Project/Problem Based Learning Lesson Template

Created By: **A Tennessee Teacher**	**Topic: Greenhouse Design Using 3D modeling and printing**	**Grade Level or Subject:** **Greenhouse Management C18H17** **10th-12th Grades**
Science Standards:		
Math Standards: (Geometry) Standard G.MG.A.2 (Major Work of the Grade) Apply geometric methods to solve real-world problems		
ELA Standards: 9-10 9-10.SL.PKI.4 Present information, findings, and supporting evidence clearly, concisely, and logically, so that listeners can follow the line of reasoning; ensure the organization, development, substance, and style are appropriate to purpose, audience, and task. 9-10.SL.PKI.5 Make strategic use of digital media and visual displays in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.		
Computer Science Standards:		
CTE (Program of Study) Standards: Greenhouse Design, Construction, and Components		

2.3 Design: Create an annotated model representing research-based practices in greenhouse planning and design and justify the process outlined for specific crops. The design must include at least the following items: structure materials, layout, lighting, bench arrangements, traffic flow, and physical location
Additional Standards (Social Studies, Art, Physical Education, etc.):

PBL Summary: Write a few sentences describing this PBL lesson/unit. Students will draw upon a wide base of cross-curricular knowledge including geometry, horticulture, computer-aided design, and English/Language arts to create a model of a greenhouse. Students will first draft a hand drawn greenhouse model using scaling and best practices (see standard 2.3 above). This model, once approved, will be transferred to a CAD program and then successfully 3D printed. All scaling, angles, and measurements for surface areas must be included in the final design and used to determine build cost. The design must include: a list of structure materials, an annotated layout, lighting plan, bench layout, proposed location, and traffic flow plan. The student must notate the proposed primary crop/plant usage of this greenhouse in order to justify design decisions. Students will concurrently be working on achieving the BASF	**Multi-Dimensional/Driving Question:** Think of a relevant problem with multiple solutions that will drive student learning. How might you, as a member of an innovative design team, design a greenhouse to implement new and innovative plant production techniques here in West Tennessee?

plant science certification while working on this PBL. Students will need to rely heavily on material learned from this certification in order to make informed decisions that will determine the design and function of their greenhouse.	

Tennessee Academic Standards for Science Connection		
Disciplinary Core Idea(s): *ETS1: Engineering Design A. Defining and Delimiting and Engineering Problems B. Developing Possible Solutions C. Optimizing the Solution Design	Science & Engineering Practice(s): *Constructing explanations and designing solutions *Obtaining, evaluating, and communicating information *Asking questions (for science) and defining problems (for engineering)	Cross Cutting Concept(s): *Scale, proportion, and quantity that integrate measurement and precision of language *Systems and system models with defined boundaries that can be investigated and characterized

21st Century Skills Addressed (circle all that apply):

Creativity Collaboration Critical Thinking Communication

Culminating Event: What final student learning products will show student mastery of the content area standards?

*Students will design and create a 3D printed model of a greenhouse that will include bench layouts within the design. Students must also submit design plans outlying the proposed lighting, location, and traffic flow for the space.

* Students will use both multimedia and 3D models to present their greenhouses and accompanying research to industry professionals for review and critique

*Students will successfully pass the BASF Plant Science Certification Exam (ICEV)

Hook / CTSO Competition Event: Develop an introductory activity that will spark student interest and further questions. Take students to compete in the FFA Career Development Event: **State Floriculture CDE (Career Development Event) April 22, 2025**	**Industry/Community Partners:** List potential business or industry partners that could add to the learning experience for students. Include websites or contact info. *Morris Nursery www.morrisnursery.net *Greenway Nursery www.greenwaynursery.com *Gibson Farmers CO-OP	What do you need from these partners (i.e. guest speaker, field trip, help facilitate an activity)? ● Utilize partners to view additional greenhouse setups different from the school's (field trips) ● Utilize partner expertise at the beginning of the unit to highlight important greenhouse design tips (guest speakers)

This event will allow students to learn and collaborate with other students in real world simulations. Students can then tie in that experience to their individual greenhouse designs.	www.gfcoop.com	• Partners will be used to introduce the function and necessary components of a greenhouse along with challenges they face.
Daily Activities: What activities will students complete to answer the multi-dimensional/driving question (that reinforces content from the standards)? 1. Students will identify the types of plants they wish to grow and the methods needed to grow these plants. Identification of these plants will come from the Floriculture CDE Competition guidelines. They will then research the best types of greenhouses and systems to accommodate their chosen plants. Students will focus on incorporating new technologies and green innovation into their plans. 2. Students will create a scaled, hand-drawn greenhouse plan (including lighting, traffic flow, bench layouts, location, etc.) 3. Students will compute all the necessary surface areas/ angles for their greenhouse and its components. 4. Utilizing the computed surface areas, students will give a necessary structure materials list, pricing, and total cost-to-build 5. Students will *move* the plan to a CAD program (TinkerCAD) 6. Students will 3D print their final design prototype		**Resources/Materials Needed:** Computers (chromebooks will be sufficient), CAD software (TinkerCAD), 3D printers (Makerbots), Filament (PLA), Graph paper, Architect scales, Pencils Engineering Notebooks (physical)

7. Students will create a presentation outlining their project and its alignment with the engineering design process. *Students will break down how they answered the driving question. *Students will address problems that they encountered and how they addressed them including how their design changed over time. *They will walk the listener through their greenhouse design, their decision making processes and how much it would cost to construct their product. 8. Students will utilize a necessary reflection period after receiving feedback 9. Students will continually be preparing for the BASF Plant Science Certification exam.	

