Animation with Object Efficiency

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Lesson Focus
One of the most important ideas in modern computer science is the *object.* Without objects, modern window-based user interfaces and much of modern film techniques would be almost impossible to do. Objects allow designers and programmers to *encapsulate* information so that other details can be ignored when necessary. This lesson shows how an object made of connected parts can be animated by displaying it as a series of graphic images. This lesson can be done entirely off computer by building a traditional flip book with a PostIt note pad, or entirely on a computer using slide production software (PowerPoint, Keynote, Google Drive Slides). Or you can combine them for a very rich experience.

Age Levels
Intended for 11 - 13 (US Middle School grades 6 - 8)
Can be used in lower High School (e.g. 9th grade)

Objectives
Introduce students to:
- ✦ how an object is a collection of parts.
- ✦ how an artist's manikin is an example of an object.
- ✦ how computer animation is based on the simple flip book.

Anticipated Learner Outcomes
Students will be able to
- ✦ use the concept of *object* to create a drawing of something with articulated parts.
- ✦ create a flip book animation either with PostIt pads, or by using standard slide production software.
- ✦ explain how thinking in terms of an object allows them to work more efficiently.

Alignment to Curriculum Frameworks
See attached curriculum alignment sheet.

Internet Connections
- ✦ https://youtu.be/NjI-uqnmBGA (Animation with Sticky notes)
- ✦ https://youtu.be/iExiCGV7jzI (Animation with Index cards)
- ✦ http://entertainment.howstuffworks.com/computer-animation.htm

Recommended Reading
- ✦ https://en.wikipedia.org/wiki/History_of_animation
- ✦ https://en.wikipedia.org/wiki/Mutoscope
- ✦ https://npobjects.wordpress.com/2013/02/16/wooden-drawing-mannequin/
- ✦ http://www.artsupply.com/Animal-Manikins_c_2262.html

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- https://en.wikipedia.org/wiki/Flip_book
- https://en.wikipedia.org/wiki/Computer_animation
- https://en.wikipedia.org/wiki/Dynabook
- https://en.wikipedia.org/wiki/Adele_Goldberg_(computer_scientist)

Optional Writing Activity

- How does thinking in terms of objects that have parts help you organize the process of creating a flip book animation either on the computer or with PostIt pads?

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◆Lesson Objectives

Introduce students to:
- ✦ how an object is a collection of parts.
- ✦ how an artist's manikin is an example of an object.
- ✦ how computer animation is based on the simple flip book.

◆Materials

- ✦ Graph paper for drawing initial objects.
- ✦ Pencils with good erasers.
- ✦ Fine point pens sufficient for each student to have one.
- ✦ Either an artist's manikin or a picture of a manikin.
- ✦ To do the 'Physical Flip Book Activity', sufficient 3 X 3 PostIt pads for each student in your class. Alternatively use 3 X 4 index cards (approximately 30 per student) and a rubber band. (See the videos in section 'Internet Connections'.)

◆Procedure

This activity can be done either entirely off the computer or entirely on the computer. If you choose not to do both activities, then allow students to create more complicated objects and larger animations in whichever medium you choose.

If you choose to use slide production software as part of the lesson, please make sure you and your students are familiar with this method beforehand. Most middle school curricula in the US now expects students to create slide presentations as part of 8th grade language arts. You can use any slide creation tool including Microsoft PowerPoint, Apple Keynote, or Google Drive Slides. This activity requires the following skills:
- ✦ creating a sequence of empty slides.
- ✦ using the drawing tools in the software to create a version of the student's object.
- ✦ using the 'group' and 'ungroup' features to assemble the object parts into a single object.

View the video most useful for you to organize the lesson.

Creating an Articulated Object Drawing:
1. Show your students an artist's manikin if you have one. Alternatively show them a picture from one of the resources listed in the 'Recommended Reading' section. Discuss how the whole *object* is made up of parts. See the 'Student Resource Page'.
2. Depending on whether you are using PostIt notes or index cards, have your students watch the appropriate video. If you can't show the video, you will have to demonstrate the process for them.
3. Distribute graph paper and pencils to your students with Worksheet 1. Support them as they create an articulated figure, and discourage them from creating something too elaborate. Remind them of the time constraints, and suggest that they can create their own animation on their own, at another time. Even students with poor fine motor skills can draw stick figures to illustrate the technique. Emphasize that once they have an initial object, they just have to vary it a little bit, frame by frame. Encourage them to keep it simple.

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Transferring the Drawing to the PostIt notes:

1. Have students practice creating a flip book by drawing dots on subsequent pages, progressing and enlarging the dot as each page is used. Also have them experiment with a drawn line. The Sticky Notes video (https://youtu.be/Njl-uqnmBGA) illustrates this.
2. Have your students transfer their articulated drawings to flip book cards. Make sure they only use an open side for drawing. As shown in the videos, the closed edge is held in the hand to secure the flip book. Encourage them to modify their drawing as needed.
3. Encourage them to share their work. Discuss how thinking about an articulated object supported their animation design. Make sure they put their name on the back of the stack.

