Category	Life Sciences
Theme	Food Security
Unit 3 Title	We Garden!
Unit Essential Question	How can we improve food production to meet the needs of the growing populations?
Grade Level	Grade (6-8)

Unit Overview

The problem:
With the ever increasing population in Egypt and elsewhere, people need increasing amounts of food. In order to meet the increased food needs in Egypt, we have a lot of options such as importing food, which costs a lot of foreign currency, growing more food or rationalizing our food consumption. The government economic agenda gives priority to different agriculture projects with the aim to enlarge the cultivated area and to guarantee sufficient production of the main crops to satisfy the needs of the growing population. Can you help design a system that facilitates gardening for food production?
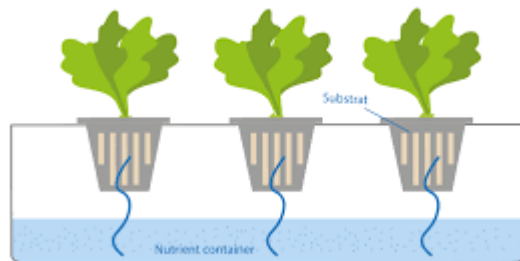
Source: https://www.files.ethz.ch/isn/14877/Hamza-Mason%202004SAVED.pdf

Unit summary:

As they get to learn about improving food production through gardening, students will explore how a plant grows, their cell structure, reproduction, and growth. Besides, students will gain an understanding of how plants can improve air quality, provide agriculture space, increase the aesthetic quality of roofs. They will find out how plants can help them find solutions to some problems in their communities and the world such as urbanization, impact of rapid population growth which erodes the quality of life by decreasing the individual's access to sufficient food. Furthermore, they will acquire knowledge and skills about different methods of growing plants: soil-based and hydroponic planting.

The design challenge for this unit is:
Students will use the information they learn about planting methods and combine that with information about plant characteristics and factors affect its growth to design an inexpensive, aesthetically appealing garden system which allows the plants to thrive and be able to produce more food.

Hydroponic design system

Source: **https://hannainst.com/hydroponics-wick-growing-system**
Soil planting

Source:http://journalstar.info/wp-content/uploads/2019/06/sponsored-raised-bed-garden-boxes-how-to-make-build.jpg

Established Goals
Throughout this unit students will: **Knowledge and understanding:** ● Describe how plants are important parts of maintaining a balanced environment. ● Explain farming methods and tools used by the ancient Egyptian civilizations. ● Recognize the environmental factors affect plant growth. ● Determine the properties and distribution of ecosystems on the earth's surface. ● Collect, organize and represent statistical data . ● Recognize the importance of statistics and probability in real life applications. **Skills:** ● Use research skills to learn about different ways of growing plants. ● Use an observation log for a period of time to record data and write notes. ● Apply a rubric to evaluate content of digital resources. ● Demonstrate how engineers use plants to create technologies that benefit humans. **Values and attitudes:** ● Appreciate the value of natural resources. ● Recognize the importance of social skills to solve a problem. ● Express appreciation to the aesthetic value in designing tools or devices.

Standards Correlation		
Next Generation Science Standards (NGSS)	**The Common Core State Standards (CCSS Math)**	**The Common Core State Standards (CCSS Literacy)**
MS-LS1-4.Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively. MS-LS1-5.Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms. MS-LS2-4. Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations. **MS-ETS1 Engineering Design**	*CCSS.MATH.CONTENT.6.G.A.1* *Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes; apply these techniques in the context of solving real-world and mathematical problems.* CCSS.MATH.CONTENT.5.MD.C.3 Recognize volume as an attribute of solid figures and understand concepts of volume measurement. CCS.7.SP.2.Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. CCSS.MATH.CONTENT.6.SP.B.5.C Giving quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as	CCSS.ELA-LITERACY.RI.6.1 Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. CCSS.ELA-LITERACY.RI.6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments. CCSS.ELA-LITERACY.RI.6.3 Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text (e.g., through examples or anecdotes). CCSS.ELA-LITERACY.W.7.1 Write arguments to support claims with clear reasons and relevant evidence. CCSS.ELA-LITERACY.W.7.2

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.	describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.	Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content. CCSS.ELA-LITERACY.SL.7.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 7 topics, texts, and issues, building on others' ideas and expressing their own clearly. CCSS.ELA-LITERACY.SL.7.1.D Acknowledge new information expressed by others and, when warranted, modify their own views.
National Standards (Maths & Science)	**National Standards (Literacy & Social Studies)**	**Digital Literacy Standards (Massachusetts Curriculum Framework)** http://www.doe.mass.edu/frameworks/dlcs.pdf
Prep. 2 science:	Geography (Prep1):	Safety and Security [6-8.CAS.a]

