano, one of the world's most active volcanoes (see figure 3). The problem scenario prompts students to begin the process of exploring the overall problem by having them develop an understanding of key concepts such as aeronautics, remote sensing, and airborne remote sensing. It also provides students with a sense of being airborne mission scientists who use aeronautics principles and remote sensing data to study an environmental problem of the earth.



Mission request letter (ARS-1)

Pacific Disaster Management Agency

NASA Airborne Mission Science Division

NASA Dryden Flight Research Center

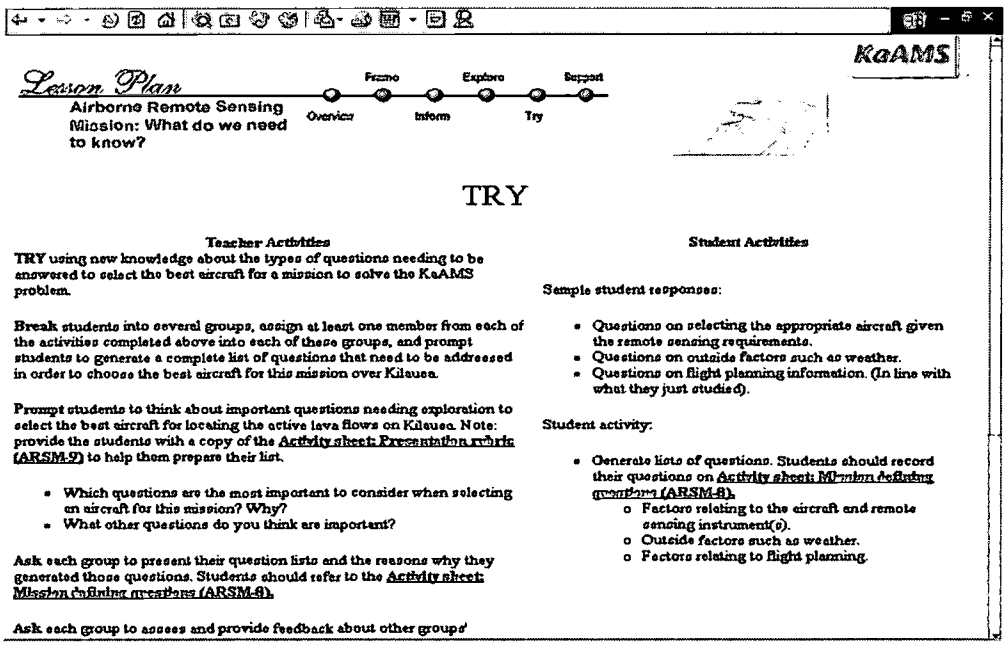
Edwards, California 93536

Dear airborne mission scientist,

Our agency studies many types of natural hazards in the Pacific region including tsunamis, landslides, earthquakes, and volcanic eruptions. Kilauea, an erupting basaltic shield volcano on the island of Hawaii, has been continuously active since January, 1983. Since the beginning of the eruption, over 180 homes in many communities have been destroyed. In addition, the eruption has affected the island's road network. The main Chain of Craters Road linking the area near the top of Kilauea with the community of Kalapana has been covered by lava causing problems for the residents. Our agency constantly monitors Kilauea in a number of ways. We often utilize airborne image data to map the locations of recent lava flow deposits and, more importantly, the areas of the volcano where lava flows are currently active.

We would like to request your help in locating active lava flows on Kilauea. The knowledge of their location will aid the Agency in providing information concerning the location and extent of lava flow activity and support the Agency's on-going effort to re-examine our emergency evacuation plans in the event of substantial eruptions.

Figure 3. An Example of the Problem Scenario



KaAMS

Lesson Plan

Airborne Remote Sensing Mission: What do we need to know?

Frame Explore Support

Overview Inform Try

TRY

Teacher Activities

TRY using new knowledge about the types of questions needing to be answered to select the best aircraft for a mission to solve the KaAMS problem.

Break students into several groups, assign at least one member from each of the activities completed above into each of these groups, and prompt students to generate a complete list of questions that need to be addressed in order to choose the best aircraft for this mission over Kilauea.

