AlgebraJamN Website Design Document

By Paul McCreary

Executive Summary

This is a website to support the activities of the AlgebraJamN project at Xavier University of Louisiana.

About AlgebraJamN

The primary purpose of AlgebraJamN is to provide the means by which New Orleans high school instructors can teach algebra-level skills *and* high-end technology use. The algebra and pre-algebra skills are the content of computer-based lessons. The computer algebra system, *Mathematica*, is the primary software used in the project. This computer algebra system is specifically designed as a high-end computational tool for scientists and mathematicians. Using *Mathematica*, we are able to generate computer animations based on student answers. The animations and still graphics are used as visual cues to indicate correctness of student answers. These graphic cues are based on advanced mathematics that serves as the core of a graduate-level course for in-service teachers. High school teachers who learn or recognize this mathematics in their students' lessons will have a powerful tool that extends the lessons to challenge the quickest and the brightest in any classroom.

The lessons are currently used by groups of students gathered about one or two computers. Collaboration among students is an important feature of the mathematics lessons and of the supporting technology. Students helping other students is a natural development, especially when the new technology is introduced. Individuals who learn the computer ropes quickest instruct their immediate associates, who in turn help spread the "constructed" knowledge of how to operate with the computer algebra system. (One student might ask, "Why won't my cell execute?" and another reply, "Maybe you forgot a semicolon, like I did yesterday.")

If an excelling student is asked to show what they have newly learned to some of their peers, the means to do so successfully is immediately at hand. The graphics in the lessons are there for all to view and for the student to use as a visual aid in explaining new discoveries. There is a second area of challenge that can be extended to more motivated students. The computer code in *Mathematica* is itself a sophisticated programming language. Students modify the code in very rudimentary ways to change colors and object sizes in the graphics. More motivated students can be prompted to investigate the *Mathematica* code at more sophisticated levels.

About the AlgebraJamN Website

The most recent versions of the project lessons will be posted on the AlgebraJamN web site so that they are available to download at participating schools. Regular communication among participants during the academic year will be facilitated through the web site and a direct link to the WebBoard at the Center for the Advancement of Teaching at Xavier University. An interactive instruction page at the web site will lead novice users through the steps necessary to make the online connections for tutoring and consulting.

Statement of Purpose

Our use of high-end technology in the AlgebraJamN project serves as a natural context for two levels of learning, namely, an algebra/pre-algebra course for high school students and a graduate level course for in-service high school teachers. The advanced mathematics lie in the graphic animations that serve as visual cues in the lessons for the high school students. The graphics and background mathematics have been carefully chosen to be closely associated with each topic facing students in the lesson.

There is unquestionably considerable value in students and teachers learning about high-end technologies. One might wonder about the feasibility of incorporating and using technologies in most existing classroom settings. Many envision a massive infusion of money being necessary for hardware and software acquisition. We believe this not to be the case. We recognize that the current high school mathematics curriculum is packed to overflowing with basic and essential skills. However, learning technical skills can be woven into lessons on basic mathematics skills in such a way that the two support each other and, in the end, do not require more learning time.

Choice of high-end technology

Our choice of a computer algebra system (CAS) was guided by two considerations. We needed robust and versatile software to produce computer animations within the lessons and allow teachers to modify exercises on the spot. We also chose software that will provide a powerful tool for student investigation in group projects and in subsequent mathematics and science courses. The computer algebra system that we chose, *Mathematica*, is more sophisticated than strictly required for the animations and graphics in the lessons. Consequently, it presents more difficulties for the students and teachers who are novice users. However, these difficulties can be readily overcome in the context of students helping other students. Further, the value added by students learning to operate with the high-end software makes the additional effort well worth it. The CAS provides a natural context to insert computer animations that are generated from student responses to exercise problems. That is, students enter their numeric answers to exercises and the computer uses those numbers to produce the graphic cues to let the students know if their answer is correct or not. Further, those graphic cues have been carefully chosen to incorporate mathematics that is an embodiment of the same elementary mathematics skills that are the content of the lesson for the high school students, but at a more advanced level. This additional and highly enriching material can be used by teachers to challenge the quickest and brightest students in their classes in the context of the same lessons used by the entire class.

