

Unit 2: CAD and Rapid Prototyping (7 weeks)

Content Area: **Technology**
Course(s):
Time Period: **Full Year**
Length: **Full Year**
Status: **Published**

UNIT RATIONALE

CAD has become a very important tool for engineers to design and test ideas before committing resources to large scale production. CAD teaches math and science concepts in a way students can understand that relates directly to real-world models. 3D printing is a natural extension of CAD, as it takes 3D models and creates physical products. Its use has become more ubiquitous in industry as a way to rapidly prototype new products and iterate on them with very low cost.

ESSENTIAL QUESTIONS

What is CAD and how is it used in Engineering?

What is 3D printing?

How does 3D printing work?

STANDARDS

NEW JERSEY STUDENT LEARNING STANDARDS: 21st CENTURY

CRP.K-12.CRP2.1	Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.
CRP.K-12.CRP4.1	Career-ready individuals communicate thoughts, ideas, and action plans with clarity, whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to

apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.

CRP.K-12.CRP7.1

Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.

CRP.K-12.CRP8.1

Career-ready individuals readily recognize problems in the workplace, understand the nature of the problem, and devise effective plans to solve the problem. They are aware of problems when they occur and take action quickly to address the problem; they thoughtfully investigate the root cause of the problem prior to introducing solutions. They carefully consider the options to solve the problem. Once a solution is agreed upon, they follow through to ensure the problem is solved, whether through their own actions or the actions of others.

CRP.K-12.CRP11.1

Career-ready individuals find and maximize the productive value of existing and new technology to accomplish workplace tasks and solve workplace problems. They are flexible and adaptive in acquiring new technology. They are proficient with ubiquitous technology applications. They understand the inherent risks-personal and organizational-of technology applications, and they take actions to prevent or mitigate these risks.

NEW JERSEY STUDENT LEARNING STANDARDS: CONTENT AREA

SAVED

New Jersey (NJSLS) - Grades 6-8 - Computer Science and Design Thinking (2020)

8.1.8.DA.3:

Identify the appropriate tool to access data based on its file format.

8.1.8.DA.5:

Test, analyze, and refine computational models.

8.2.8.ED.2:

Identify the steps in the design process that could be used to solve a problem.

8.2.8.ED.3:

Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

8.2.8.ED.5:

Explain the need for optimization in a design process.

8.2.8.ED.7:

Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

CS.6-8.8.1.8.DA.3

Identify the appropriate tool to access data based on its file format.

CS.6-8.8.1.8.DA.5

Test, analyze, and refine computational models.

CS.6-8.8.2.8.ED.2

Identify the steps in the design process that could be used to solve a problem.

CS.6-8.8.2.8.ED.3

Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).

CS.6-8.8.2.8.ED.5

Explain the need for optimization in a design process.

CS.6-8.8.2.8.ED.7

Design a product to address a real-world problem and document the iterative design

process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

NEW JERSEY STUDENT LEARNING STANDARDS: CAREER READINESS, LIFE LITERACIES AND KEY SKILLS

TECH.9.4.8.CI.4	Explore the role of creativity and innovation in career pathways and industries.
TECH.9.4.8.CT.2	Develop multiple solutions to a problem and evaluate short- and long-term effects to determine the most plausible option (e.g., MS-ETS1-4, 6.1.8.CivicsDP.1).
TECH.9.4.8.TL.2	Gather data and digitally represent information to communicate a real-world problem (e.g., MS-ESS3-4, 6.1.8.EconET.1, 6.1.8.CivicsPR.4).
TECH.9.4.8.IML.3	Create a digital visualization that effectively communicates a data set using formatting techniques such as form, position, size, color, movement, and spatial grouping (e.g., 6.SP.B.4, 7.SP.B.8b).