English	الجغرافيا (Geography)	العلوم (Science)
Explain the connection between the persistence of data on the Internet, personal online identity, and personal privacy. 4. Describe and use safe, appropriate, and responsible practices (netiquette) when participating in online communities (e.g., discussion groups, blogs, social networking sites). 5. Differentiate between appropriate and inappropriate content on the Internet. Ethics and Laws [6-8.CAS.b] 2. Explain possible consequences of violating intellectual property law and plagiarism. Interpersonal and Societal Impact [6-8.CAS.c] 5. Evaluate the bias of digital information sources, including websites. Digital Tools [6-8.DTC.a] Individually and collaboratively, use advanced tools to design and create online content (e.g., digital portfolio, multimedia, blog, webpage). Collaboration and Communication [6-8.DTC.b]	- يحلل البيانات من المنظور الجغرافي مستخدما الأدوات الجغرافية المختلفة (مثل: الخرائط, الرسوم البيانية, النماذج, الصور, والكرات الأرضية). - يستخدم الخرائط والنماذج والمجسمات لتوضيح التوزيعات المكانية على سطح الأرض مثل: توزيع القارات, والمحيطات, والأقاليم النباتية, والأقاليم المناخية. - يستخدم شبكة المعلومات الدولية (الإنترنت) في جمع معلومات مصورة عن (المجموعة الشمسية, والأقاليم المناخية, والأقاليم النباتية). - المجال الثالث: البيئة المجتمع - المعيار الأول: توضيح العلاقة المتبادلة بين البيئة الطبيعية والبيئة البشرية - يعطي تعريفا لكل من (البيئة – النظام البيئي - التوازن البيئي - مجموعة شمسية – مجرة – كوكب – نجم - تسونامي ..) - يوضح تأثير الإنسان في البيئة الطبيعية. Geography (Prep. 2). - يقارن بين خصائص الأقاليم النباتية وأهميتها في الوطن العربي - يستنتج العلاقة بين الأقاليم المناخية والأقاليم النباتية المجال الرابع: البيئة والمجتمع المعيار الأول توضيح العلاقة المتبادلة بين البيئة الطبيعية والبيئة البشرية - يبحث مشكلة بيئية معاصرة في وطنه العربي مستخدما تكنولوجيا المعلومات وأثرها على الإنسان - يستنتج تأثير بعض الأنشطة الاقتصادية على البيئة بالوطن العربي	- يفهم المتعلم أهمية وآليات النقل في الكائنات الحية - يوضح مفهوم النقل وأهميته للكائنات الحية - يوضح مفهوم الانتشار - يستقصي عمليا الانتشار كعملية حيوية لنقل المواد من وإلى الخلية - يوضح مفهوم الاسموزية - يستقصي عمليا الاسموزية كعملية حيوية لنقل المواد من وإلى الخلية - يوضح أهمية الانتشار والأسموزية للكائن الحي - يصف سلوك الخلية في الأوساط مختلفة التركيز - يصف كيفية امتصاص النبات للماء والأملاح المعدنية من التربة - يبين توزيع ووظيفة أنسجة النقل في النباتات الزهرية - يوضح مفهوم وأهمية النتح للنبات.

	- يضع خطة للتنمية المستدامة للموارد الاقتصادية بالوطن العربي التربية الوطنية: المجال الأول المواطنة والوعي السياسي المعيار الأول: تعرف مفهوم المسؤولية المجتمعية وأهميتها - يتعرف مفهوم المسؤولية المجتمعية - يقدر أهمية ممارسة المسؤولية المجتمعية على تقدم المجتمع	1. Communicate and publish key ideas and details individually or collaboratively in a way that informs, persuades, and/or entertains using a variety of digital tools and media-rich resources. Research [6-8.DTC.c] Perform advanced searches to locate information using a variety of digital sources (e.g., Boolean Operators, limiters like reading level, subject, media type). 2. Evaluate quality of digital sources for reliability, including currency, relevancy, authority, accuracy, and purpose of digital information. 3. Gather, organize, and analyze information from digital sources by quoting, paraphrasing, and/or summarizing. 4.Use digital citation tools to cite sources using a school- or district-adopted format [e.g., Modern Language Association (MLA)], including proper citation for all text and non-text sources (e.g., images, audio, video)