Students helping other students

An apprenticeship approach is used to handle many of the technical skills that students must learn. Students show each other how to operate the computer and how to interpret the responses to their computed answers. Using online communication links, students can collaborate with those in other schools and consult with university tutors and mentors.

Online communication links

Copies of the computer-based lessons are available to download from AlgebraJamN's web site. These lessons require a copy of the software *Mathematica* in order to operate. We use a variety of software applications to facilitate communication among participants. Currently we organize direct email messages among participating individuals and online discussions through a WebBoard set-up through the Center for the Advancement of Teaching at Xavier University. We are preparing to use Timbuktu and C-u-see-me to facilitate tutoring between university undergraduates and high school students.

Positive effects on high school students of early exposure to high-end software

Our use of the high-end software does not take away from "regular" curriculum topics and activities in pre-algebra and algebra classes. Indeed, the lessons we have developed help integrate the existing curriculum and the use of equipment in technology-rich classrooms. Certainly, there is no "extra" time available in the high school mathematics curriculum. High school teachers are acutely aware of this issue. If new technology skills are added in, as it were, this can only be done if the addition provides an increased efficiency in learning the basic, existing skills in the curriculum.

Comments about the software *Mathematica*

The computer algebra system, *Mathematica*, is sufficiently powerful and versatile to be used by curriculum developers to produce interactive animations. It is very extendible, making it extremely valuable for students in their future work. Wide exposure among a high school student population presents a valuable resource for instructors of upper-level courses. With a student population that is known to be adept with a computer algebra system, a teacher can plan lessons, assignments, and projects that build on this tool. Students and teachers who have experience using *Mathematica* as an analytic tool will provide an immensely valuable resource for themselves, their peers, and their colleagues. Instructors who introduce the software will find a receptive audience among their students who recognize the shift away from "business as usual". These students are consequently more willing to modify their classroom behavior. Teachers and interns can be introduced to using *Mathematica*-based lessons through organized in-service sessions.

Two computers are enough

One extremely important goal of this project is to stay within the realm of the technology already available in New Orleans high schools. In many cases, particularly if the lessons are used as materials to supplement exiting text and curricula in pre-algebra and algebra classes, it is not necessary for a class to have a computer for each student. Two computers are enough to make a substantial impact on student learning and on classroom activities. Small groups gathered around each computer can facilitate collaboration. Students are in a position to naturally and effectively help each other. We can also help arrange for modest upgrades when a key component is missing from the high school's technology infrastructure.

Graduate-level in-service high school teachers' course

By design, these lessons also provide a context for a graduate level course in which the high school instructors can learn from the very same lessons provided to their students. Note that this bridges the gap between what teachers learn in "enrichment" workshops or in-service institutes and what they can implement from these workshops into their own classrooms.

Content Outline

I. INTRODUCTION

We introduce the AlgebraJamN project because the purpose of the web site is to facilitate this project's activities. The goal of the of the project's web site is to facilitate the links between New Orleans high school students and teachers, on the one hand, and Xavier University undergraduates and faculty, on the other hand. This is made possible by online applications that allow tutors and mentors to communicate in real time online. The high school teachers will be contacting Xavier to consult about teaching computer-based lessons and about using the high-end software. The web site will serve as a distribution point for new lessons and for the communication link for tutor/mentors.

- A. Mission statement (one sentence).
- B. Executive summary (one page).
- C. Project statement (several pages).
    1. Computer algebra system (CAS).
    2. Students helping students.
    3. Two computers are enough.
    4. Online connections.
    5. Technical support.

II. LESSONS

The algebra and pre-algebra lessons used in the project are based in the computer algebra system *Mathematica*. They produce animations from student responses to exercises. The animations give visual cues about correctness of student answers and mathematics behind each animation is related to the mathematics of the exercise in question. Finally, the mathematics behind the animations is used as the core of a graduate-level course for inservice teachers.

- A. Instructor versions
- B. Student versions
- C. Preliminary sketches
- D. Recent arrivals, recently produced by high school teachers

III. ABOUT THE SOFTWARE

About the software used in the project.

