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Project-Based Learning Lesson Plan For

Sixth-Grade Mathematics Students

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Classroom computers were first being introduced to most Northside Independent School District schools in 1996. At about that same time, Dr. Michael Simkins (2001) became the director for the *Challenge 2000 Multimedia Project*. Dr. Simkins (2004) describes the outcome (project-based learning with multimedia (PBL+MM)) of that study as "a method of teaching and learning in which students acquire new knowledge and skills in the course of designing, planning, and producing a multimedia product." In an article written for the Association of Supervision and Curriculum Development (2002), he asserts that this particular method "connects to the real world…to a real audience…fulfills a real need…connects to student interests…applies students' special talents and skills…to a real-world purpose…with…student engagement…just about guaranteed (p.1)."

In his video instruction for Walden University, Dr. Simkins (2004) explains the seven key dimensions of project-based learning. It must be aligned to curriculum content standards, deliberately assess student expectations, extend over a clearly defined period of time, involve considerable student decision-making and collaboration, have a purposeful connection to the real world, and employ multimedia in its process and presentation. Students plan, design, and produce a product, while teachers provide coaching and encouragement as facilitators.

As an Inclusion teacher, I do not have much input in terms of lesson planning and design other than offering modifications and accommodations for students with special needs. A few times each year, however, when the classroom teacher is absent, I get an opportunity to perform whole class instruction. Last year, I noted the problems sixth grade students were having trying to master the concepts of ratios, fractions, decimals, and percents. Anticipating eventual

application through the Pathways for the Advancement of Virtual Education (PAVE) courses I am enrolled in, I developed a WebQuest which specifically addresses these four mathematical applications (http://pave4.pavenet.org/users/RHarvey/Pave/DreamWorks/WebQuestMM.htm #WebQuestHomePage). The last few weeks of school, math teachers at my school, attempted to reinforce these skills in preparation for their students' progress to seventh grade. I was afforded the opportunity to combine groups of students with learning deficits from three classrooms and share my project with them. Working alone with a large group of students who struggle in both mathematics and technology taught me two important lessons: (1) project-based learning is great for student-centered engagement, and (2) when learning is fun, students are motivated to remain on task and do their best.

The overall purpose of the WebQuest is for students to reinforce their learning and understanding of relationships between and among ratios, fractions, decimals, and percentages while demonstrating their ability to provide spread-sheet and graphic representation of data. Additionally, they share their investigation results in the form of personally created PowerPoint presentations. In the process, over 25 Texas Essential Knowledge and Skills (TEKS) objectives are addressed in math, language arts, and technology (see Appendices A and B).

Upon satisfactory completion of the entire WebQuest, students complete brief search activities targeted predominately at M&M candies, collect data from direct observation and compare it with publicized information on the Internet, develop an EXCEL spreadsheet with a fully labeled Pie Chart graphical representation, created a multifaceted PowerPoint presentation, and written a reflective summary using Microsoft Word. In the process, they count, compare and contrast, prepare part-to-whole ratios, change ratios to fractions in simplest terms, convert fractions to decimals, and express decimals as percentages. In relating data they derive from

personal observation to that expressed as the norm for packaging by M&M Corporation, students may find a variety of real world connections: Truth in advertising, law of averages, close approximations, or the difference between fact and fiction. Students have considerable freedom to present their findings with the parameters of a rubric assessment included in the WebQuest.

Once they collect their data, they create the spreadsheet and pie chart graph. They use these and Internet websites to respond to a number of questions that may be resolved in a handful of searches or as many as a dozen or more. The process is designed to provide considerable engaging tasks which force encounters with thoroughly entertaining material that may lead one or members of a collaborative group off task. Remaining on track and staying the course demands self- and group-discipline with one eye on the rubric as a guideline and the other eye on the clock for task completion. Their presentation is recommended to be a PowerPoint slideshow. The amount of appropriate creativity that students put into their Pie Charts and PowerPoint presentations determines the higher grades.