Transferring the Drawing to the Slide Production Software:

1. *Make sure you know how to do the process described on the worksheet.*
2. Demonstrate to your students how to draw their figure as articulated objects that are then 'grouped'. These directions are a bit too complicated for middle school students to read. Practice this function and demonstrate it to them.
   a. Start with a blank page in the software. Create each object needed for each part and assemble them together. You can use the duplicate function to copy redundant parts (such as legs, eyes, and arms). Emphasize how thinking about objects really makes the process more efficient.
   b. Show them (or remind them) about using 'group' to create one whole object. Put your first object on the left side of the page. Use the duplicate function to make sufficient copies for each frame of the paper drawing.
   c. 'Ungroup' each frame image and modify it according to the pencil drawing by changing the part and repositioning the figure as needed. Regroup each image when you are finished so it stays together as one object.
   d. Now copy the slide a sufficient number of times for the number of frames you have.
   e. Go back to the top and delete all of the images except the first. On the second slide, delete all but the second, on the third, all but the third, etc.
   f. If everything was done properly, you should be able to 'flip through' your animation by clicking through the sequence of slides in 'play' or 'present' mode.
3. Have your students redraw their figures on the computer following the procedure outlined above. If their drawings are too elaborate, encourage them to simplify them. A key aspect of this exercise is to create the articulated parts as individual objects and then *group* the objects.
4. Depending on the expertise of you and your students, you can enhance your animations with color, backgrounds, etc. If you know how to use the animation features of your software, or you know how to export to a video, show that to your students as well.
5. If your school has a public video display, see if you can post your animations for the whole school to view.

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◆Time Needed

✦ 2 sessions, at most 1 hour each. If you do both the physical and the slide production software, spend one session on each and encourage students to draw very simple figures. If you choose to do one or the other you can encourage students to produce more elaborate animations.

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Frequently asked questions:

Why Objects (from Computer Science)

Object-oriented programming was invented at Xerox PARC in the 1960s, in order to manage the data required to create sophisticated user-friendly computer tools. Alan Kay and Adele Goldberg invented a language called Small Talk for a device called a Dynabook. It took almost 40 years for the Dynabook to find its way to universal access as an iPad or tablet.

What is an *object* in computer science?

An *object* is a way for computer scientists to organize information so they can manage the complexity of data. A crucial idea in computer science is the idea that an object *encapsulates* information that includes other objects. The objects that make up the whole are also made up of objects: for example, the leg has a thigh, shin, and foot. The foot in turn has parts, including five toes. Each object can be manipulated separately as well, without worrying about all the other objects.

Is this what Computer Scientists mean by an *object hierarchy?*

NO! An *object hierarchy* is often thought of as an 'is-a' hierarchy. Biologists love is-a hierarchies. The idea is that all objects in a class have some of the same attributes. For example, all living things have cells. Subclasses in a hierarchy have attributes that distinguish them. The object hierarchy organizes things (e.g. data) so that information can be *inherited.* So for example: *dogs are mammals which are animals, which are living things.* A particular dog inherits the attribute of having cells because it is an instance of a class of dogs, which are mammals, etc.

An object can have parts, and some, but not all, computer scientists call this a *parts hierarchy.* This is convenient for graphics and animation because you don't have to worry about the whole animal if you just want to wink its eye.

What is an Articulated Artist's Manikin?

An *articulated manikin* is typically a wooden model that has joints that can be moved. It helps an artist to draw realistic positions and create realistic movement. Note that if you invent your own imaginary creatures you can decide where their articulation points should be and break all the usual rules. Also, articulate objects are essential to modern robotics, but that's a lesson for another day.

What is Flip Book Animation?

A flip book is a bound collection of papers with drawings on each page that progress in movement as each page is turned. Patented in 1968 by John Barnes Linnett, it is the basis for animation techniques on the computer. An animation algorithm fetches, or constructs, a page of graphics to be displayed in something called a *buffer.* This is just a very fast part of computer memory. Once the buffer is loaded, its contents are displayed. In modern computer this process is done at the hardware level, which is why you will often here talk about a *graphics card.*

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Creating an Articulated Object:
1. Position your graph paper into landscape mode (longer side horizontal). Divide it into 6 vertical sections and four horizontal sections making up 24 frames for your animation.
2. In the leftmost section, draw an articulated figure. It can be human, animal, monster, imaginary. Don't make it too elaborate because you will be drawing it many times. In the last frame draw your figure in the position in which it will stop moving. In the remaining frames, draw variations of your figure by moving some of its component parts. For example you might nod the head, move the legs, wink an eye, have it open its mouth. Think about how the first frame progresses through to the last frame. Remember that later you will be copying your figures to the PostIt notes.