Prompt students to think about important questions needing exploration to select the best aircraft for locating the active lava flows on Kilauea. Note: provide the students with a copy of the Activity sheet: Presentation rubric (ARSM-9) to help them prepare their list.

- Which questions are the most important to consider when selecting an aircraft for this mission? Why?
- What other questions do you think are important?

Ask each group to present their question lists and the reasons why they generated those questions. Students should refer to the Activity sheet: Mission defining questions (ARSM-8).

Ask each group to assess and provide feedback about other groups'

Student Activities

Sample student responses:

- Questions on selecting the appropriate aircraft given the remote sensing requirements.
- Questions on outside factors such as weather.
- Questions on flight planning information. (In line with what they just studied).

Student activity:

- Generate lists of questions. Students should record their questions on Activity sheet: Mission defining questions (ARSM-8).
  - o Factors relating to the aircraft and remote sensing instrument(s).
  - o Outside factors such as weather.
  - o Factors relating to flight planning.

Figure 4. An Example of "Propose Ideas" Learning Phase

Learning Phase 2: Propose Ideas and Search Information

After studying the problem scenario, the learning stage of "Propose Ideas and Search Information" encourages teachers and students to propose their initial ideas of what they need to know to solve the problem and ways they might solve the problem (see

figure 4). They are encouraged to explore existing NASA web resources to learn the basic science necessary to solve the problem. A lesson plan within this learning stage, for example, presents a variety of learning activities for students to develop an understanding of who airborne mission scientists are, how they explore the world, and how these scientists work together.

To support these activities, a guided reflective journal for students is provided. Students are encouraged to write their own reflective journals while participating in activity bursts to explore new concepts and principles such as aeronautics, remote sensing, the roles of airborne mission scientists, and characteristics of volcanoes and lava flows. The reflective journal helps students reflect on what they have learned throughout the learning processes of KaAMS.

Learning Phase 3a: Conduct Mission

After searching information and developing an understanding of the problem, students are given an opportunity to select which NASA aircraft they will use to run their mission to collect actual data (see figure 5). In this learning stage, students are prompted to think about how data can be collected using airborne remote sensing aircraft by taking part in a kite aerial photography activity. To support students' learning in this learning stage, for example, several hand-on activities such as flying a kite, developing film, and analyzing data images are provided for students.