- A. The primary software used by the AlgebraJamN project is the computer algebra system, *Mathematica*. This provides the software context for the lessons developed to teach algebra and pre-algebra in high school courses.
    1. *Mathematica*.
- B. The web editing software has been used by project participants to produce the pages at this web site.
    2. Homesite.
    3. BBEdit?
- C. The online communications software provides the means by which Xavier undergraduate tutors contact New Orleans high school students who are using project lessons and have questions.
    1. Timbuktu
    2. CuSeeMe

IV. ABOUT THE PARTICIPANTS

The participants of the AlgebraJamN project are a diverse group of instructors and students at Xavier University and New Orleans high schools. Our personal and professional background information should help others to better understand our goals, commitments, and activities.

A. About me.
B. About interns.
C. About high school teachers.
D. About high school interns.
E. About the institutions.
    1. Xavier University of Louisiana.
    2. Active participating high schools.(need to get permissions/understanding)
        a) Xavier Preparatory High School.
        b) Warren Easton High School.
        c) McDonough 35.

V. ACTIVITIES

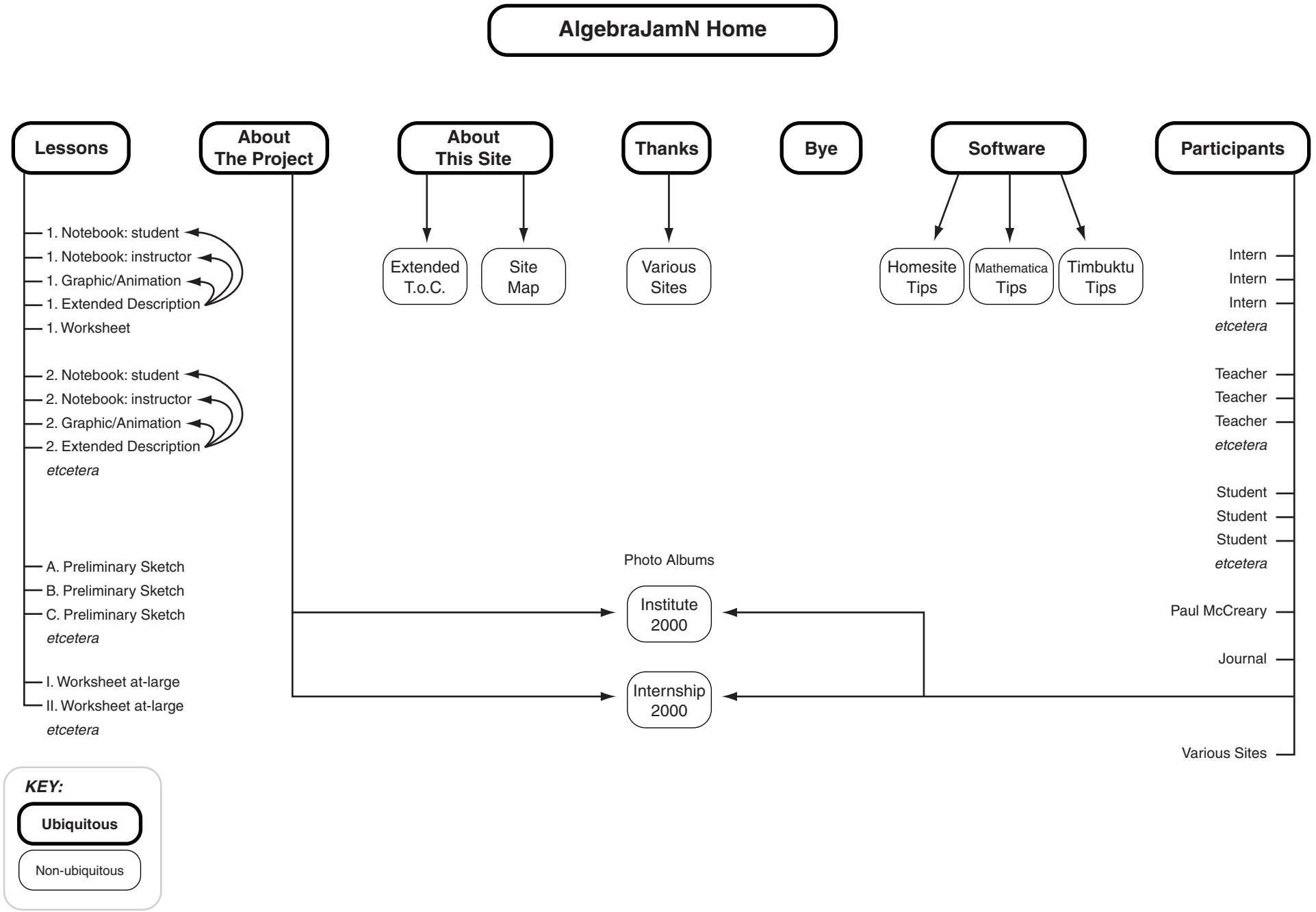
A. Summer institute for high school teachers.
B. Summer internships for Xavier undergraduates.

