I·D·E·A·S

Integrated Design + Education + Arts Studio

App Factor: Inventing to Solve Problems
Instructional Plan

OVERVIEW OF LESSON:

Students will investigate the nature of inventions and articulate their knowledge of problems in the 1800's and inventions that resulted to solve those problems. Next, students explore the Rhythmatical iPod® app, an "invention" designed to solve the problem of engaging students in math concepts. Finally, students will collaborate to design a storyboard for their own iPod® app invention.

SUBJECT MATTER:

English
Math
History

GRADE LEVEL(S):

6

App Factor: Inventing to Solve Problems

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TIME ALLOTMENT:

Five class periods

LEARNING OBJECTIVES:

Students will be able to
- Demonstrate and articulate the process of inventing something to solve a problem.
- Design a game that will teach a math skill.
- Work with others to design and communicate ideas.
- Conduct peer critiques and use critical information from others
- Reflect on the process of inventing.

LEARNING STANDARDS:

Content
Standards listed below are not given in their entirety. Rather, the parts of the standards covered by this instruction are included. For complete text of the Virginia Standards of Learning, go to: http://www.doe.virginia.gov/testing/sol/standards_docs/index.shtml

English

6.1   The student will analyze oral participation in small-group activities.
   a) Communicate as leader and contributor.
   b) Evaluate own contributions to discussions.
   c) Summarize and evaluate group activities.
   d) Analyze the effectiveness of participant interactions.

6.6   The student will write narratives, descriptions, and explanations.
   a) Use a variety of planning strategies to generate and organize ideas.
   b) Establish central idea, organization, elaboration, and unity.
   c) Select vocabulary and information to enhance the central idea, tone, and voice.
   d) Expand and embed ideas by using modifiers, standard coordination, and subordination in complete sentences.
   e) Revise writing for clarity.

Math
6.3   The student will

a) find common multiples and factors, including least common multiple and greatest common factor

US History

USI.8 The student will demonstrate knowledge of westward expansion and reform in America from 1801 to 1861 by
c) describing the impact of inventions, including the cotton gin, the reaper, the steamboat, and the steam locomotive, on life in America;

USII.4 The student will demonstrate knowledge of how life changed after the Civil War by
e) explaining the impact of new inventions, the rise of big business, the growth of industry, and life on American farms;

Music
MS.4   The student will create music through a variety of experiences.
1. Discuss how a composer communicates ideas by manipulating elements of music.
2. Improvise melodies, rhythms, and harmonies.
3. Compose melodies, rhythms, and harmonies.
4. Create arrangements of known melodies, using traditional or nontraditional sound sources, including computer-related technology.

MS.9   The student will identify and compare the relationships between music and other disciplines.

Technology
See complete Technology standards at http://www.iste.org/standards/nets-for-students/nets-student-standards-2007.aspx

1. Creativity and Innovation
a. apply existing knowledge to generate new ideas, products, or processes.
b. create original works as a means of personal or group expression.
c. use models and simulations to explore complex systems and issues.
d. identify trends and forecast possibilities.

2. Communication and Collaboration
a. interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. develop cultural understanding and global awareness by engaging with learners of other cultures.
d. contribute to project teams to produce original works or solve problems.

4. Critical Thinking, Problem Solving, and Decision Making
   a. identify and define authentic problems and significant questions for investigation.
   b. plan and manage activities to develop a solution or complete a project.
   c. collect and analyze data to identify solutions and/or make informed decisions.
   d. use multiple processes and diverse perspectives to explore alternative solutions.

5. Digital Citizenship
   a. advocate and practice safe, legal, and responsible use of information and technology.
   b. exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
   c. demonstrate personal responsibility for lifelong learning.
   d. exhibit leadership for digital citizenship.