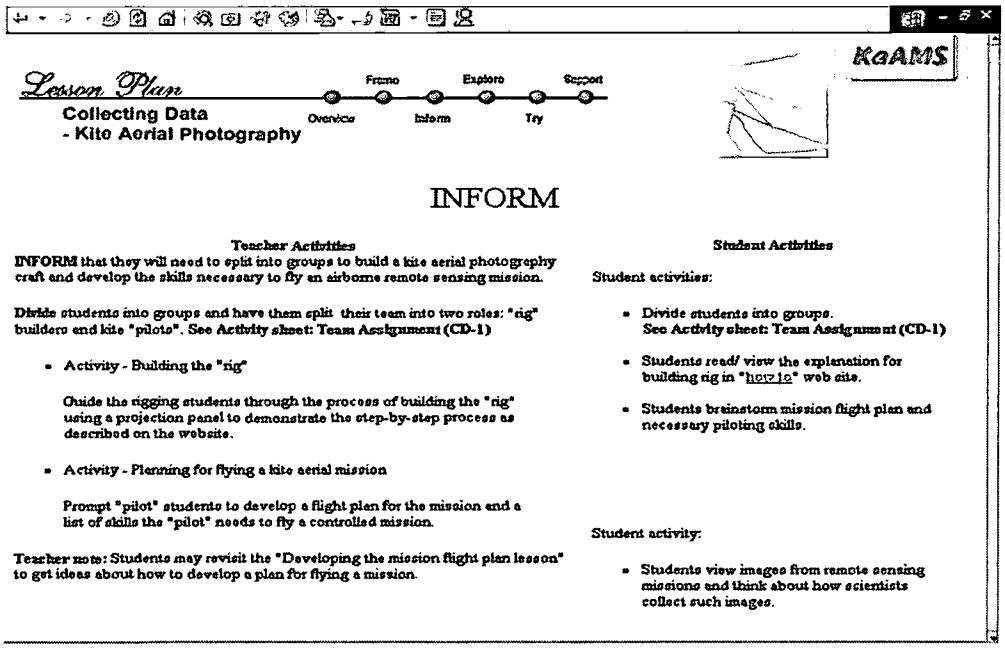


Figure 5. An Example of "Collect Data" Learning Phase

After collecting the data, students participate in numerous activities to learn how to analyze and interpret both visible and infrared remote sensing images (see figure 6). They analyze and interpret two actual NASA images about Kilauea volcano to locate the active

lava flows. To support these learning activities, rich visual images existed in NASA websites and guidelines from NASA scientists are provided for students to analyze and interpret their data. These supports help students to understand how to interpret the data and then find the location of active lava flows.

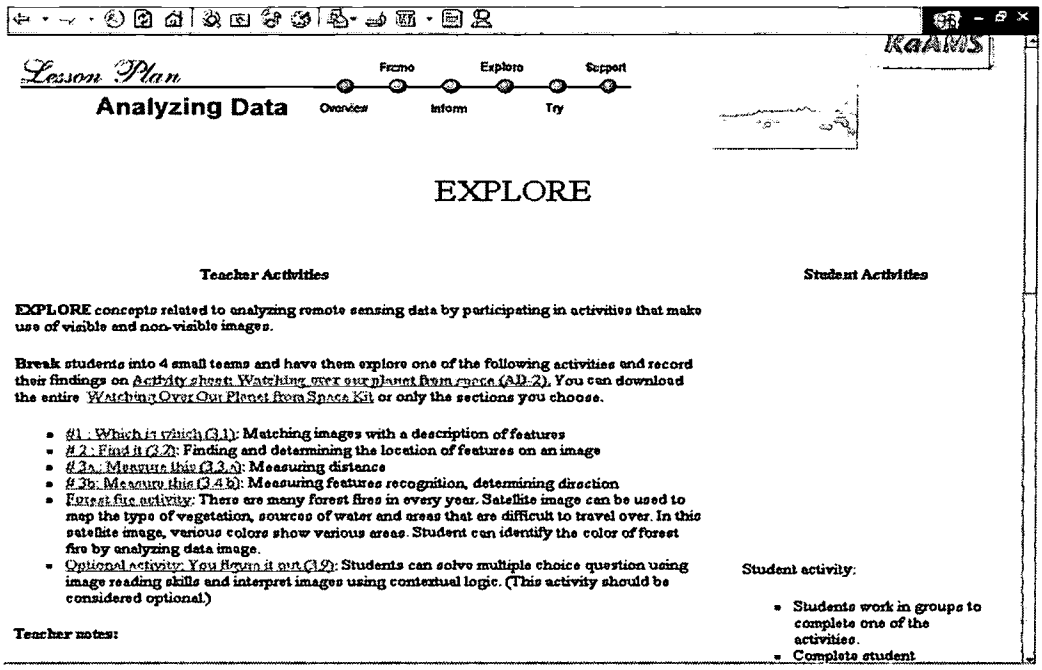
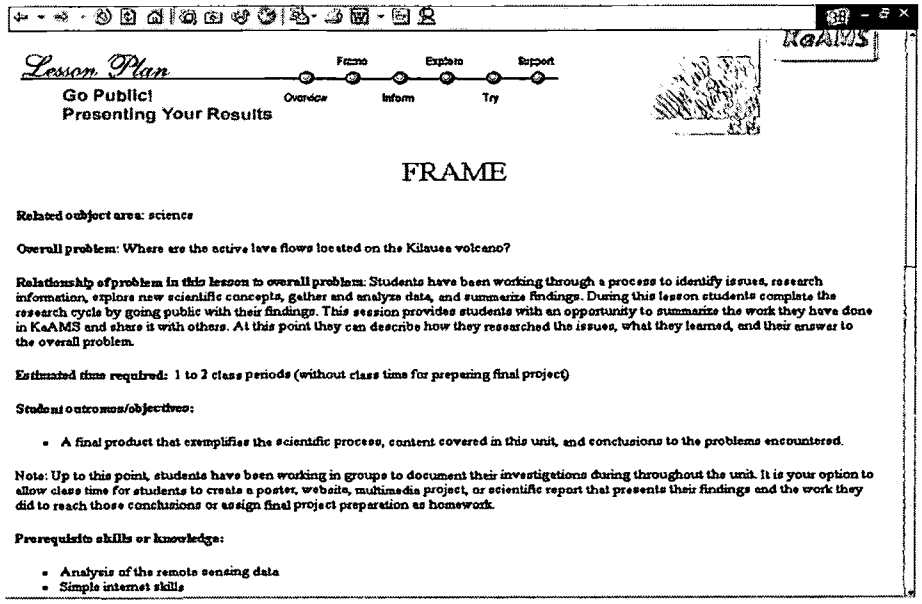