Integrated Concepts

Science	Engineering & Technology	Maths
- Plant structure - Plant classification - Plant adaptation - Plant fertilization - Plant Reproduction - Plant nutrition Plant cycles (Photosynthesis-Transpiration)	Models of planting systems	- Statistics - Mode-median-mean - Area - Volume - Three dimensional figure
Literacy/ Language Arts	**Social Studies**	**Citizenship**
- Informational text - Research paper structure - Reflection - Paraphrasing - Present claims & findings	- Farming methods and tools in ancient civilization - Overpopulation - Urbanization - Climate & plant types	Social responsibility
Digital Literacy	**Art**	**Physical Education**
Evaluate credibility of online resources	- Nature & art - Environmental art	Natural grass & playing fields

Lesson	Lesson Questions	Learning Objectives	Assessment Evidence

Phase 1: Identify the problem/the need	- What is overpopulation? - What are the effects of increasing population? - What are the most overpopulated areas in the world and Egypt? - How does overpopulation happen? - How does urbanization relate to overpopulation? - How can environmental engineers help us improve food production to meet the needs of the growing populations?	-Identify the definition and effects of overpopulation -Dramatize the problem of overpopulation -Rank 10 countries with the largest population (from largest to smallest). -Compare food production with population density -Calculate population density of Egypt governorates. -Suggest solutions to the problem of food shortage. -Evaluate the reliability of a country population statistics of different digital resources	
Design challenge milestone 1	What are we designing? And why?	-Identify the need and requirements for the engineering design project. -Brainstorm ideas about preliminary constraints, requirements, and target audience -Raise questions about the problem of the design challenge	

Phase 2: Search/learn the basics (plant characteristics)	What is the structure of a typical flower? What are the characteristics of each part of the flower? What are the functions of each part of the flower? What makes a flower male, female or unisexual? What are the types of reproduction in plants? What is the process of reproduction in plants? What is pollination? What are the types of pollination? How do flowers get pollinated? How do flowers get fertilized? How does sexual reproduction differ from asexual reproduction in plants? What are examples of asecual reproduction in plants?	• Name the different parts of a typical flower. • Identify the characteristics and functions of the different parts of a typical flower. • Identify the organs that make a flower male, female or unisexual. • Name the reproductive organs in flowering plants. • Identify the environmental factors which affect plant growth. • Evaluate the effect of a missing element on plant growth. • Measure the growth rates of plants and display results on different types of graphs. • Choose the appropriate type of grass for different playing fields.	
Phase 2: search/learn the basics (plant growth)	What things are needed in order for photosynthesis to occur? What are the products of photosynthesis? Where in the plant does photosynthesis occur? What affects a plant growth? How does soil type affect plant	• Explain the main components of photosynthesis process • Compare the amounts of photosynthesis that occur under conditions of low and high light levels • Calculate the mean, mode, median and range for the number of bubbles produced in the experiment	

	growth? What types of grass can be used in playing fields? How colors can be used to draw nature? How is art related to nature?	- Apply the scientific method steps to conduct an experiment - Identify the environmental factors which affect plant growth. - Evaluate the effect of a missing element on plant growth. - Measure the growth rates of plants and display results on different types of graphs. - Choose the appropriate type of grass for different playing fields. - Describe Fauvism and how it differs from other styles. - Draw and create large flowers utilizing vivid, contrasting colors and detail. - List the characteristics of Fauvism.	
Engineering Design Milestone 2	What new things did we learn about the design problem? Do we need to change anything with our design overall goals?	Revisit initial design questions. Conduct further research on the design problem as needed. Reflect on knowledge and skills acquired during phase 2. Connect acquired knowledge and skills to the design challenge.	
Phase 3 Explore possible solution	How did agriculture play a role in ancient Egypt? What agricultural techniques did	Explore the agricultural techniques used by ancient Egyptians. Identify the tools they use to grow plants.	