Arts
See complete Arts standards at http://artsedge.kennedy-center.org/educators/standards.aspx

Music Content Standard #3: Improvising melodies, variations, and accompaniments
   Students improvise simple harmonic accompaniments

   Students improvise melodic embellishments and simple rhythmic and melodic variations on given pentatonic melodies and melodies in major keys

Music Content Standard #8: Understanding relationships between music, the other arts, and disciplines outside the arts
   Students compare in two or more arts how the characteristic materials of each art (that is, sound in music, visual stimuli in visual arts, movement in dance, human interrelationships in theatre) can be used to transform similar events, scenes, emotions, or ideas into works of art

   Students describe ways in which the principles and subject matter of other disciplines taught in the school are interrelated with those of music (e.g., language arts: issues to be considered in setting texts to music; mathematics: frequency ratios of intervals; sciences: the human hearing process and hazards to hearing; social studies: historical and social events and movements chronicled in or influenced by musical works)

CRITICAL AND CREATIVE THINKING OBJECTIVES:

A complete listing and explanation of critical and creative thinking objectives can be found at www.ideas.soe.vt.edu.

Brainstorming	Students will generate as many solutions or ideas related to a topic as possible within a given amount of time.
Conceptualizing	Students will verbalize or represent ideas using 2D and 3D representations, movement, or other forms relevant to the context
Observing	Students will observe things related to the challenge closely to identify details, procedures, and methods
Extrapolating	Students will transfer knowledge of one topic to another.
Questioning	Students will identify missing or unclear information and ask questions to seek clarity.
Composing	Students will use written, oral, and symbolic language to communicate a summary of thoughts, ideas, and solutions.
Judging worth	Students will describe the usefulness of their ideas to the context of the challenge.
Embracing multiple points of view	Students will present ideas and arguments through the lens of multiple perspectives.
Remaining open minded	Students will identify how ideas from multiple experiences (to include senses, fantasy, aesthetics, feelings, and actions of others) influenced their ideas.
Persisting	Students will continue to work until goals are met.
Maintaining intrinsic motivation	Students will identify how the task or problem provides personal satisfaction.
Identifying worth/applicability of ideas	Students will make positive statements about the value of their ideas to the context.
Risk taking	Students will describe how the final product is relevant, appropriate and valuable to the initial challenge and context.

PREREQUISITE KNOWLEDGE:

Students should be able to describe the impact of inventions of the 1800's and/or 1900's on the society of the times.

MEDIA/TECHNOLOGY COMPONENTS:

Windows 7 "That was my idea" commercial (available at the following website:

http://www.microsoft.com/showcase/en/us/details/49c831a6-e895-40ea-a5db-

d9087d25fabe)

Rhythmatical App (available free from the App Store)

MATERIALS:

Class set of iPod® Touches
Rhythmatical App, available for free from the App Store
Elmo Projector (helpful, but not required)

PREPARATION FOR TEACHERS:

Teachers should install the Rhythmatical App on each iPod (or prepare to have students do the same) before beginning the unit.

Teachers should practice using the Rhythmatical App prior to introducing it to students. A teacher toolkit is available online at https://sites.google.com/site/rhythmaticalthegame/home.

Teachers should identify an older class of students (likely high school) with whom to collaborate on iPod app creation.

INSTRUCTIONAL PLAN:

Preparation: *To develop motivation and build connections to prior knowledge*

Show a Windows 7 "My Idea" commercial (you can find the "Collaborate" video at http://www.microsoft.com/showcase/en/us/details/49c831a6-e895-40ea-a5db-d9087d25fabe). Ask students if something like this has ever happened to them – they've had an idea that got developed into something real. Brainstorm how people come up with ideas for new products, concepts, etc. Make a list of students' suggestions. Talk about the fact that many new products come about as a result of people trying to solve problems or answer questions that they have. Draw correlations between the problems that existed in the 1800's and/or the 1900's and the inventions that came about as a result of those problems.

Connections: *Students explore the Rhythmatical app for the iPod.*

Explain to students that many iPod apps have been invented to solve problems that people face. For example, sometimes teachers face the problem of making math engaging and interesting for students. To solve this problem, students and faculty members at Virginia Tech invented Rhythmatical to help students practice math skills.