VI. THANKSGIVING

We thank our current sponsors, especially WRI, which has contributed the use of the software *Mathematica*. WRI personnel have been supportive and helpful, providing resources and encouragement throughout the development of our computer-based algebra lessons. The Center for the Advancement of Teaching at Xavier University has supported this project at critical moments of our development and has provided essential critique and suggestions.

A. Sponsors
B. Partners
C. Friends

Experiential Flowchart

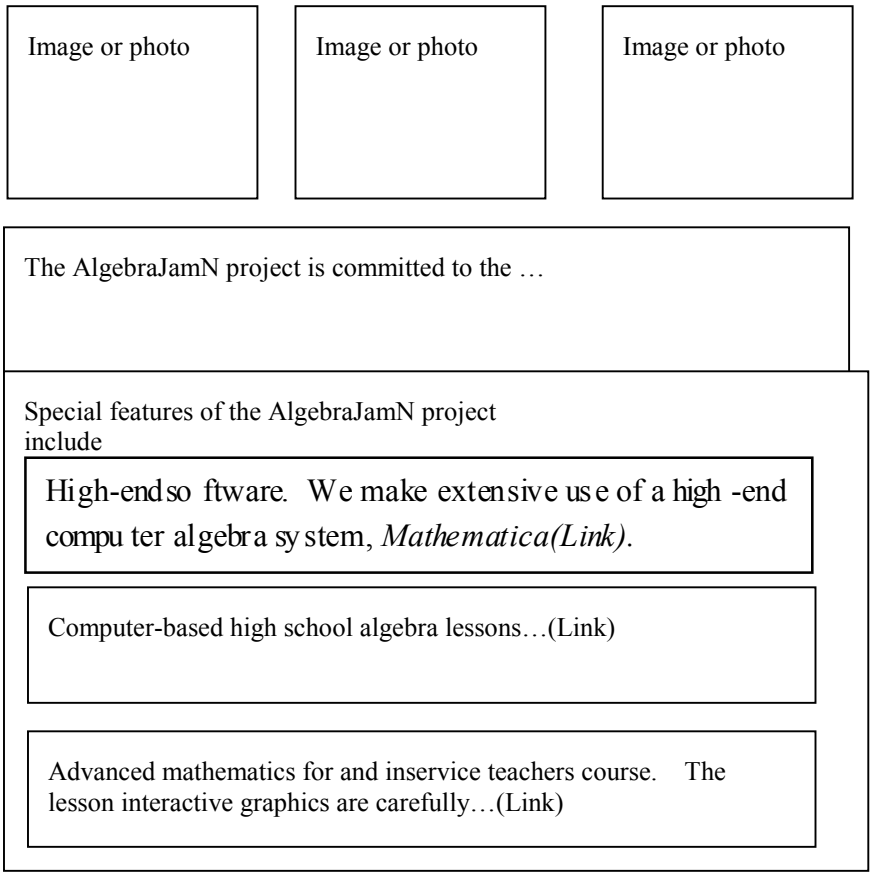


Interface Mockups

Template for Home Page.