NEW JERSEY STUDENT LEARNING STANDARDS: COMPUTER SCIENCE AND DESIGN THINKING

CS.6-8.8.1.8.DA.3	Identify the appropriate tool to access data based on its file format.
CS.6-8.8.1.8.DA.5	Test, analyze, and refine computational models.
CS.6-8.8.2.8.ED.2	Identify the steps in the design process that could be used to solve a problem.
CS.6-8.8.2.8.ED.3	Develop a proposal for a solution to a real-world problem that includes a model (e.g., physical prototype, graphical/technical sketch).
CS.6-8.8.2.8.ED.5	Explain the need for optimization in a design process.
CS.6-8.8.2.8.ED.7	Design a product to address a real-world problem and document the iterative design process, including decisions made as a result of specific constraints and trade-offs (e.g., annotated sketches).

PRE-ASSESSMENTS

What is CAD and how is it used in Engineering? discussion

INSTRUCTIONAL PLAN

MODULE 1

Activity 1 - Introduction to CAD

<p>Student Learning Intentions (SLI) WALT: (We are learning to...)</p>	<p>I am learning about CAD so that I can define it and describe its importance in modern day engineering and manufacturing.</p> <p>I am learning about the advancements in CAD so that I can understand its use and how new technologies are created.</p>
<p>Student Learning Strategies</p>	<p>Peer learning Self-reflection Class discussion Visual models Videos</p>
<p>Success Criteria</p>	<p>I can define CAD as computer aided design - a way for engineers to digitally design 3-dimensional objects and simulations on a computer.</p> <p>I can recognize advancements in CAD as expansion and adoption of a new technology.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Participation in class discussions.</p>
<p>Activities and Resources</p>	<p>Introduce the new unit with a question to be answered individually by students: What is CAD and how is it used in Engineering? After students share their answers, engage in a discussion that leads students to Computer Aided Design, and its importance in today's product design and manufacturing.</p> <p>After this discussion, begin a presentation with opportunities for questions and class discussion about CAD, its origins/history, and how it's used today and will be in the future.</p> <p>If time allows after the presentation, demonstrate how technology has advanced to the point where we can 3D scan people and objects with "everyday" items - cell phone or iPad with 3D scanning software. Since the scan will take several minutes to record and process, ask</p>

	students to list some projects or products that might make use of 3D scanned models.
Suggested Modifications	

MODULE 2

Activity 2 - Introduction to TinkerCAD

Student Learning Intentions (SLI) WALT: (We are learning to...)	I am learning about TinkerCAD so that I can create digital 3D models.
Student Learning Strategies	Self-reflection Class discussion Hands-on software tutorials Teacher and peer modeling/demonstration Vocabulary
Success Criteria	I can use proper vocabulary to accurately describe what I'm doing in CAD software. I can create and modify an object and groupings of objects in a 3D CAD program.
Formative Assessment (drives instructional decisions)	Participation in class discussions. Successful completion of the software tutorials. Check-ins on student progress conducted daily.
Activities and Resources	Review important CAD info from the previous day - what it is and how it's used. Pose the question to students: what is the most important output from CAD/3D design? - the 3D model file. So how do we make one? Introduce students to TinkerCAD through a quick video ,

	<p>then have them follow instructions to create an account and join the class.</p> <p>Introduce and have students work through the 10 preliminary TinkerCAD lessons available through the “Learning” link in the software - if students have already completed them, they should review and assist by pairing with another student in the class who has not. Walk through how to complete the lessons by doing the first one as a class, explaining where to go within the software, how the lessons are laid out, and how to tell when they are complete.</p> <p>On the second day of this assignment, highlight some vocabulary for students, and ask them to demonstrate where they can be found or used within the software: Axes, workplane, grouping, shapes, inspector, selection, handles. Students will be expected to learn and use the vocab throughout the unit to describe their work appropriately.</p>
Suggested Modifications	

MODULE 3

Activity 3 - Building in TinkerCAD using Design Thinking

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about TinkerCAD so that I can create digital 3D models.</p> <p>I am learning how to visualize complex shapes as a series of simple ones so that I can create interesting, custom 3D models in TinkerCAD.</p>
Student Learning Strategies	<p>Self-reflection Class discussion Hands-on software tutorials Teacher and peer modeling/demonstration Vocabulary</p>
Success Criteria	<p>I can use proper vocabulary to accurately describe what I'm doing in CAD software.</p>