Technology plays an important part of the entire ‘Quest. Windows-driven software provides all the tools students need to complete the assigned tasks. Making calculations can be done with desktop calculator. Spreadsheet and pie chart information, reflective summary, and final presentation use a laundry list of Microsoft tools: Word, Excel, PowerPoint, and/or Publisher. Multitasking becomes routine through use of mouse, monitor, and keyboarding skills while negotiating the various toolbars to accomplish the final product.

Small group collaborative effort is recommended for students with special needs. Prior collaboration with a gifted/talented class may be beneficial depending upon level of severity or type of disabilities. One of the most difficult aspects of any project is making an authentic connection to the real world. The hope of the WebQuest is that students see the connection

between packaging and distribution and, perhaps inventories. At the same time the variety of activities inherent in this type of project brings several types of technological literacy into play in order to achieve a successful end product worthy of display. Students need to determine what needs to be accomplished, how long they have to get the job done, and what shape their final presentation will take. Cooperative planning, data discovery and organization, task sharing, and basic social skills all play important roles in along the way.

The beauty of a WebQuest is that it is almost a given certainty that *Habits of Mind* and *Learning Styles* and *Multiple Intelligences* will factor into the successful completion of the project. The step-by-step task procedures, as well as the final outcome framed by a rubric assessment, in a WebQuest help promote what Costa and Kallick (2000) describe as essential worthwhile habits of mind: “managing impulsivity and striving for accuracy (p.44).” Students are required to make evaluative judgments about data collection and agreement or disagreement of their data with posted information. Completing the entire WebQuest incorporates most if not all of the 16 *habits* described in that have been identified (Appendix C).

Every one of the *Habits* become employed through the WebQuest applications. Students are challenged to make predictions, speculate as to whether their own data may be supported by others, encourage to hypothesize pervasiveness of their conclusion(s). All the while, they must explain their reasoning based upon comparisons in sorting (candies), and analyzing results of their findings which were based upon individualized observations and collaborative exchanges.

Persisting is key to completing any large project. WebQuests tend to promote student interest and provide enough challenge to keep students actively involved. By assigning student peer-buddies and emphasizing step-by-step procedures inherent in the WebQuest format most students should be able to remain on-task and complete it with minimal concern for *managing*

impulsivity. *Listening with understanding and empathy* becomes necessary whenever project make use of peer-buddies who to relate one-on-one or in small groups during student collaboration. In the course of the WebQuest, students will have varying numbers and colors of candies; *thinking flexibly* they will have to individualize their charts. Later, they will create PowerPoint presentations as well as expository written reflective summary papers which will all reflect this individualized creative thinking. *Metacognition* is more fully enhanced through student reflective summaries and classroom discussion sessions which allow students to think about what they performed, how and how well they did it. The Excel spreadsheet data needs to be accurate in order to reflect correct conversions between ratios, fractions, decimals, and percentages - *striving for accuracy* during this phase of the WebQuest ensures a more complete project. Since WebQuests pose several questions to guide student performance and data collection. Subsequent reflection and discussion, *questioning and posing problems* further develops possible responses and strategies for finding answers to similar problems. Students *apply past knowledge* throughout the *M&M WebQuest* to effectively negotiate the multiple tasks involved in the process. Their previous learning in both mathematics and use of technology resources are used throughout. *Thinking and communicating with clarity and precision* helps students successfully and more accurately respond to Quiz questions, draft and complete a reflective summary, and formulate a brief PowerPoint presentation. Students have to organize and present their findings clearly and logically *gathering data through all senses.* The nature of WebQuests suggests visual, auditory, and hands-on activities that get the whole-student involved in the process of discovery and learning. Allowing peer interaction further enhances this through collaborative exchanges and sharing out of their creative ideas. Students employ *creating, imagining, and innovating* by personalizing their own Pie Chart display and developing a