Allow students time to play Rhythmatical on the iPod. This app will allow students the opportunity to practice their knowledge of SOL 6.3 as they find the greatest common factor for groups of numbers.
After students explore the app, have them work in groups to answer the following questions:

1. What math skill is practiced in this game?
2. Describe how the game creators incorporate music and rhythm into practicing math skills.
3. To what extent does the musical component of the game play a role in the game's objective? How could you incorporate music differently?
4. What is your feedback on how the screen looks as you play the game?
5. How is the player evaluated during the game?
6. What is the goal of this game? Why do you think the inventors of the app chose this game as a suitable format to solve the problem they recognized?
7. What different types of expertise do you think were needed to create this game?
8. How could you improve this game?
9. Where do you think the "my idea" for this app originated?

Discuss the students' answers to these questions as a class. Help students to discover that it takes the talent of many people with different abilities to develop something new, so the fact that all people have unique and diverse abilities is a benefit to us all.

Project: *Design an app for the iPod that relates to a math SOL.*

Using the scale in Appendix A, ask each student to rate his/her knowledge of each of the 6th grade math SOLs. Based on the results, divide students into groups that contain a mixed level of ability on one or more of the SOLs. The goal is to create a group that contains a "subject matter expert", a student with moderate knowledge of the subject, and a student with weaker subject knowledge. (This grouping scheme will provide weaker students with a peer model from whom they can learn and offer the potential for a range of abilities within each group. Conceptually, a student with weaker skills might possess stronger skills in a different area – such as graphic design). *Note: Teachers can remove rows of the table to limit the self-evaluation to skills covered in class so far.*

Working in groups, students will conceptualize an App that they can develop related to the Math SOL assigned to their group. Students will ensure that their projects address the following topics and questions:

Requirements
- Establish a clearly written set of instructions for your game.
- Establish sample problems for each level.
- Decide how players will receive evaluation (scores) and feedback.
- Seek advice from classmates on how your game could improve.
- Organize information so that players understand the beginning, middle, and end of the game.
- Provide reference materials if necessary.
- Use type, headings and graphics to categorize information.

Questions
1. What SOL will you be demonstrating in your game?
2. How will you evaluate student learning of your topic?
3. What will be the goal of your game?
4. How will you inform users of the instructions for playing the game?
5. What will your game screens look like?
6. How many levels will you use?
7. How will you advance through levels?
8. How will users receive feedback to determine whether they are playing the game appropriately to advance through the levels?
9. What will be the end result of your game?

After an initial brainstorming session, students will create a storyboard to depict the design of their game. It could be an original drawing or a computer-generated storyboard. The storyboard will contain a splash page image, an instructions screen, a scoring screen, and several screens to depict sample levels of their game.

Once storyboards are complete, students will consult other groups to obtain feedback on which areas of their design need revision. They should obtain feedback regarding each of the questions listed above.

Using the feedback from other groups, students will modify their storyboards and prepare a 10-15 minute presentation for the class to pitch their concept. The presentation will answer each of the questions listed above and include all components of the storyboard created by the team.

Teacher will arrange collaboration with a class of older students who will try to develop the concept into an actual game for the iPod.
- Collaboration between older and younger students will take place via email, video conferencing, Blackboard, or something similar.

Reflection: Students will write an individual reflection paper about their projects and group work. The papers should address each of the following topics:
- How the group generated their game concept
- Problems they encountered – individually and within the group
- What they like most and least about their final project and why
- What the most interesting part of the project development was and why
- What they learned about group work and game design

Extension Activities:
- Draw connections to challenges encountered by early explorers and inventors (possibly as a requirement within the math game they conceptualize)
- Economic concepts connected to marketing project
- Maintain a class Internet site that addresses problems and answers questions. This could possibly be managed by gifted students who would research the questions.
- Compare and contrast the Rhythmatical app with other educational apps (free downloads are available – see resources section below)
- Use the help site (https://sites.google.com/site/rhythmaticalthegame) as a teaching tool/resource
- Students evaluate the Rhythmatical app, perhaps designing their own rubrics, and use it to conduct surveys and develop graphs to display data

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ASSESSMENTS:

Students will be assessed on their storyboard pages and their reflection papers. See rubrics attached to this document.