	<p>I can create and modify an object and groupings of object in a 3D CAD program.</p> <p>I can put together basic solid and hole shapes in interesting ways to create complex shapes in TinkerCAD.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Participation in class discussions.</p> <p>Successful completion of the software tutorials.</p> <p>Check-ins on student progress conducted daily.</p>
<p>Activities and Resources</p>	<p>Review vocabulary from previous day and introduce navigation and abstraction vocab: Navigation, Pan, Tilt, Orbit, Zoom, translation, rotation, scaling. Again, prompt students to identify how each of these concepts is used in the TinkerCAD software.</p> <p>When this new vocab has been covered, introduce the next set of tutorials on TinkerCAD: <i>Introduction to Primitive Shapes, Creating Holes, Die from Scratch, and Chess Pawn</i>. These mini-project tutorials are set up similar to the intro ones and walk students through more advanced concepts directly related to creating complex designs. <i>Intro to Primitive Shapes</i> shows students how to begin to identify the basic shapes that can be grouped together to make complex ones; <i>Creating Holes</i> shows students that any shape they design can be used as a “hole” to cut away from a solid shape; <i>Die from Scratch</i> introduces text and numbers beyond the simple basic shapes and how to use the workplane tool; and <i>Chess Pawn</i> puts together all of these skills and more to create a complex, recognizable shape.</p>
<p>Suggested Modifications</p>	

MODULE 4

Activity 4 - Personalized Keychain Project

<p>Student Learning Intentions (SLI) WALT:</p>	<p>I am learning about TinkerCAD so that I can create</p>
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<p>(We are learning to...)</p>	<p>digital 3D models.</p> <p>I am learning how to visualize complex shapes as a series of simple ones so that I can create interesting, custom 3D models in TinkerCAD.</p> <p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p>
<p>Student Learning Strategies</p>	<p>Self-reflection Class discussion Drawing practice Visual models Engineering Design Process Hands-on project work</p>
<p>Success Criteria</p>	<p>I can use proper vocabulary to accurately describe what I'm doing in CAD software.</p> <p>I can create and modify an object and groupings of objects in a 3D CAD program.</p> <p>I can put together basic solid and hole shapes in interesting ways to create complex shapes in TinkerCAD.</p> <p>I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Successful completion of the design challenge.</p> <p>Using the Engineering Design Process to guide project creation.</p> <p>Check-ins on student progress conducted daily.</p>
<p>Activities and Resources</p>	<p>As students complete the mini-tutorials, they will receive their first original design assignment - creating a personalized keychain in TinkerCAD.</p> <p>The project should be introduced as a way to continue to follow the engineering design process. Students begin by identifying the task, constraints, and requirements, then brainstorm and blueprint their intended design.</p>

	<p>The keychains should have:</p> <ul style="list-style-type: none"> • Empty (hole) areas in the design that cut completely through the keychain. • A keyring hole of diameter 3mm (or 1/8 inch) near an edge. • Text appropriate for school (maybe your name or initials). • An original design or embossed/debossed image made by you. <p>Show students examples of what each of these requirements represent, and allow them to be creative! Students will be assessed based on their use of the design process to create a keychain that meets the provided requirements.</p> <p>This project is not intended to take more than a couple days, and is meant as a bridge directly into 3D printing.</p>
<p>Suggested Modifications</p>	

MODULE 5

Activity 5 - Introduction to 3D Printing

<p>Student Learning Intentions (SLI) WALT: (We are learning to...)</p>	<p>I am learning about 3D printing so that I can understand its importance to design and manufacturing today.</p>
<p>Student Learning Strategies</p>	<p>Peer learning Self-reflection Class discussion</p>