	ancient Egyptians use? What tools did the Egyptians use for farming and irrigation? What crops did the Egyptian Farmers grow? What were the main farming seasons? How did the Egyptian Farmers water their crops? Why was a papyrus plant common in ancient Egypt? What are the pros and cons of hydroponic and soil planting?	● Explain the main farming seasons. ● Create a Facebook album to display the importance of a papyrus plant, environmental conditions for its growth. ● Illustrate the importance of a papyrus plant and its structure. ● Debate hydroponic planting as methods of planting. 　● Explore different methods of growing plants. 　● Do a research paper on the pros and cons of hydroponic and soil planting. 　● Support evidence of how they feel about the topic.	
Engineering Design Milestone 3	What are the available solutions to the problem? Which solutions are more effective? How can we make use of the available solutions in creating our design?	Research existing solutions to the unit's problem. Evaluate existing solutions by identifying their strengths and weaknesses. Decide on ideas or technologies that could inspire the design solution.	
Phase 4 Plan for action	What are the materials needed for the design?	● Select materials to be used for the design ● Give feedback on other	

Engineering Design Milestone 4	How much does the garden system cost? What are the design constraints? What are the solutions? What types of plants we can grow? What are the shapes of containers?	teams' ideas. ● Apply a brainstorming technique to generate ideas about the challenge. ● Calculate the area the plants need and the volume of 3D shapes. ● Sketch the final prototype for the garden. ● Choose the type of plants which they grow.	
Phase 5 Build, test & redesign **Engineering Design Milestone 5**	Would our design meet the required specifications? What are the weaknesses and strengths of the design? What can we do to improve our design?	1. Create an initial (prototype) version of the design. 2. Evaluate design functions with regards to specifications. 3. Redesign to solve problems in initial design and make the necessary modifications.	
Phase 6 Communicate & reflect **Engineering Design Milestone 6**	How can we present our solution? How do we evaluate the entire design process? How do we feel about the entire process? To what extent are we satisfied with our participation within the design teams? How was our final product different from the initial design? What helped us decide on the final solution? What did we learn from the process? What do we need to consider for future designs?	1. Present the final designs and describe the process. 2. Communicate with other teams to get feedback. 3. Reflect on the full design process.	

Phase 1 **Identify the Problem or Need**
Activity 1:Overpopulation

Activity Duration: **90 minutes**	**Activity type:** **Individual and group work**	**Resources** **Suggested website for strategies to arrange students for group work** **https://www.teachhub.com/30-ways-arrange-students-group-work**

Activity objectives:
- Identify the definition and effects of overpopulation
- Dramatize the problem of overpopulation

Materials needed:
Posters, colored markers
Printed worksheets

Procedures:
-Students are asked to draw the map of their country. They are divided into four different group sizes, but they are given the same amount of materials to do the required task.
-The teacher can determine each group size based on the class size. If the class size is 25, the first group size can be 10 students. The second group size is 5 students. The third group size is 3 students. The last group size is 7 students.
- Each group is given a poster and three markers to draw the map. Students are given 15 minutes to organize their work and do the task.
-After doing the task, students are individually asked to reflect on the task, answering the questions below:

Reflection worksheet

Name:..

Brief description of the previous map task :...............................

(What were you asked to do and what did you really do?)

Answer:

-Did you face any problems to achieve the task? And Why?

-Did you have an equal opportunity to share in the task?

-How can we define "population and overpopulation" based on your experience to do the task?

-What are the major effects of overpopulation?

-After doing the reflection task, the teacher splits the students back to the same groups of the first task. The big group sizes are divided into sub-groups.

-The groups are asked to summarize their answers of the reflection worksheet to be presented to the whole class.

-The teacher guides the students to focus their presentations on three main points: their experience of the first task, definition of overpopulation and its effects. They are asked to justify their answers and provide examples.

-After presentations, the teacher adds any possible effects which are not stated by students, corrects any misconceptions about the definition of overpopulation, reaches an overarching definition of "overpopulation" with the students.

Activity 2: Statistics of Population

Activity duration:90 minutes	Activity type: Pair and group work	Resources
		• **A World population data sheet** • **CAPMAS Wheat Production** • **An interactive map which illustrates the population of Egypt's Governorates(CAPMAS)** • **Areas of Egypt's Governorates**

Activity objectives:
- Rank 10 countries with the largest population (from largest to smallest).
- Calculate population density of Egypt governorates.
- Compare food production with population density
- Evaluate the reliability of a country population statistics of different digital resources

<u>**Materials needed:**</u>

1-A World population data sheet can be downloaded from here:

2-An interactive map which illustrates the population of Egypt's Governorates

3-Areas of Egypt's Governorates worksheet

4-CRAAP Test worksheet

5-Notebooks

6-Highlighter pens

7-Tape measure

<u>**Procedures:**</u>

-The teacher hands out the world population data sheet and asks the students to use their notebooks to create a table to highlight and rank 10 countries with the largest population (from largest to smallest).