Home page for the

AlgebraJamN Project

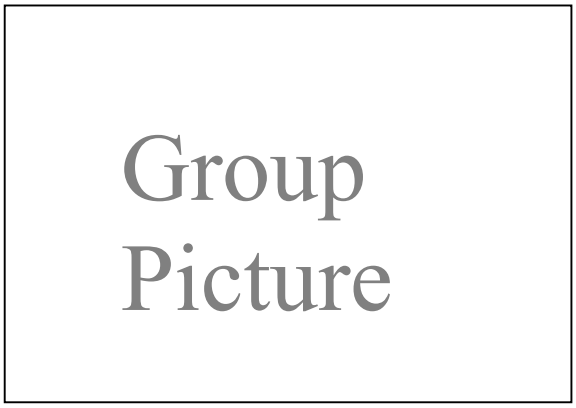


Ubiquitous Links Ubiquitous Links Ubiquitous Links

Template for Participants Page.

Participants

of the AlgebraJamN Project



We are

high school student interns:

studentName1**(link to personal webpage)**

studentName2**(link to personal webpage)**

.

.

Xavier undergraduate interns:

Kordice Watson**(link to personal webpage)**

Julian Stewart**(link to personal webpage)**

high school teachers:

Ann Luke**(link to personal webpage)**

Merlin McGhee**(link to personal webpage)**

.

.

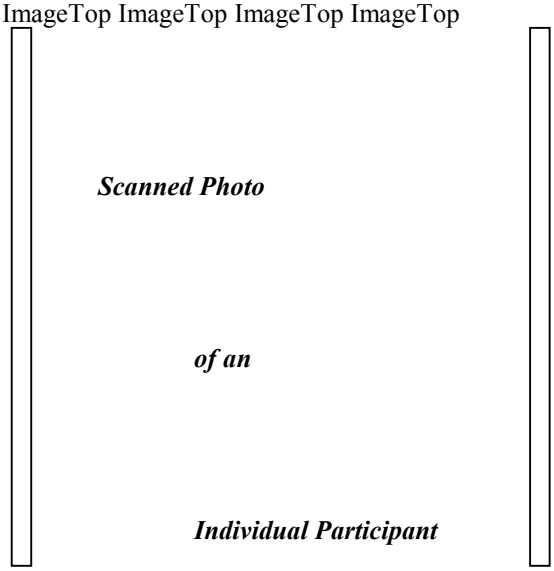
Xavier University Faculty:

Paul R. McCreary**(link to personal webpage)**

Ubiquitous Links Ubiquitous Links Ubiquitous Links

Template for an Individual Participant's Webpage.

ImageTop ImageTop ImageTop ImageTop



ImageBottom ImageBottom ImageBottom

Ann Luke

Affiliation: Xavier Prep High School

Levels and courses usually taught: Junior-level Aglebra,

Soph Geometry, Calculus II.

PersonallyWrittenText PersonallyWrittenText PersonallyWrittenText

PersonallyWrittenText PersonallyWrittenText PersonallyWrittenText

PersonallyWrittenText PersonallyWrittenText PersonallyWrittenText

Image1111Top Image2222Top Image3333Top

Image11Bottom Image22Bottom Image33Bottom

PerssonalLinks **PersersonalLinks** **PerssonalLinks**

Ubiquitous Links Ubiquitous Links Ubiquitous Links

Template for Software Page.

Software that We Use.

Mathematica *(Link)*

A high-end computer algebra system, *Mathematica,* allows us to produce high quality, interactive graphics. Since students become acquainted with this sophisticated software tool, they are able to extend their investigations…