COMMUNITY EVENTS AND CONNECTIONS:

Schedule an interview with the creators of Rhythmatical to discuss their process and compare it to the students' process as well as processes of historical contributions. Potential questions for the development team include:
1. *What was the inspiration/ thought process for the project?*
2. *What sequence of events occurred from the first ideas until where you are now?*
3. *What are some of the challenges/difficulties you faced during the process?*
4. *What have you learned while working on this project?*
5. *What would you do differently?*
6. *What advice would you offer to others thinking of designing apps or electronic games to be used as educational tools?*
7. *What, if any, other inspirational ideas have resulted during the process?*
8. *What are your plans for the future with regards to this project?*

9. *How do you intend getting this project into the hands of students?*

Visit the Institute for Creativity, Arts, and Technology (ICAT) at Virginia Tech to learn how faculty, students, and members of the community work together to create innovative projects.

ADDITIONAL RESOURCES:

Grants that could be obtained to help with financing of IPod touches:

1. www.gatesfoundation.org/grants/

   - Improve education and use of technology in classroom
   - Over 6 billion awarded in U.S. since 1994

2. www.cisco.com/public/750/fdn_home.html

   - One time awards of $10,000 for technology in classroom

3. www.eschoolnews.com/tsc/index.php?sid=590366774&t=index#funding

   - Comprehensive funding for school-based technology
   - $ or technology donations for k12 education

4. www.toshiba.com/about/taf/grant.html

   - Grades 1-6 or 7-12; up to $1,000 per award
   - Improve classroom teaching and learning of math with technology

5. www.rgkfoundation.org/guidelines.php#programs

   - K12 math and technology grants
   - $25,000 maximum awarded

6. http://e-Grants.ed.gov

   - Technical assistance and dissemination to improve results for children with disabilities
   - Grants awarded in K12 public schools
   - Supplemental or additional grants can be obtained as well

Additional iPod Math apps (free or nearly free!):
- Math Drills Lite - explore addition, subtraction, multiplication and division using number lines, wooden blocks, facts and hints.
- Basic Math - application based on drill and practice
- Free Equation Genius - math equation solver
- Child Math Lite - challenge kids of various ages at different levels of difficulty
- Flash cards - fun way to master basic math skills
- Math Tappers Multiples - help children learn basic multiplication facts

CREDITS:

Rhythmatical Project Development Team

- o Michael Evans, Assistant Professor, Learning Sciences and Technology, Virginia Tech
- o Heather Moorefield-Lang, Assistant Professor, University Library, Virginia Tech
- o Betti Kreye, Clinical Assistant Professor, Teaching and Learning, Virginia Tech
- o Vernon Burnsed, Professor, Department of Music, Virginia Tech

Rhythmatical Teachers' Advisory Board

- o June Kelly, Patric County Public Schools, fourth grade
- o Reba Hoffman, Montgomery County Public Schools, eight grade science
- o Eric Ruppert, Giles County Public Schools, sixth grade social studies and science

"App Factor: Inventing to Solve Problems" Curriculum Development

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IDEAS Team

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- o Teri Finn, graduate student, School of Education

Additional thanks goes to Sue Magliaro, Director, School of Education and Truman Capone, Director, School of Visual Arts.

ABOUT THE INTEGRATED DESIGN + EDUCATION + ARTS STUDIO:

The Integrated Design + Education + Arts Studio (IDEAS) is part of the Institute for Creativity, Arts, and Technology (ICAT) at Virginia Tech.

By merging the forces of art and technology into applicable prekindergarten through secondary school (PK-12) programs that strengthen student achievement, Virginia Tech is on the leading edge of a new paradigm in education. ICAT will reach beyond current educational models to fuse arts and technology with content. Our purpose is to strengthen critical and creative thinking skills that prepare students for future careers. ICAT will both generate research and produce learning modules and environments that address real needs identified by educators.

For more information, please see our website at www.ideas.soe.vt.edu.

WE VALUE YOUR FEEDBACK:

Please tell us about how you used the curriculum materials and/or arts project in your classroom. We welcome feedback, suggestions for improvement, and success stories. Find out more at www.ideas.soe.vt.edu.

Get the kit. The IDEAS team has available for loan a number of instructional kits for our various projects. Among other things, each kit includes a FlipCam, a small camera you can use to give us feedback. Because we can't be in the classroom with you, we turn to technology to help provide us a glimpse of the experience you and your students have with the program. That's where the FlipCam comes in.