	<p>Videos</p> <p>Visual models</p> <p>Teacher and peer modeling/demonstration</p>
Success Criteria	I can describe several ways that 3D printing is used by people to create and iterate on real-world designs.
Formative Assessment (drives instructional decisions)	<p>Participation in class discussions.</p> <p>Successful export and sharing of 3D model files.</p>
Activities and Resources	<p>After students have finished their keychain projects, introduce 3D printing with video. After, engage students in discussion - ask what stood out to them from the video, or for something new that they learned.</p> <p>Share resources with students and describe 3D printing through an infographic. Walk students through the process of conceptualizing an idea, planning, building a 3D model, and preparing it for 3D printing.</p> <p>When finished, show students how to export their 3D models from TinkerCAD for 3D printing and sharing. When students have finished their keychain projects, they can export and share them for printing.</p>
Suggested Modifications	

MODULE 6

Activity 6 - Cell Phone Stand Iteration Project

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about TinkerCAD so that I can create digital 3D models.</p> <p>I am learning how to visualize complex shapes as a series of simple ones so that I can create interesting, custom 3D models in TinkerCAD.</p> <p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p>
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	<p>I am learning about the importance of reflection and iteration in the engineering design process.</p>
<p>Student Learning Strategies</p>	<p>Self-reflection Iteration Class discussion Visual and physical models Engineering Design Process Journal writing Hands-on project work Teacher and peer modeling Vocabulary</p>
<p>Success Criteria</p>	<p>I can use proper vocabulary to accurately describe what I'm doing in CAD software.</p> <p>I can create and modify an object and groupings of objects in a 3D CAD program.</p> <p>I can put together basic solid and hole shapes in interesting ways to create complex shapes in TinkerCAD.</p> <p>I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.</p> <p>I can reflect on a design I have created and make changes that improve it through iteration.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Participation in class discussions.</p> <p>Successful completion of the design challenge.</p> <p>Successful completion of the reflection for their design.</p> <p>Check-ins on student progress conducted daily.</p>
<p>Activities and Resources</p>	<p>Introduce 3D Printing Vocab: Rapid Prototyping, FDM/FFF, GCode, Slicer, Layer Resolution, Print Speed. Show students examples of GCode and slicers; and relate layer resolution and print speed to 3D print quality.</p> <p>Students will continue their practice within the TinkerCAD software and use the Engineering Design Process to iterate on their previously created cell phone stand prototypes. Describe to students how engineers often go</p>

through many iterations and prototypes before arriving at a finished product - it's important to note how improvements may be made and try to accomplish them!

For this project, students will need to:

1. Review and reconsider improvements on their cell phone stand prototypes. The new 3D model will still need to meet the original requirements:

- A cradle or shelf to hold the phone upright at an angle between 90 degrees and 135 degrees.
- A base to keep the stand from falling over.
- A channel to run a charging cable through and secure the charging port under the phone.

2. Create a new project and build the cell phone stand in TinkerCAD.

3. Once complete, add a Google Doc to this assignment and complete a one-paragraph reflection on the project. Students can include what they did, what they thought of the project, what they changed to improve it, compare it to the cardboard prototype, etc. This is the COMMUNICATE step in the Engineering Design Process.

4. Once the cell phone stand has been built in CAD, double check that there are no floating or disconnected pieces.

Suggested Modifications

MODULE 7

Activity 7 - How do 3D Printers Work?

Student Learning Intentions (SLI) WALT:
(We are learning to...)

I am learning about CAD and 3D printing terms so that I can accurately describe my work in CAD and when 3D printing.

	<p>I am learning about the parts of a 3D printer so that I can describe how a 3D printer works to create a printed model</p>
<p>Student Learning Strategies</p>	<p>Peer learning Self-reflection Class discussion Systems understanding through hands-on process replication Visual and physical models Teacher and peer modeling/demonstration Vocabulary</p>
<p>Success Criteria</p>	<p>I can use proper vocabulary to accurately describe my work in CAD software and when 3D printing.</p> <p>I can describe the process of 3D printing from filament to printed model</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Participation in class discussions.</p> <p>Hands-on replication of 3D printer actions.</p> <p>Exit ticket question.</p>
<p>Activities and Resources</p>	<p>Introduce the next section of 3D printer vocab: filament, ABS, PLA, Extruder, Nozzle, Hotend, Printbed. During the introduction, show students examples of each while demonstrating 3D printer parts and technology using a deconstructed 3D printer as well as 3D printed models.</p> <p>To better understand how a 3D printer works, explain to students that <i>they</i> will now go through the actions of a 3D printer. Create small groups of students. Have one student act as the “printer” (they will use a 3D printing pen), and the other student(s) will write instructions out like GCode to be followed using a simple coordinate plane. Throughout the activity, reinforce 3D printer vocab and the process of 3D printing as covered in the demonstrations earlier.</p> <p>To gauge understanding, students should answer a question in Google Classroom at the end of class - “From start to finish, list the four main parts of a 3D printer, in the order that filament travels to them. Next, explain what happens to the filament as it goes through this process.” Ans: Through the extruder, to the hotend, out the nozzle, onto the printbed. The filament is forced through the</p>