Figure 6. An Example of "Analyze Data" Learning Phase

Learning Phase 4: Propose Solution

After analyzing and interpreting the data, students write results of their investigation for the KaAMS mission, locating the active lava flows on Kilauea (see figure 7). Each student group presents the best solution and shares it with the other students and teachers. After all the solutions are presented, students have an opportunity to revise their solutions based on feedback from their peers, teachers, and experts before making their final statement. With this statement, they complete their investigation and mission.



Lesson Plan

Go Public!
Presenting Your Results

Frame Explore Support
Overview Inform Try

FRAME

Related subject area: science

Overall problem: Where are the active lava flows located on the Kilauea volcano?

Relationship of problem in this lesson to overall problem: Students have been working through a process to identify issues, research information, explore new scientific concepts, gather and analyze data, and summarize findings. During this lesson students complete the research cycle by going public with their findings. This session provides students with an opportunity to summarize the work they have done in KaAMS and share it with others. At this point they can describe how they researched the issues, what they learned, and their answer to the overall problem.

Estimated time required: 1 to 2 class periods (without class time for preparing final project)

Student outcomes/objectives:

- A final product that exemplifies the scientific process, content covered in this unit, and conclusions to the problems encountered.

Note: Up to this point, students have been working in groups to document their investigations during throughout the unit. It is your option to allow class time for students to create a poster, website, multimedia project, or scientific report that presents their findings and the work they did to reach those conclusions or assign final project preparation as homework.

Prerequisite skills or knowledge:

- Analysis of the remote sensing data
- Simple internet skills

Figure 7. An Example of "Propose Solution" Learning Phase

Across each learning Phase of KaAMS, the following characteristics of PBL can be found:

- Authentic, ill-structured problem situation
- Assumption of roles by the students
- Reflections about what they know, what they need to know
- Planning the investigation procedure
- Access to rich NASA web resources
- Active investigation
- Learning activities situated within real NASA missions
- Reflective thinking exercises
- Peer and expert collaboration
- Learner activities/tools in interpreting data gathered
- NASA scientist support
- Shared solutions with peers and experts

Formative Evaluation of KaAMS

Overall Assessment and Research Strategy of KaAMS

The assessment strategy for the entire KaAMS project was divided into three major phases designed to capture data that would support initial product development (alpha testing), on-going resources development and implementation planning (beta testing), and the KaAMS impact on the stakeholders in the learning environment (research-impact analysis). See Figure 8. The diagram below illustrates the flow of alpha, beta, and

research processes used for each of the two major products developed; (1) lava flow and (2) coral reef missions. This report summarizes overall data collection methods and procedures as well as the findings from the alpha development for the lava flow Mission.