HomeAlliance*(Link)*

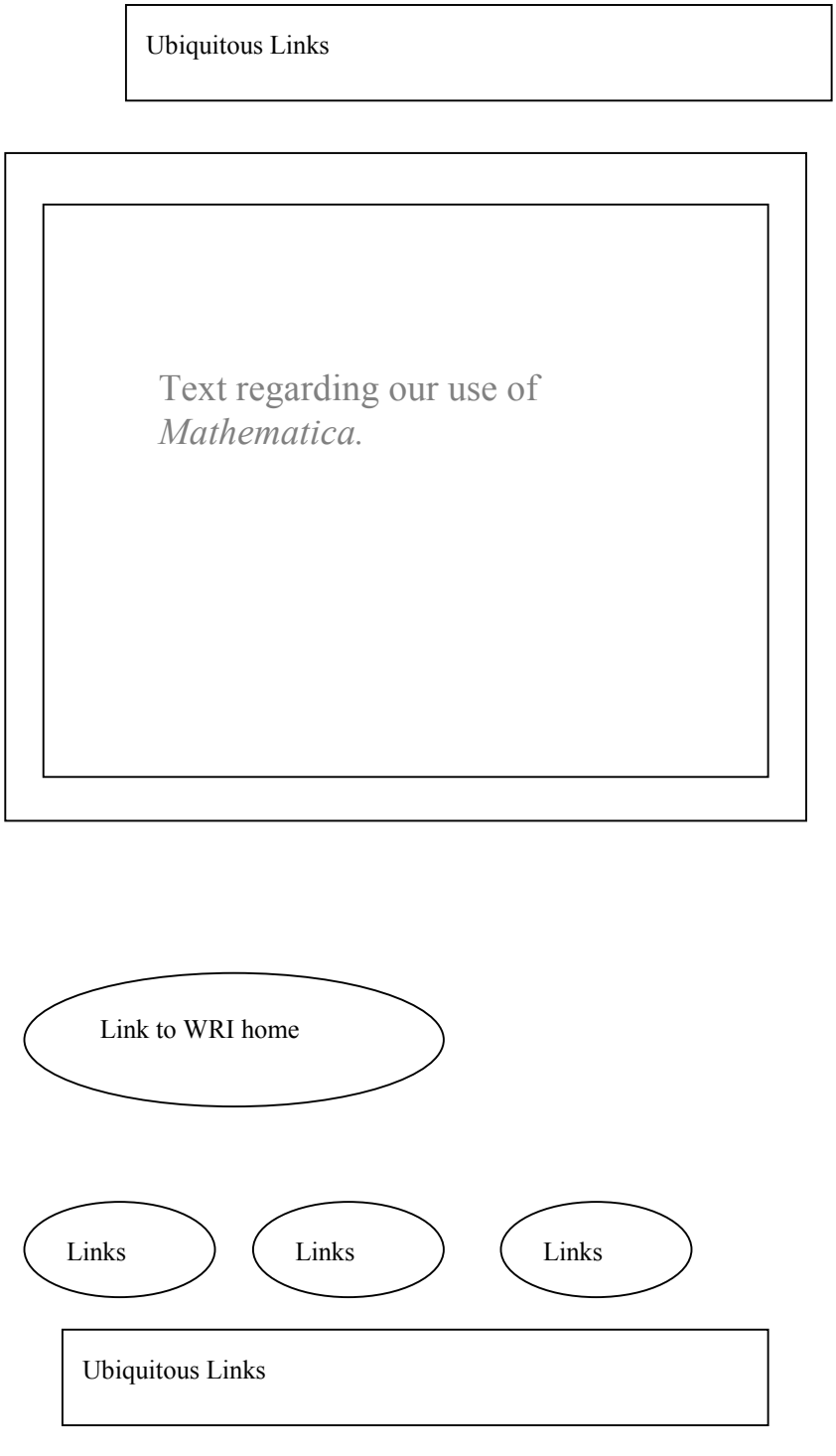
Webpage authoring is one skill…

Timbuktu*(Link)*

Direct communication from a distance is made possible by…

Template for Particular Software Page.

Mathematica



Template for Lessons Page.

Lessons and Related Materials.

Lessons:

Icon **Lesson One, Signed Number Operations.**

Student Version(*Mathematica* notebook, Link)

InstructorVersion(*Mathematica* notebook, Link)

Related Worksheets (link)

Animation from the lesson(link)

Icon **Lesson Two, Point and Lines.**

Student Version(*Mathematica* notebook, Link)

InstructorVersion(*Mathematica* notebook, Link)

Related Worksheets (link)

Animation from the lesson(link)

.

.

Preliminary Sketches/Future Lessons (*Mathematica* notbooks):

Icon **Non Round Rollers.**

Icon **Parametric Spaces**

.
.

Stand-Alone Worksheets:

Icon **Factoring**

Icon **Solving linear equations**

.

Template for Lesson Webpage.

Lesson One: Signed Number Operations.

Image produced by the *Mathematica* code in the lesson notebook.