PowerPoint slide-show. Throughout the WebQuest, they are encouraged towards *responding with wonderment and awe* by the multiplicity of questions and variety of assigned tasks. Throwing a little humor into the mix by way of introducing George Carlin's "*No Blue Food*" is designed to get students to ponder such questions. What else is, is not included? Is this a dumb question, or logical one? Students are told the time constraints of the project and the various steps are introduced; then they are left somewhat to their own designs to complete the assignment. *Taking responsible risks* takes on a number of forms. What if the student eats his/her candy before making the counts? How should the chart and presentation be presented? *Finding humor* also permeates this cognitive journey. The nature of the WebQuest *Introduction* suggests the process of discovery may be fun. Including Carlin's *Blue Food* gig in the Quiz promotes creative thinking. Looking at Ms as Es, 3s, and Ws introduces different perspectives and suggests a fun way of looking at things. The M&M Web pages are entertaining as well. *Thinking interdependently* through collaborative efforts, sharing ideas and suggestions, and assisting one another is the only way to succeed. *Remaining open to continuous learning* cements the experience into real-world context. One question within the WebQuest ponders whether other candies have such lists of designated colors/flavors (e.g. Skittles). Are there other things in life that have order and reason? What things of particular student interest are there worth checking into that might involve things learned in Math Class?

WebQuests easily employ all aspects of Bloom's Taxonomy (1956, 1984) spanning the spectrum from simple recall knowledge to complex evaluative self-assessments.
Recall of previously learned material is drawn upon in multiple applications. Comprehension: understanding how to connect the dots between concepts and converting data from ratios to fractions, then to decimals and percentages, and then translating data into visual format comes

into play early in the WebQuest. When students begin calculating data, using data to formulate responses to the Quiz, creating their Pie Chart, and putting together a comprehensive multi-media (PowerPoint) presentation, taking the bits and pieces of past learning and putting them into practice demonstrates their ability to apply what they have learned and begin to stretch beyond to meet new challenges. Students are analyzing data from the onset, separating data into parts and seeing how they relate to the other parts to more fully understand the whole process and see big picture of the WebQuest. Additionally, being able to distinguish between what is fact and what might be implied requires varying levels of critical thinking; comparing and contrasting results, creating displays, and interpreting them provide continuous challenge. From the early stages of drafting initial data to finalizing their reflective summaries, students utilize their skills of synthesis compiling data and information and then organizing them into comprehensive arrangements relating their findings and implications in a comprehensive reflective summary and multimedia presentation. Throughout the process, the built-in rubric provides both guidance and self-evaluation enabling them to make reasonable comparisons and logical conclusions.

Similarly, WebQuests offer opportunities for every type of learner as described by Silver, Strong, & Perini (2000) in terms of integrating *Learning Styles and Multiple Intelligences* For the *sensing-feeling* (SF) learner peer collaboration in the Computer Lab with students to his or her immediate left and right establish a small group comfort zone. The WebQuest format's basic premise, and connection to M&Ms candies provide real-life experience and opportunities for the SF student's self-expression. The process and set up allow the sensing-feeling student to use both cooperative and assisting skills. The WebQuest step-by-step format and rubric pacing assessment guide provides the "right way to do it" information which the *sensing-thinking* (ST) student needs. He or she responds best to order and consistency, so the step-by-step procedure is

a good fit. The opportunity to share his or her feelings in writing a reflective summary is also good. Meanwhile, the *intuitive-thinking* (NT) students thrive on lots of independent discovery, manipulation, and self-expression making for a good chance for increased on-task behavior. Even though the math concepts are not new, the context in which they are presented and demanded provide new learning experiences. The NT curious nature is challenged and fact gathering comes natural, making this individual a valuable member of any group. The self-expression offered by creating charts and PowerPoint presentations promotes imaginative innovation and provokes interest for the *intuitive-feeling* (NF) student. Since they are apt to first see how the math concepts connect to provide data for the visual displays, their presence is a plus for peers right and left. As the WebQuest shifts gears, this NF student readily adapts and can help keep peers stay on track in terms of both time and task.