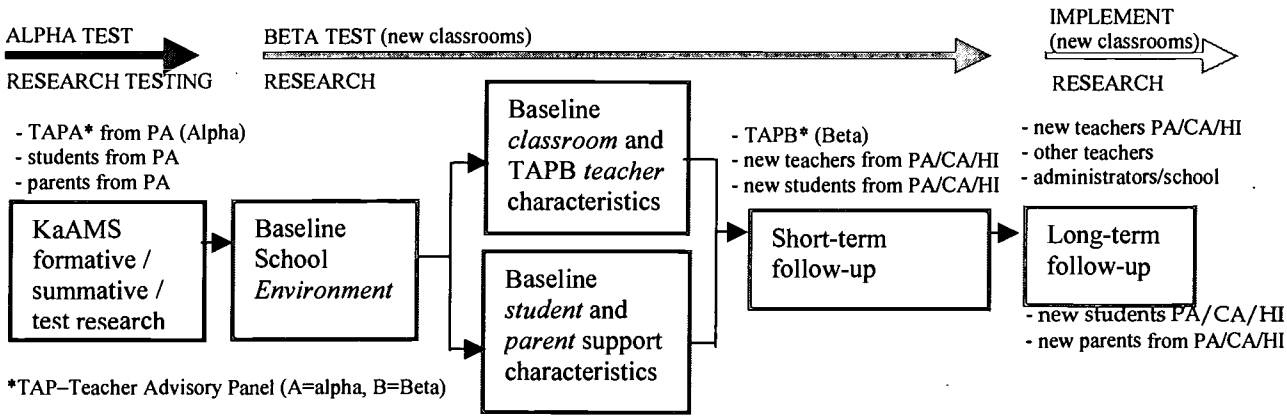


Figure 8. Overall Assessment and Research Strategy

Method of Formative Evaluation

During the Alpha testing, formative and summative evaluation data were collected. With project enhancement in mind, data collected from key stakeholders included five levels of assessment: (1) reaction, (2) learning gains, (3) performance, (4) education system changes, and (5) impact on the greater society. Research protocols were also tested to assess their effectiveness in measuring the effects of KaAMS materials on teachers, students, and stakeholders in the surrounding community, namely parents. See Table 2.

Table 2: Research questions and assessment

Research Questions	Assessment
• How are teachers using KaAMS and NASA resources?	Performance
• How are teachers changing their teaching practices (e.g. teaching strategies, incorporation of NASA resources, etc.) over time as a result of using KaAMS and NASA resources?	Performance/ System Change
• How are student levels of interest in pursuing science-related career changing over time as a result of using KaAMS and NASA resources?	Learning Gains
• How does the use of KaAMS diffuse to the surrounding school system?	Impact on Greater Society

All formative evaluation instruments were administered throughout the alpha testing phases to gather feedback from teachers while preparing for and using the KaAMS materials. Interviews, observations, and focus groups were also conducted at least once per week with teachers and students during the 6-month alpha classroom trials. The summative instruments were administered to teachers at the end of the KaAMS classroom trials and final interviews and focus groups were conducted with teachers and students. The research instruments were administered to teachers and students for pre- and post-test data collection and at and additional 1-month follow-up period for students. Parents were surveyed at the beginning and end of the school year.

Participants

Three middle schools in a rural Pennsylvania school district participated in the KaAMS alpha test classroom trials, East, West, and Distant. Six different classrooms from these schools were actively involved. Four were 6th grade, one was 7th grade, and one was an 8th grade honors class. The six teachers who participated provided data about themselves, their classrooms, and success of using KaAMS materials during the alpha testing cycle. Teaching experience ranged from 3 to 23 years; initial preferences for primary teaching strategies included hands-on activities, collaborative activities, role play, and problem-based learning; half of the teachers had moderate success using web resources in their classrooms the other half had not used such resources in their classrooms.

Data were collected from a total of 144 students, 82 were boys, 59 girls and 3 did not respond to the gender question. On average, the students had a moderate level of interest in pursuing science.

One hundred and fifty three parents of KaAMS students returned surveys indicating their initial perceptions of science in their school and child's success and interest in science as well as reporting their highest attained level of education. A majority of the parents did not have college degrees, worked in non-science related jobs, and had a neutral opinion of their child's school's science program.

Measures and Instruments

Formative and Summative evaluation: A series of instruments, observation protocols, and interview protocols were developed to collect formative and summative data from the teachers and students during the alpha testing development cycle.