You can download(link) the *Mathematica* notebook for this lesson. Note that operating the lesson notebook will require that you have *Mathematica* software on our computer.

Extended description of what is in this lesson's* Mathematica *notebook.

You may view an animation(link) produced by *Mathematica* for this lesson.

Image.gif

Image.gif

Ubiquitous Links

Media Inventory

I. LESSONS AND RELATED MATERIALS
- A. Text
  1. Introductory remarks regarding advanced mathematics being embedded in the lesson graphics and about *Mathematica* software being required to operate the lessons.
  2. Suggested paths to take in browsing through the materials.
  3. Extended description of each lesson/notebook.
- B. *Mathematica* notebooks.
  1. Student and instructor versions for each of ten (10) lessons.
  2. Preliminary sketches of future lessons.
  3. Advanced topics for teachers and advanced high school students.
  4. New arrivals, i.e., what high school teachers have produced recently.
- C. Images.
  1. Small graphic icons to represent/identify each lesson.
  2. Full size graphic images from each lesson to illustrate text descriptions.
- D. Animations produced with *Mathematica* and modified for displaying on the web.
- E. Web pages, one for each lesson.

II. PARTICIPANTS
- A. Text.
  1. About the summer session, 2000.
  2. About each individual participant.
  3. Captions for photos.
- B. Images.
  1. Thumbnail images to index the photo albums.
  2. High resolution images for the photo album.
- C. Web pages, one for
  1. all thumbnail images together.
  2. each high resolution image for the photo album, with caption.
  3. each participant.
     a) Five high school students.
     b) Four high school teachers.
     c) Two Xavier University undergraduate interns.
     d) One Xavier University faculty member.

III. SOFTWARE
- A. Text.
  1. Description of how and why we use each of the three main software applications
     a) *Mathematica.*
     b) Homesite.
     c) Timbuktu.
  2. Tips about using the applications
- B. Webpages.
  1. One for each of the three applications.
  2. One for the tips about each application.

IV. ABOUT THIS SITE
- A. Text.
  1. Statement of Pupose.
  2. Extended table of contents.
- B. Images.
  1. Example graphics to serve as icon for
     a) Lessons.
     b) Participants.
     c) About this project
     d) Software.
  2. Site Map.
- C. Webpages.
  1. Extended table of contents.
  2. Site Map.

V. ABOUT THIS SITE
- A. Text.
  1. Statement of Pupose.
  2. Extended table of contents.
- B. Images.
  1. Example graphics to serve as icon for
     a) Lessons.
     b) Participants.
     c) About this project
     d) Software.
  2. Site Map.
- C. Webpages.
  1. Extended table of contents.
  2. Site Map.

VI. FRIENDS AND SPONSORS
- A. Text.
  1. Thanks to Wolfram Research Incorporated, makers of *Mathematica*, and to CAT and the DOE of Xavier University.
  2. Comments about the original AlgebraJam project.
- B. Webpages. Just one.

VII. OTHER MEDIA ITEMS
- A. Buttons.
  1. Ubiquitous buttons.
     a) Home.
     b) Lessons.
     c) Participants.
     d) About this site.
     e) About this project.
     f) Thanks.
     g) Software.
     h) Bye.
  2. Extended table of contents.
  3. Link buttons on the Home page to:
     a) Lessons.
        (1) Lessons index page.
        (2) About the embedded, advanced mathematics.
     b) Software.
        (1) Software main page.
        (2) Mathematica page.
  4. Link buttons on the Software page to:
     a) *Mathematica* page, which holds links to:
        (1) Corporate home page for WRI, producers of *Mathematica.*

(2) Selected WRI sites for program/notebook development.
(3) Grant application form for WRI corporate grants.

b) Homesite page.
c) Timbuktu page.

5. Links on the Thanks page to:
   a) Corporate home page for WRI, producers of *Mathematica.*
   b) Grant application form for WRI corporate grants.
   c) Center for the Advancement of Teaching at Xavier University.
   d) Division of Education at Xavier University.
6. Link on the Bye page to a "Goodbye" animation.
7. Links on the Lessons index page to each individual lesson, preliminary sketch, related worksheet, and stand alone worksheet:
   a) On each individual lesson, etc. page there will be links to the various available *Mahematica* notebooks, related worksheet, and associated images and animation example.
8. Links on the Participants index page to each participant's individual page:
   a) On each individual's page there will be links to personal interest sites.
9. Links on the About this Site page to the
   a) About this Project page.
   b) Participants index page.
   c) Thanks page.
10. Links on the About this Project page to the
   a) Participants page.
   b) Lessons page.
   c) Thanks page.