Creating a Physical Flip Book
1. If you are using a PostIt pad you have more than enough sheets to practice drawing animation. Start with a dot, moving it around the area as the pages ae flipped. Then try a regular line so you understand how your image will appear and where it won't. You can use the back of the index cards to practice if you have those.
2. Transfer your drawings of your articulated figure to your flip book. You might decide to modify some drawing so that the animation is more interesting.
3. Have fun sharing your flip book. Consider coloring your drawings!
4.

Creating a Flip Book with Slide Production Software
1. Your teacher will demonstrate how to efficiently use objects to transfer your drawings to the computer. If you create the parts of your figure as individual objects, you can use the 'group' feature to collect the parts into a single image. Start by doing your work on a single empty slide.
2. Use the duplicate function to create copies of your starting image. Make enough for each image you draw. Ungroup each copy, one by one, and modify it so that it matches one of your images. Make sure you place it where it belongs if your animation moves around the page. Make sure you keep things in the right order.
3. Once you have all your images on a single page, duplicate the slide enough times so that you have as many pages as you have images.
4. Starting with the first slide, delete all but the first image. On the second page, delete all but the second image. On the third page, keep just the third image. Continue this procedure for all the slides.
5. Press 'play' or 'present'. Click through your slides to see your animation in action!
6. Using your knowledge of the software, explore what you can do to enhance your animation. Or get silly - for example, what happens if you reorder the slides?
7. Share your work with others!

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Student Worksheet:

Creating an Articulated Object:

3. Position your graph paper into landscape mode (longer side horizontal). Divide it into 6 vertical sections and four horizontal sections making up 24 frames for your animation.

4. In the leftmost section, draw an articulated figure. It can be human, animal, monster, imaginary. Don't make it too elaborate because you will be drawing it many times. In the last frame draw your figure in the position in which it will stop moving. In the remaining frames, draw variations of your figure by moving some of its component parts. For example you might nod the head, move the legs, wink an eye, have it open its mouth. Think about how the first frame progresses through to the last frame. Remember that later you will be copying your figures to the PostIt notes.

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6. Transfer your drawings of your articulated figure to your flip book. You might decide to modify some drawing so that the animation is more interesting.

7. Have fun sharing your flip book. Consider coloring your drawings!

Creating a Flip Book with Slide Production Software

8. Your teacher will demonstrate how to efficiently use objects to transfer your drawings to the computer. If you create the parts of your figure as individual objects, you can use the 'group' feature to collect the parts into a single image. Start by doing your work on a single empty slide.

9. Use the duplicate function to create copies of your starting image. Make enough for each image you draw. Ungroup each copy, one by one, and modify it so that it matches one of your images. Make sure you place it where it belongs if your animation moves around the page. Make sure you keep things in the right order.

10. Once you have all your images on a single page, duplicate the slide enough times so that you have as many pages as you have images.

11. Starting with the first slide, delete all but the first image. On the second page, delete all but the second image. On the third page, keep just the third image. Continue this procedure for all the slides.

12. Press 'play' or 'present'. Click through your slides to see your animation in action!

13. Using your knowledge of the software, explore what you can do to enhance your animation. Or get silly - for example, what happens if you reorder the slides?

14. Share your work with others!

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Teacher Resource:
Alignment to Curriculum Frameworks

Note: All lesson plans in this series are aligned to the Computer Science Teachers Association K-12 Computer Science Standards, the U.S. Common Core State Standards for Mathematics, and if applicable also to the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics, the International Technology Education Association's Standards for Technological Literacy, and the U.S. National Science Education Standards which were produced by the National Research Council.

◆ **National Science Education Standards Grades 5-8 (ages 10-14)**
  CONTENT STANDARD E: Science and Technology
  As a result of activities, all students should develop
  ✦ Understandings about science and technology

◆ **National Science Education Standards Grades 9-12 (ages 14-18)**
  CONTENT STANDARD E: Science and Technology
  As a result of activities, all students should develop
  ✦ Understandings about science and technology

◆ **Standards for Technological Literacy – All Ages**
  The Nature of Technology
  ✦ Standard 2: Students will develop an understanding of the core concepts of technology.
  The Designed World
  ✦ Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.

◆ **CSTA K-12 Computer Science Standards Grades 6-9 (ages 11-14)**
  5. 2 Level 2: Computer Science and Community (L2)
  ✦ Computing Practice & Programming (CPP)
  3. Design, develop, publish, and present products (e.g., webpages, mobile applications, animations) using technology resources that demonstrate and communicate curriculum concepts.

◆ **CSTA K-12 Computer Science Standards Grades 9-12 (ages 14-18)**
  5.3.B Computer Science Concepts and Practices
  ✦ Computing Practice and Programming (CPP)
  1. Use advanced tools to create digital artifacts (e.g., web design, animation, video, multimedia).

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