Technology Integration: How is technology being utilized to support students in creating authentic learning experiences and/or products? How does technology enhance the learning experience?

Students will utilize CAD technology in order to design a 3D model and then print it using 3D print technology. Access to both a computer, CAD technology like TinkerCAD, SketchUp, or Solidworks is essential for this unit as well as 3D printers. This technology allows students to bring their designs from a 2D to a 3D format which allows students to get a real-world feel for their designs. Students will be able to see potential flaws easier especially with regards to size and scale which allows for troubleshooting and correction.

Students will also utilize software like Google Slides, Prezi, or Powerpoint to create a multimedia presentation that will be given to industry professionals at the end of the unit.

STEM/STE(A)M Career Connections: What STEM/STE(A)M careers (within your region) can you connect to this PBL Unit of Study?

*Agribusiness Careers -Agronomy, Precision, Horticulturist, Farmer, Agriculture Equipment Technician/Sales, Crop Management/Production

*Agriculture Research
*Botanist
*Ecologist
*Sustainability Consultant
*Environmental Engineering

CTSO Connections: What Career and Technical Student Organization connection can be made with this PBL Unit of Study?
This unit of study will connect with students and provide an opportunity for them to compete in the Floriculture FFA Career Development Events. The top scoring students for this project will be selected to compete in April 2025. This event allows students to learn, collaborate, create, and be judged in real world simulations. This material will also be useful in all FFA Plant Systems competitions.

Capstone Presentation: How will students present what they've learned publicly? This can be the culminating event if that event is presenting what has been learned publicly.

*Students will present their greenhouse models to industry professionals from the partners listed and the CTE teacher at the end of the unit. This presentation will be live and will utilize a multimedia format along with the 3D printed model for review. There will be a question/answer period following the presentation which will allow students to discuss their research and models with real world professionals who can offer compliments and critiques of the given design.
Students will create an additional presentation solely on reflections and improvements of the process. This presentation will include feedback from industry partners and instructors.

Industry Credential: What industry credential opportunity is connected with this particular PBL Unit of Study?
BASF Plant Science Certification (ICEV) - online

Performance Based Rubric

Standards	Developing	On-Target	Mastery
Math Standard G.MG.A.2 (Major Work of the Grade) Apply geometric methods to solve real-world problems	Fewer than 70% of the surface areas and angles for the flooring, walls, roof, and rafters are given. Computations are done but are not correct. Labeling of the measurements is inconsistent throughout the design Materials Cost List and Total Build Cost is not computed.	71-90% of the surface areas/angles for the flooring, walls, roof, and rafters are given. Computations are correct with only 3-4 possible errors. Labeling of measurements is mostly consistent throughout the design with only 1-3 omissions.. Materials Cost List and Total Build Cost exhibits minor errors in computation.	All of the surface areas/angles for the flooring, walls, roof, and rafters are given. Computations are correct with only 1-2 possible errors. Labeling of measurements is consistent throughout the design Materials Cost List and Total Build Cost are accurate.

ELA SL.PKI.5 Make strategic use of digital media and visual displays in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.	Presentation contains all the necessary components; however, two or more of the following are present: *Presentation does not contain sufficient research or design data *Presentation is not consistent with regards to font/sizing *Presentation has few images or embedded media *Presentation has little or no animation *Presentation lacks artistic quality	Presentation contains all the necessary components; however, one of the following is present: *Presentation does not contain sufficient research or design data *Presentation is not consistent with regards to font/sizing *Presentation has few images or embedded media *Presentation has little or no animation *Presentation lacks artistic quality	Presentation contains all the necessary components, is visually pleasing, and appears professional in its overall quality.
CTE Greenhouse Design, Construction, and Components 2.3 Design: Create an annotated	Design exhibits 3 or more of the following: *Measurements for all walls, windows, doors, and roof are not labeled and/or are not computed correctly *Lighting Plan is not sufficient for greenhouse size or proposed plant production *Traffic Flow Plan is missing	Design exhibits 1-2 of the following: *Measurements for all walls, windows, doors, and roof are not labeled and/or are not computed correctly *Lighting Plan is not sufficient for greenhouse size or proposed plant production	Design is complete and fulfills all requirements of the assignment. The 3D model is clean and the design is a match to the 2D

model representing research-based practices in greenhouse planning and design and justify the process outlined for specific crops. The design must include at least the following items: structure materials, layout, lighting, bench arrangements, traffic flow, and physical location	or insufficient *Bench Layout is missing or is insufficient * Greenhouse does not align well to proposed plant production *Greenhouse location is not adequate with regards to light, drainage, water or electrical needs *Greenhouse materials list is incomplete or recommends materials that are not adequate to meet the needs of the location's climate or proposed plant production. * Greenhouse 3D model is sloppy *Greenhouse 3D model does not match the 2D drawing * Greenhouse does not exhibit any new technology or innovative practices	*Traffic Flow Plan is missing or insufficient *Bench Layout is missing or is insufficient * Greenhouse does not align well to proposed plant production *Greenhouse location is not adequate with regards to light, drainage, water or electrical needs *Greenhouse materials list is incomplete or recommends materials that are not adequate to meet the needs of the location's climate or proposed plant production. * Greenhouse 3D model is sloppy *Greenhouse 3D model does not match the 2D drawing *Greenhouse does not exhibit any new technology or innovative practices	rendering. There are only 1-3 minor errors throughout the scope of the entire project.

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