Implementation Plan.

Accomplished Activities.

At the end of Summer, 2000, as I look back on all that we have accomplished, I am as amazed as I am pleased. Two Xavier undergraduate interns have made tremendous progress in learning how to use web authoring software to design and produce the web pages for the site. Four high school teachers have become acquainted with the computer-based lessons that will be distributed through this web site. The teachers are almost ready to design and author new lessons, which will be added to our current list of available lessons. Six high school students participated in training activities to prepare them to support their respective teachers in the coming school year. The high school teachers gained experience in supervising students engaged in intensive, computer-based investigations and collaborative exercises. They are preparing to incorporate such computer-based activities in their classrooms. Together, we developed an inventory of what each of their classrooms will require in order to be ready to make full use of the materials available through our web site. This has given us a clear picture of what levels of support will be needed from outside the New Orleans Public Schools. We accomplished all of this as we critiqued and modified the plans for the web site, so it is clear that we had a very busy two-week summer session.

Schedule for Remaining Activities.

I. August.
   A. Contact George regarding NCSA.
   B. Contact WRI regarding *Mathematica* copies for high schools and tutors.

II. September.
   A. Generate and modify web pages. (Kordice and one more intern)
   B. Learn how to use remaining software. (Julian and one more intern.)

III. October/November.
   A. Make initial implementation in high schools.
      1. Make first online contact between Xavier and one of the participating high schools, probably Xavier Prep. (Two Xavier undergraduate interns)
      2. Conduct a week of tutored lessons from Xavier to one of the high schools. (Two Xavier undergraduate interns)
   B. Archive special workshop/extra-credit sessions at Xavier University. (Two Xavier University undergraduate interns)

IV. January.
   A. Learn how to put *Mathematica* animations on the web. (Julian)

V. February.
   A. Conduct a collaborative re-evaluation of the web site and the AlgebraJamN project. (All active participants)
   B. Open house for 3D graphics held in conjunction with the collaborative re-evaluation and with guest presenter(s) from the University of Illinois at Urbana/Champaign. (All active participants)

VI. March-April-May.

VII. June-July.
   A. Two-week summer session with high school and middle school teachers on the Xavier University campus.
   B. Two-week research trip with interns to improve lesson format (at WRI) and to learn to incorporate 3D graphics on the web (at NCSA).

Budget.

Please note that the underlined amounts have not yet been located or committed.

Phase One: Planning and modifying this document.

I. Software.

A. *Mathematica.*

Donated by producer, Wolfram Research, Incorporated, as a package valued at $1,200

B. Homesite.

Purchased @ $50/participating site/school. $ 300

C. Timbuktu

Purchased @ $50/participating site/school. $ 300

II. Stipends for Summer Session, 2000.

A. Xavier undergraduates (3 @ $400) $1,200

B. High school student interns (5 @ $200) $1,000

C. High school teachers (4 @ $650) $2,600

D. Director (1 @ $2,500) $2,500

Phase Two: Producing the web site.

III. Academic year 2000-001. Xavier undergraduate interns. (4 @ $250) ($1,000)

IV. Summer session, 2001: Developing materials for the project.

A. Two week session on campus at Xavier. Stipends for 10 high school teachers, ten high school student interns, five Xavier undergraduate interns, and Xavier faculty co-directors ($20,000)

B. Two week session on campus at University of Illinois at Urbana/Champaign and at Wolfram Research, Incorporated, headquarters. The purpose would be to hone our skills at producing high quality lessons using the latest techniques of *Mathematica* developers at WRI. Travel, stipends, room, and board for two high school teachers, two high school student interns, four Xavier undergraduate interns and one Xavier faculty director. ($20,000)

funds already allocated: $10,000

funds yet to be located/committed: ($40,100)

Total $50,100