Teachers were asked to review the KaAMS lesson plans, prepare to use the lesson plans in their classrooms, and complete evaluation surveys after each lesson and at the end of the trial indicating ease of use; value of resources, instructions, and assessment guidelines provided; success of activities; amount of preparation time; descriptions of the classroom activity during KaAMS lessons; and general feelings about using KaAMS for teaching and learning. Teachers were also asked to share feedback during interviews and focus groups including responses to questions such as: What did you like/not like about the supporting website? What parts of the lesson plans did you use - why? What additional support materials did you need to use these materials? What additional

materials did the students need? What would you change?

Periodically students were asked, during interviews and focus groups, to respond to questions such as: What did you like/not like about the KaAMS activities? How useful were the internet sites? What was happening in the classroom during KaAMS? What did you learn? and what would have made these activities more useful to you? Observational data were collected several times during the classroom trial that lasted between 3 and 6 months, depending on the classroom teacher. Observation data were collected on how the teachers used the materials, how the students participated in the activities, and artifacts developed by the teacher or students during the KaAMS lessons.

Research: The research questions were focused on the teachers, students, and parents. Teachers completed an on-line instrument eliciting background information, preferences for classroom activities, and attitudes toward the use of web resources in the classroom. The instrument was a combination of an attitude survey previously developed and validated for similar research (Koszalka, 2000), a series of questions related to perceptions of their school's ability to support the use of internet technology in the classroom (McCarthy, Grabowski, & Koszalka, 1998), and preferences for teaching styles (Grabowski, Koszalka, & McCarthy, 2000; Koszalka, Grabowski, & McCarthy, 2000). This instrument was administered at the beginning of the classroom trial period and the end (pre-post test).

Data were collected on student level of career interest in science, pre-, post, and 1-month after using KaAMS materials. Student career interest surveys were purchased from the APA. The survey also included a series of questions developed to assess reflective thinking (Koszalka, Song, 2001) and gather demographic data.

Parents were asked to complete surveys at the beginning and end of the school year to assess their perceptions of their child's school's science program. The questions were taken from previous research on measuring parents' perceptions of school programs.

Results

The initial formative feedback provided guidance in designing support structures for the KaAMS website that helped the alpha teachers connect NASA science to their curriculum and prompt active student involvement, as scientists, during science class. The results from the formative and summative evaluation resulted in: development of enhanced lesson plan structures for the KaAMS website, new content support for teachers that strengthened the relationship between the overall problem scenario and learning activities, further instructions to 'coach' teachers in using PBL, web technology, and activities that prompt student reflection, stronger ties between lesson plans and national education standards and curriculum requirements, and enhanced activities that will better meet kids' needs.

The initial research findings from the pilot classrooms were very encouraging. Although caution is warranted in interpreting these results, analysis of the research data collected during the alpha testing cycle showed significant, yet minor changes in teachers, students, and parents after the use of KaAMS in the classroom. Table 3

summarizes research findings in accordance with the KaAMS project research questions:

Table 3. Research questions and Alpha Preliminary Findings

Research Questions	Alpha Preliminary Findings
• How are teachers using KaAMS and NASA resources?	• Teachers noted the flexibility of KaAMS resources and used them in a variety of ways to enhance or change the way they teach.
• How are teachers changing their teaching practices over time as a result of using KaAMS and NASA resources?	• Several of the teachers tried new ways of integrating the web and collaborative activities into their teaching; changed their preferred method of teaching and the types of resources they used regularly in their classrooms, and their attitudes toward using web resources in the classroom.
• How are student levels of interest in pursuing science-related career changing over time as a result of using KaAMS?	• Significant increases in student level of science career interest
• How does the use of the KaAMS products diffuse to the surrounding school system?	• Parent perceptions of their child's school's emphasis on science, school's ability to provide good science experiences, and use of appropriate science resources were higher at the end of the school year than in the beginning.

Conclusions

We believe that we are providing teachers with a venue and structure for using NASA web-based materials in their classroom in meaningful and contextualized ways that will support student knowledge development in the content and processes of science. Through their high quality materials, NASA can make an impact on science in the classroom, which in combination with KaAMS strategies can change teaching practice, impress middle school kids with the importance of and strategies for conducting good science—the ultimate goal being to influence career aspirations of these kids toward science.

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