All we ask is that you document your students engaged with the program and related activities. Feel free to make the filming an integrated part of your experience. Give the camera to the students, do the filming yourself, pass it around to multiple students - however you want to document. Once you are finished with the kit, simply return the camera with the other materials. The Institutional Review Board (IRB) of Virginia Tech requires parent, student, and school assent/consent for participation in this data collection. We provide you with all the necessary permission forms and information for your supervisors.

SOL SKILLS SELF-ASSESSMENT

Instructions: Rate your knowledge of each skill below by checking one of the columns to the right.	Easy	Average	Challeng-ing
6.1 Ratios: $\frac{a}{b}$, *a* to *b*, and *a:b*. **Example**: What is the ratio of squares to triangles in the following picture? Express the ratio in each of the three ways described in the SOL description above. 			
6.2 Fractions, decimals, and percents **Example**: Write .75 as a fraction and as a percent: $.75 = {^?/_?} = ?\%$			
6.3 Integers **Example**: Write these integers in order from *least to greatest*: ⁻9, ⁺3, ⁻23, ⁺6, ⁻7			
6.4 Multiply and divide fractions **Example:** $^6/_9 \times {^1/_3} = ?$			
6.5 Positive exponents and perfect squares **Example**: $2^2 = ?$ and $2^3 = ?$			
6.6 Add, subtract, multiply and divide mixed numbers **Example**: $1\,^2/_3 \times 4\,^1/_2 = ?$			
6.7 Addition, subtraction, multiplication, and division of decimals. **Example**: 2.6 – 1.8 = _____			
6.8 Order of operations **Example**: 5 – 3 x 6 + 12 / 4 =			
6.9 Make ballpark comparisons between measurements in the U.S. Customary System of measurement and measurements in the metric system **Example**: 10 Feet ≈ ____ Meters			
6.10 Area, circumference, perimeter, and surface area			
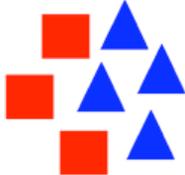
Examples: What is the area of a circle with a diameter of 3 inches? What is the area of a rectangle whose sides are 4" long and 2" wide?			
6.11 Coordinate planes **Example**: What are the coordinates of the point on the following diagram:			
6.12 Congruence of segments, angles, and polygons **Example**: Which of the two following shapes are *congruent*?			
6.13 Properties of quadrilaterals **Example**: What is the name of this quadrilateral? A. Kite B. Square C. Rhombus D. Trapezoid			
6.14 Draw conclusions and make predictions using circle graphs; compare and contrast graphs that present information from the same data set **Example**: In the graph to the right, which company has the largest percentage of sales? Of the top four selling companies, Which has the smallest percentage of sales?			
6.15 Mean and measures of center **Example**: Identify the mean, median, and mode of the following scores: *10, 10, 10, 12, 14, 15, 15*			
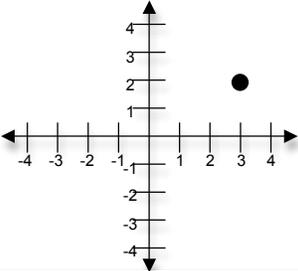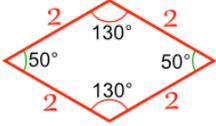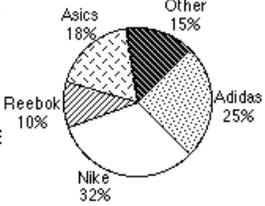
6.16 Dependent and independent events **Example**: the probability of heads landing up when you flip a coin is 1/2. What is the probability of getting tails if you flip it again? Does this scenario represent independent or dependent events?			
6.17 Geometric and arithmetic sequences. **Example**: Finish the following sequence: 1, 3, 5, ___, ___, ___			
6.18 One-step linear equations **Example**: Solve the following equation for *n.* $n + 8 = 30$			
6.19 Identity properties for addition and multiplication; Multiplicative property of zero; and inverse property for multiplication. **Example**: Which of the following equations illustrate identity property of addition? A. $xy = yx$ B. $x + 0 = x$ C. $(x + y) + z = x + (y + z)$ D. $x + 1 = 1 + x$			
6.20 Graph inequalities on a number line. **Example**: Graph the inequality $y \leq 3x - 1$			