Originally, I envisioned this WebQuest to be completed in a single 90-minute block lab period. Having attempted it, two 90-minute lab periods is more reasonable, with three providing plenty of wiggle room for students who struggle in multiple areas. Designed as a review exercise to reinforce identification of part-to-whole ratios and their relationship to fractions, decimals, and percentages, the M&M WebQuest provides math, language arts, technology, and social skill reinforcement.

To more fully engage students in decision-making and perhaps enhance their collaborative skills with adults as well as with peers, a long term student-developed project might be proposed in which students brainstorm, plan, design, organize, and develop WebQuests of their own. This concept could be further developed by challenging one class of students to complete the WebQuests designed by another class. To expand upon the use of technology, one NISD middle school could challenge another to create the best WebQuest, winner(s) to be

determined by Central Office Curriculum and Development personnel. Such projects could be posted on campus Web pages and eventually enjoyed by anyone with access to the Internet. As students become more comfortable with technology, project-based learning will undoubtedly play a predominant role in their academic instruction routine.

Appendix A

Texas Essential Knowledge and Skills (TEKS) addressed by *M&M WebQuest*:

In the process of fully completing the *M&M WebQuest*, students will satisfy the following mathematics TEKS objectives in whole or in part:

Chapter 111. Texas Essential Knowledge and Skills for Mathematics

Subchapter B. Middle School, §111.22. Mathematics, Grade 6.

(a) Introduction.

(1) Within a well-balanced mathematics curriculum, the primary focal points at Grade 6 are using ratios to describe proportional relationships involving number, geometry, measurement, and probability and adding and subtracting decimals and fractions.

(2) Throughout mathematics in Grades 6-8, students build a foundation of basic understandings in number, operation, and quantitative reasoning; patterns, relationships, and algebraic thinking; geometry and spatial reasoning; measurement; and probability and statistics. Students use concepts, algorithms, and properties of rational numbers to explore mathematical relationships and to describe increasingly complex situations. Students use algebraic thinking to describe how a change in one quantity in a relationship results in a change in the other; and they connect verbal, numeric, graphic, and symbolic representations of relationships. Students use geometric properties and relationships, as well as spatial reasoning, to model and analyze situations and solve problems. Students communicate information about objects or situations by quantifying attributes, generalize procedures from measurement experiences, and use the procedures to solve problems. Students use appropriate statistics, representations of data, reasoning, and concepts of probability to draw conclusions, evaluate arguments, and make recommendations.

(3) Problem solving, language and communication, connections within and outside mathematics, and formal and informal reasoning underlie all content areas in mathematics. Throughout mathematics in Grades 6-8, students use these processes together with technology (at least four-function calculators for whole numbers, decimals, and fractions) and other mathematical tools such as manipulative materials to develop conceptual understanding and solve problems as they do mathematics.

(b) Knowledge and skills.

(1) Number, operation, and quantitative reasoning. The student represents and uses rational numbers in a variety of equivalent forms. The student is expected to:

(A) compare and order non-negative rational numbers;

(B) generate equivalent forms of rational numbers including whole numbers, fractions, and decimals;

(C) use integers to represent real-life situations;

(2) Number, operation, and quantitative reasoning. The student adds, subtracts, multiplies, and divides to solve problems and justify solutions. The student is expected to:

(A) model addition and subtraction situations involving fractions with objects, pictures, words, and numbers;

(B) use addition and subtraction to solve problems involving fractions and decimals;

(C) use multiplication and division of whole numbers to solve problems including situations involving equivalent ratios and rates; and

(D) estimate and round to approximate reasonable results and to solve problems where exact answers are not required.

(3) Patterns, relationships, and algebraic thinking. The student solves problems involving proportional relationships. The student is expected to:

(A) use ratios to describe proportional situations;

(B) represent ratios and percents with concrete models, fractions, and decimals; and

(C) use ratios to make predictions in proportional situations.

(10) Probability and statistics. The student uses statistical representations to analyze data. The student is expected to:

(C) sketch circle graphs to display data; and

(D) solve problems by collecting, organizing, displaying, and interpreting data.