	printer by the extruder, melts in the hotend, comes out of the nozzle, deposits on the printbed, and slowly cools.
Suggested Modifications	

MODULE 8

Activity 8 - Parts of a 3D Printed Design

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about CAD and 3D printing terms so that I can accurately describe my work in CAD and when 3D printing.</p> <p>I am learning about 3D printed designs and slicer software settings so that I can plan for and work around their limitations.</p>
Student Learning Strategies	<p>Peer learning</p> <p>Self-reflection</p> <p>Class discussion</p> <p>Systems understanding through hands-on process replication</p> <p>Visual and physical models</p> <p>Teacher and peer modeling/demonstration</p> <p>Vocabulary</p>
Success Criteria	<p>I can use proper vocabulary to accurately describe my work in CAD software and when 3D printing.</p> <p>I can choose the correct settings for a 3D print so that it will complete the way I want.</p>
Formative Assessment (drives instructional decisions)	<p>Participation in class discussions.</p> <p>Hands-on creation of vocabulary models.</p>
Activities and Resources	<p>Review and reinforce the 3D printing process from the previous activity. Lead this into a discussion of what 3D prints ultimately look like.</p> <p>3D prints don't always come out perfect. There are many things that have to be checked before printing, and</p>

	<p>sometimes extras need to be printed along with the design just to make it finish correctly.</p> <p>Present examples of the same models that were sliced using different settings for infill and supports. Explain how the models were exactly the same, but the settings were different when they were processed for 3D printing. Ask students how very tall buildings and bridges are made, and how that might be relevant to 3D printing (they're all supported!). Hot melted plastic acts more like a liquid, so it doesn't just stay in place. When there are overhangs, support structure needs to be printed underneath, and removed after the print finishes. Show examples and provide explanations for each of the remaining 3D printer vocab words: Infill, Overhang, Raft, Shell, Slice, Support.</p> <p>To demonstrate understanding, have students work in small groups to identify and create examples of each of the vocab words using 3D printing pens and drawings, where appropriate.</p>
Suggested Modifications	

MODULE 9

Activity 9 - CAD and 3D Printing Vocab Review and Quiz

Student Learning Intentions (SLI) WALT: (We are learning to...)	I am learning about CAD and 3D printing terms so that I can accurately describe my work in CAD and when 3D printing.
Student Learning Strategies	<ul style="list-style-type: none"> Gamification Vocabulary Self-reflection Peer learning
Success Criteria	I can use proper vocabulary to accurately describe my work in CAD software and when 3D printing.
Formative Assessment (drives instructional decisions)	<p>Participation in vocabulary game.</p> <p>Completion of vocabulary quiz.</p>

Activities and Resources	Spend a period reviewing CAD and 3D printing vocabulary through Factile Jeopardy (or similar) in preparation for a quiz the next day. Full quiz ; abbreviated quiz .
Suggested Modifications	

