Summary:
In these two lessons, students will learn about additive manufacturing and how it can be used in medical applications for patient education. In the first lesson, students will be introduced to the concept of additive manufacturing and understand how it is different from normal manufacturing methods. In the second lesson, students will gain an understanding to

Learning Objectives:
Following participation in this lesson, students should be able to:
- Understand and explain the different types of additive manufacturing
- Understand current, general applications of additive manufacturing
- Be able to identify the advantages of a physical 3D model over a 2D drawing or a 3D rendering
- Describe what a cerebral aneurysm is and how cases and treatment may differ by patient

Lesson Plan:

**Lesson 1 – Introduction to Additive Manufacturing and its Uses**

*Time: 60 minutes*

Opening activity – How to create 3D objects from single layers

Have students split up into groups and brainstorm different ways that a three-dimensional model may be created through building layer-by-layer. Have them share their ideas with the rest of the class.

Lecture – Introduction to additive manufacturing

Discuss general methods of traditional manufacturing and compare/contrast to the general methods of additive manufacturing. Discuss the different types of additive manufacturing. Specific types to discuss include stereolithography apparatus (SLA), selective laser sintering (SLS), laminated object manufacturing (LOM), fused deposition modeling (FDM) and three dimensional printing (3DP). (Resource: http://www.rpc.msoe.edu/machines.php).

Discussion questions –
- When is it beneficial to use additive manufacturing instead of mass manufacturing?
• When is it beneficial to use a certain type of additive manufacturing over another?
• What kind of product would you make and sell using additive manufacturing if you had the chance?

Lesson 2 – Discussion of Patient Specificity of Cerebral Aneurysms

Time: 60 minutes

Activity – Learning using different information representations
Provide all of the students with a simple 3D object to look at, such as dice. Tell the students to create a 2D drawing of this shape. Then, instruct the students draw this same shape on a piece of paper in three-dimensional perspective. Ask the students which of these three things provides the most information. Discuss what kinds of information about the object are left out in the picture with 3D perspective and the 2D picture.

Lecture –
Discuss what an aneurysm is and why intracranial aneurysms are dangerous. Blow up a normal balloon and then blow up a balloon that has had a portion of its wall weakened beforehand to demonstrate how weakening can contribute to wall protrusion. Discuss the different types of cerebral aneurysm and locations where they may be located. Review the types of treatment currently used to prevent cerebral aneurysms from rupturing. Show students illustrations of a CTA or MRA scan of a blood vessel with an aneurysm. Show the students an illustration of a 3D rendering. (Resources: http://www.ninds.nih.gov/disorders/cerebral_aneurysm/detail_cerebral_aneurysms.htm, http://www.taafonline.org/ba_detection.html, https://www.youtube.com/watch?v=v1fdoabjCWk)

Discussion questions –
• As a patient, would it be easier to understand your treatment using a textbook illustration or a specific illustration?
• What kind of model would you prefer to look at to visualize your treatment, 2D, a 3D drawing, or a 3D model? Why?
• What advantages does additive manufacturing have for visualizing medical conditions that vary greatly from patient to patient?
• What are some other possible medical applications of additive manufacturing?

Wisconsin academic standards covered in this lesson plan:
• 4C1.a.5.m: Explain how a recently developed product or service fulfills a human need or desire
• 4C3.a.5.m: Conduct a shared dialogue with others on a common problem or task
• 4.C.b.4.m: Use idea generating practices as part of a group
• BT1.a.7.m: Recognize advances and innovations in medical technologies are used to improve health care
• MNF1.f: Select and use manufacturing technologies