STUDENT NAME _____

APP FACTOR: INVENTING TO SOLVE PROBLEMS RUBRICS

Game Storyboard	3	2	1	0
Instructions	Instructions complete and written clearly	Instructions complete but unclear	Instructions incomplete	Instructions not included
Sample Problems	Sample problems for each level included	Missing sample problems for one level	Missing sample problems for more than one level	No sample problems included
Organization	Information is organized so that there is a clear beginning, middle, and end	There is a clear beginning, middle, and end; however, information is not well-organized	The beginning, middle, or end is not clearly defined.	Game concept includes no beginning, middle, and end
Categorization	Presentation uses type, headings, and graphics to categorize information	Presentation uses type, headings, and graphics to categorize, but information is mis-categorized	Presentation contains categorization but is not highlighted with type, headings, and graphics	Presentation contains no categorization and no type, headings, and graphics
Standard of Learning (SOL)	The SOL is correctly addressed through the game mechanics	The SOL is correctly addressed through the game mechanics, but some portions are missing	The SOL is incorrectly addressed in the game mechanics	There is no SOL addressed in the game mechanics

STUDENT NAME _____

Evaluation	Game includes both evaluation and feedback at each level	Game includes either evaluation or feedback at each level	Game includes evaluation and/or feedback, but not at each level	Game includes no evaluation or feedback
Screen Shots	Presentation includes screen shot for each level of the game	Presentation is missing screen shot for one level of the game	Presentation is missing screen shots for more than one level of the game	Presentation does not include screen shots of the game
Levels	Game storyboard includes at least three levels	Game storyboard includes at least two levels	Game storyboard includes only one level	
Column Total				
Rubric Total	_____ out of 24			

STUDENT NAME _____

Reflection Paper	4	2	0
Game Concept	Reflection describes how the group generated their game idea, game design, and game assessment	Reflection is missing one or more of the following: game idea, game design, or game assessment	Reflection does not describe the process of generating a game concept
Challenges/Obstacles	Reflection discusses challenges or obstacles encountered individually as well as within the group	Reflection discusses challenges or obstacles encountered individually but not within the group	Reflection does not discuss challenges or obstacles
Likes	Reflection discusses what learner liked most and why	Reflection does not include an explanation of why	Reflection does not discuss likes
Dislikes	Reflection discusses what learner disliked most and why	Reflection does not include an explanation of why	Reflection does not discuss dislikes
Project Development	Reflection discusses most interesting aspect of project development and why	Reflection does not include an explanation of why	Reflection does not discuss most interesting part of project development
Group Work	Reflection describes what was learned about game design and group work	Reflection describes either game design or group work learning outcomes	Reflection does not describe game design or group work learning outcomes
Column Total			
Rubric Total	_____ out of 24		

STUDENT NAME _____

Critical and Creative Thinking	3	2	1	0
Conceptualizing	Student uses storyboards and written language to represent fully ideas for game design.	Student uses storyboards and written languages to represent some of the ideas for a game design.	Student uses storyboards and/or written language to represent few ideas for a game design.	Student fails to represent ideas for game design.
Extrapolating	Student uses knowledge about inventions in general AND Rhythmatical in particular to inform the game's design.	Student uses knowledge about inventions in general OR Rhythmatical in particular to inform the game's design.	Student uses knowledge from some other source to inform the game's design.	Student does not transfer knowledge from one topic to another.
Remaining open-minded	Student identifies how ideas from others influenced his/her own ideas.	Student identifies how some ideas from others influenced his/her own ideas.	Student does not identify ideas that influenced his/her own ideas.	Student rejects others' ideas.
Identifying worth/ applicability of ideas	Student makes plenty of positive statements about the value of his/her ideas to the context.	Student makes a few positive statements about the value of his/her ideas to the context.	Student makes no positive statements about the value of his/her ideas to the context.	Student makes negative statements about the value of his/her ideas to the context.
Column Total				
Rubric Total	_____ out of 12			