MODULE 10

Activity 10 - Movable Parts Project

Student Learning Intentions (SLI) WALT: (We are learning to...)	<p>I am learning about TinkerCAD so that I can create digital 3D models.</p> <p>I am learning how to visualize complex shapes as a series of simple ones so that I can create interesting, custom 3D models in TinkerCAD.</p> <p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p> <p>I am learning about clearance, tolerance, wheels and axles, hinges, and ball and socket joints so that I can create designs with movable parts.</p>
Student Learning Strategies	<ul style="list-style-type: none"> Peer learning Self-reflection Class discussion Drawing practice Visual models Engineering Design Process Journal writing Hands-on project work Teacher and peer modeling
Success Criteria	<p>I can use proper vocabulary to accurately describe what I'm doing in CAD software.</p> <p>I can create and modify an object and groupings of object in a 3D CAD program.</p> <p>I can put together basic solid and hole shapes in</p>

	<p>interesting ways to create complex shapes in TinkerCAD.</p> <p>I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements..</p> <p>I can use tolerance and clearance effectively to create a design that incorporates movable parts.</p>
<p>Formative Assessment (drives instructional decisions)</p>	<p>Participation in class discussions.</p> <p>Successful completion of the design challenge.</p> <p>Successful completion of the Engineering Design Process Journal for their design.</p> <p>Check-ins on student progress conducted daily.</p>
<p>Activities and Resources</p>	<p>Introduce next CAD Project: Create Using Movable Parts</p> <p>Introduce design examples and demonstrate how each was built. Explain the concepts behind creating successful movable parts, and demonstrate why each is important using 3D printed models.</p> <p>Students will follow the engineering design process to research, brainstorm, sketch, blueprint, and model a project that utilizes movable parts.</p> <p>The design should:</p> <ul style="list-style-type: none"> • Have at least two movable joints • Contain no more than 10% "borrowed" or pre-made parts • Be no smaller than 2 inches in any dimension (overall) • Be no larger than 6 inches in any dimension (overall) •

	<p>Be an original design, by the student.</p> <p>Students will complete an engineering design process journal, recording design decisions from start to finish, and will be assessed based on their adherence to the project requirements and their journal reflections.</p>
Suggested Modifications	

MODULE 11

Activity 11 - CAD Free Choice Project

<p>Student Learning Intentions (SLI) WALT: (We are learning to...)</p>	<p>I am learning about TinkerCAD so that I can create digital 3D models.</p> <p>I am learning how to visualize complex shapes as a series of simple ones so that I can create interesting, custom 3D models in TinkerCAD.</p> <p>I am learning to use the engineering design process to plan and produce a product that solves a problem.</p> <p>I am learning about the importance of communication in the engineering design process.</p>
<p>Student Learning Strategies</p>	<ul style="list-style-type: none"> Peer learning Self-reflection Class discussion Drawing practice Visual models Engineering Design Process Journal writing Hands-on project work Teacher and peer modeling
<p>Success Criteria</p>	<p>I can use proper vocabulary to accurately describe what I'm doing in CAD software.</p> <p>I can create and modify an object and groupings of objects in a 3D CAD program.</p>

I can put together basic solid and hole shapes in interesting ways to create complex shapes in TinkerCAD.

I can use the engineering design process to understand a problem and develop a solution that meets specified constraints and requirements.

I can communicate a design I have created to others and give feedback on peers' designs.

Formative Assessment (drives instructional decisions)

Successful completion of the design challenge.

Successful completion of the Engineering Design Process Journal for their design.

Check-ins on student progress conducted daily.

Activities and Resources

Introduce a final CAD assignment: Choice Project

For this project, students will make something decorative and/or functional. The design needs to be:

- No smaller than 5cm in at least one dimension (exceptions can be made - check with Mr. Meyers first).
- No larger than 10cm x 10cm x 10cm.
- Functional (it needs to do something) and/or decorative (it can be just for show).
- Of moderate complexity (see the teacher for approval)
- Each student's own personal design!

This project will act as a culmination of students' learning in CAD and 3D printing, and should demonstrate all the concepts covered to create both a successful 3D model and 3D printed object. Students will complete an

engineering design process journal, will show off their work through a critique, and will be assessed based on the project requirements and reflections on work through journals.

Suggested Modifications

SUGGESTED MODIFICATIONS

Suggested Modifications (ELL, Sp. Ed, Gifted, At-risk of Failure)

English Language Learners

Native language support: The teacher provides auditory or written content to students in their native language.