(11) Underlying processes and mathematical tools. The student applies Grade 6 mathematics to solve problems connected to everyday experiences, investigations in other disciplines, and activities in and outside of school. The student is expected to:

(A) identify and apply mathematics to everyday experiences, to activities in and outside of school, with other disciplines, and with other mathematical topics;

(B) use a problem-solving model that incorporates understanding the problem, making a plan, carrying out the plan, and evaluating the solution for reasonableness;

(C) select or develop an appropriate problem-solving strategy from a variety of different types, including drawing a picture, looking for a pattern, systematic guessing and checking, acting it out, making a table, working a simpler problem, or working backwards to solve a problem; and

(D) select tools such as real objects, manipulatives, paper/pencil, and technology or techniques such as mental math, estimation, and number sense to solve problems.

(12) Underlying processes and mathematical tools. The student communicates about Grade 6 mathematics through informal and mathematical language, representations, and models. The student is expected to:

(A) communicate mathematical ideas using language, efficient tools, appropriate units, and graphical, numerical, physical, or algebraic mathematical models; and

(B) evaluate the effectiveness of different representations to communicate ideas.

(13) Underlying processes and mathematical tools. The student uses logical reasoning to make conjectures and verify conclusions. The student is expected to:

(A) make conjectures from patterns or sets of examples and non-examples; and

(B) validate his/her conclusions using mathematical properties and relationships.

Appendix B

Texas Essential Knowledge and Skills (TEKS) addressed by *M&M WebQuest*:

In the process of fully completing the *M&M WebQuest*, students will satisfy the following technology TEKS objectives in whole or in part:

Chapter 126. Texas Essential Knowledge and Skills for Technology Applications; Subchapter B. Middle School, §126.12. Technology Applications (Computer Literacy), Grades 6-8.

(b) Introduction.

(1) The technology applications curriculum has four strands: foundations, information acquisition, work in solving problems, and communication.

(2) Through the study of technology applications foundations, including technology-related terms, concepts, and data input strategies; students learn to make informed decisions about technologies and their applications. The efficient acquisition of information includes the identification of task requirements; the plan for using search strategies; and the use of technology to access, analyze, and evaluate the acquired information. By using technology as a tool that supports the work of individuals and groups in solving problems, students will select the technology appropriate for the task, synthesize knowledge, create a solution, and evaluate the results. Students communicate information in different formats and to diverse audiences. A variety of technologies will be used. Students will analyze and evaluate the results.

(c) Knowledge and skills.

(1) Foundations. The student demonstrates knowledge and appropriate use of hardware components, software programs, and their connections. The student is expected to:

(A) demonstrate knowledge and appropriate use of operating systems, software applications, and communication and networking components;

(B) compare, contrast, and appropriately use the various input, processing, output, and primary/secondary storage devices;

(C) demonstrate the ability to select and use software for a defined task according to quality, appropriateness, effectiveness, and efficiency;

(E) use technology terminology appropriate to the task;

(F) perform basic software application functions including, but not limited to, opening an application program and creating, modifying, printing, and saving documents;

(2) Foundations. The student uses data input skills appropriate to the task. The student is expected to:

(A) demonstrate proficiency in the use of a variety of input devices such as mouse/track pad, keyboard, microphone, digital camera, printer, scanner, disk/disc, modem, CD-ROM, or joystick;

(B) demonstrate keyboarding proficiency in technique and posture while building speed;

(C) use digital keyboarding standards for data input such as one space after punctuation, the use of em/en dashes, and smart quotation marks; and

(3) Foundations. The student complies with the laws and examines the issues regarding the use of technology in society. The student is expected to:

(A) discuss copyright laws/issues and model ethical acquisition and use of digital information, citing sources using established methods;

(B) demonstrate proper etiquette and knowledge of acceptable use while in an individual classroom, lab, or on the Internet and intranet;

(4) Information acquisition. The student uses a variety of strategies to acquire information from electronic resources, with appropriate supervision. The student is expected to:

(A) use strategies to locate and acquire desired information on LANs and WANs, including the Internet, intranet, and collaborative software; and

(B) apply appropriate electronic search strategies in the acquisition of information

(5) Information acquisition. The student acquires electronic information in a variety of formats, with appropriate supervision. The student is expected to:

(A) identify, create, and use files in various formats such as text, bitmapped/vector graphics, image, video, and audio files;

(6) Information acquisition. The student evaluates the acquired electronic information. The student is expected to:

(A) determine and employ methods to evaluate the electronic information for accuracy and validity;

(B) resolve information conflicts and validate information through accessing, researching, and comparing data; and

(C) demonstrate the ability to identify the source, location, media type, relevancy, and content validity of available information.

(7) Solving problems. The student uses appropriate computer-based productivity tools to create and modify solutions to problems. The student is expected to:

(A) plan, create, and edit documents created with a word processor using readable fonts, alignment, page setup, tabs, and ruler settings;

(B) create and edit spreadsheet documents using all data types, formulas and functions, and chart information;

(C) plan, create, and edit databases by defining fields, entering data, and designing layouts appropriate for reporting;

(D) demonstrate proficiency in the use of multimedia authoring programs by creating linear or non-linear projects incorporating text, audio, video, and graphics;

(F) differentiate between and demonstrate the appropriate use of a variety of graphic tools found in draw and paint applications;

(G) integrate two or more productivity tools into a document including, but not limited to, tables, charts and graphs, graphics from paint or draw programs, and mail merge;

(I) use technical writing strategies to create products such as a technical instruction guide; and

(8) Solving problems. The student uses research skills and electronic communication, with appropriate supervision, to create new knowledge. The student is expected to:

(A) participate with electronic communities as a learner, initiator, contributor, and teacher/mentor;

(B) complete tasks using technological collaboration such as sharing information through on-line communications;

(C) use groupware, collaborative software, and productivity tools to create products;

(D) use technology in self-directed activities by sharing products for defined audiences; and

(E) integrate acquired technology applications skills, strategies, and use of the word processor, database, spreadsheet, telecommunications, draw, paint, and utility programs into the foundation and enrichment curricula.

(9) Solving problems. The student uses technology applications to facilitate evaluation of work, both process and product. The student is expected to:

(B) resolve information conflicts and validate information through research and comparison of data.

(10) Communication. The student formats digital information for appropriate and effective communication. The student is expected to:

(A) use productivity tools to create effective document files for defined audiences such as slide shows, posters, multimedia presentations, newsletters, brochures, or reports;

(B) demonstrate the use of a variety of layouts in a database to communicate information appropriately including horizontal and vertical layouts;

(C) create a variety of spreadsheet layouts containing descriptive labels and page settings;

(D) demonstrate appropriate use of fonts, styles, and sizes, as well as effective use of graphics and page design to effectively communicate; and

(E) match the chart style to the data when creating and labeling charts.

(11) Communication. The student delivers the product electronically in a variety of media, with appropriate supervision. The student is expected to:

(A) publish information in a variety of ways including, but not limited to, printed copy, monitor display, Internet documents, and video;

(B) design and create interdisciplinary multimedia presentations for defined audiences including audio, video, text, and graphics; and

(12) Communication. The student uses technology applications to facilitate evaluation of communication, both process and product. The student is expected to:

(B) determine and employ technology specifications to evaluate projects for design, content delivery, purpose, and audience, demonstrating that process and product can be evaluated using established criteria or rubrics;

(D) evaluate the product for relevance to the assignment or task.

Appendix C

Habits of Mind

Persisting

Managing impulsivity

Listening with understanding and empathy

Thinking flexibly

Thinking about thinking (metacognition)

Striving for accuracy

Questioning and posing problems

Applying past knowledge to new situations

Remaining open to continuous learning

Thinking and communicating with clarity

and precision

Gathering data through all senses

Creating, imagining, innovating

Responding with wonderment and awe

Taking responsible risks

Finding Humor

Thinking interdependently

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