Adjusted Speech: The teacher changes speech patterns to increase student comprehension. This could include facing students, paraphrasing, clearly indicating the most important ideas, and speaking more slowly.

Visuals: The teacher uses graphics, pictures, visuals, and manipulatives. This helps ELL students better understand and comprehend the subjects at hand.

Front-Loading Vocabulary: The teacher front loads vocabulary. This means providing students with a list of important vocabulary words they will need to know for a book, lesson, etc. prior to the lesson being taught. Including pictures to go with the vocabulary words is also very beneficial for the students.

Special Education Students

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Oral Reading: The teacher will read work orally to students. Class work such as tests and literature circles may need to be read aloud to the student.

Timers: The teacher will use timers as an instructional tool. The use of timers is beneficial for students who have trouble completing tasks. Timers can be helpful so the student is aware of how much time they have to complete an assignment.

Students with 504 Plans

Chunking: The teacher presents information in a way that makes it easy for students to understand and remember. Chunking is based on the presumption that our working memory is easily overloaded by excessive detail. The best way to deliver information is to organize it into meaningful units. Because students with special needs get overloaded easily, chunking is an effective strategy to use with them.

Checking for Understanding: It is important to constantly check for understanding, especially for students who have accommodations. Teachers want to make sure students understand the concepts being covered in a way that makes sense to them.

Extra time: The teacher provides students with special needs extra time to complete work or answer questions. It is important to give students enough time to process their thoughts.

Gifted & Talented Strategies

Extensions/Enrichments: Teachers will provide gifted and talented students with extension/enrichment projects. Students will be challenged to further their understanding, to apply acquired knowledge, and/or to produce something in reference to acquired knowledge.

Modify/Change Activities: Teachers will monitor and modify activities to accommodate those students who need to be challenged further. Additional reading, problem-solving, writing, or project work is necessary for those students who are ready to move on at a rate more accelerated than their peers. In this way, G & T students are provided the same opportunity for support as special needs students.

Students at Risk of School Failure

Directions or Instructions: Make sure directions and/or instructions are given in limited numbers. Give directions/instructions verbally and in simple written format. Ask students to repeat the instructions or directions to ensure understanding occurs. Check back with the student to ensure he/she hasn't forgotten.

Peer Support: Peers can help build confidence in other students by assisting in peer learning. Many teachers use the 'ask 3 before me' approach. This is fine, however, a student at risk may have to have a specific student or two to ask. Set this up for the student so he/she knows who to ask for clarification before going to you.

Alternate or Modified Assignments: Always ask yourself, "How can I modify this assignment to ensure the students at risk are able to complete it?" Sometimes you'll simplify the task, reduce the length of the assignment or allow for a different mode of delivery. For instance, many students may hand something in, the at-risk student may jot notes and give you the information verbally. Or, it just may be that you will need to assign an alternate assignment.

Increase One to One Time: When other students are working, always touch base with your students at risk and find out if they're on track or needing some additional support. A few minutes here and there will go a long way to intervene as the need presents itself.

Contracts: It helps to have a working contract between you and your students at risk. This helps prioritize the tasks that need to be done and ensure completion happens. Each day write down what needs to be completed, as the tasks are done, provide a checkmark or happy face. The goal of using contracts is to eventually have the student come to you for completion sign-offs.

Hands On: As much as possible, think in concrete terms and provide hands-on tasks. This means a child doing math may require a calculator or counters. The child may need to tape record comprehension activities instead of writing them. A child may have to listen to a story being read instead of reading it him/herself.

Tests/Assessments: Tests can be done orally if need be. Break tests down in smaller increments by having a portion of the test in the morning, another portion after lunch and the final part the next day.

Seating: Seat students near a helping peer or with quick access to the teacher. Those with hearing or sight issues need to be close to the instruction which often means near the front.

REFLECTIONS

INTERDISCIPLINARY CONNECTIONS: NEW JERSEY STUDENT LEARNING STANDARDS FOR ELA, SOCIAL STUDIES, SCIENCE AND/OR MATHEMATICS

LA.RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

LA.RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

LA.RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).