-The teacher asks the class to watch a video on how to draw a bar graph to represent their data.

-Students are given the answers guide to do peer-assessment and review their graphs and data.

-The teacher divides the class into 5 groups and asks them to measure the area of the class.They will first measure the length and then the width of the room. Then multiply the length and width. Length x Width =**Area**.

-Students are asked to divide the number of students by the area of the class. Groups compare their results and the teacher asks them : If we divide the population by the area, what can we call the result?

-The teacher elicits answers and finally displays the equation: **Population Density = Number of People / Land Area.**

-The teacher asks the students to use the interactive map which displays the population of Egypt's Governorates and the handout of areas of Egypt's Governorates to calculate the population density of five governorates.

-The students work in pairs to access Central Agency for Public Mobilization And Statistics (CAPMAS) to compare food production of wheat, sugar cane and rice with Egypt Population in different years.(A handout of these statistics can be printed out)

-The teacher gets the students analyse the statistics and discuss what they elicit after comparing food production to population.

Wheat production
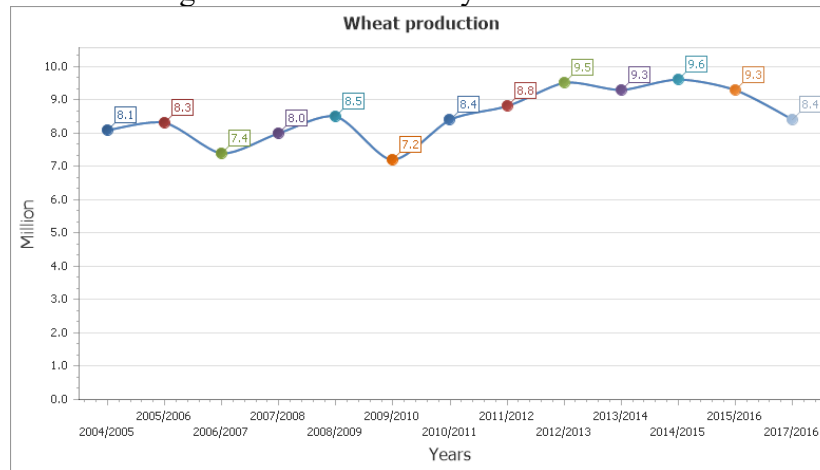
(Example of food production)
Source: https://www.capmas.gov.eg/Pages/IndicatorsPage.aspx?page_id=6151&ind_id=2361
-Finally, the teacher has the students compare Egypt Population Statistics of different digital resources.
(website 1-   website 2-   website 3)
-The teacher raises a discussion with the students and asks if they think these resources differ in showing accurate statistics and how they can determine the reliability of resources we get information from. What makes a resource accurate and reliable?
-After discussion, students watch a video about **CRAAP (Currency, Relevance, Authority, Accuracy, and Purpose)** Test which is a tool to evaluate resources.
-The teacher asks the students to apply CRAAP Test to evaluate the three websites they used to search Egypt population. An extra task can be applying the rubric to one of the statistics handouts used in the class today.

Is it Current?
When was it published? Are their references current? Is currency important for your topic?

Is it Relevant?
Does the info relate to my topic? What audience is it written for? Is it at an appropriate level for my needs?

Is it Authoritative?
Who is the author/organization? Are they qualified? Is it edited or peer-reviewed? If a website, does the URL tell you anything?

Is it Accurate?
Where does the information come from? Are there references? Are there errors, broken links etc

What is its Purpose?
What's the purpose of the information? Advertising? Scholarly work? Opinion? Is there bias?

Adapted from Meriam Library, California State University, Chico California

Sources : https://libguides.csun.edu/iep/craap

Engineering Design Milestone		
Activity duration: 45 minutes	**Activity type: Group Work**	**Resources** ● **Source of Project Graphic Organizer** ● **GRASPS** ● **Video**
Activity objectives: ● Identify the need for the engineering design project. ● Express the problem of the challenge in their own words. ● Suggest topics they need to know to solve the problem of the challenge. ● Raise questions about the problem of the design challenge		
Materials needed: Printed worksheets		

Envelopes
Colored index cards
Procedures:
-The teacher lets the students choose colored index cards from a stack to be divided into five groups based on the colors they picked up.
-The teacher tells the students that a letter has been sent to them today. The letter shows that your community suffers from vegetable shortage in the groceries and its price increase and they need the engineer teams of the class to find a solution to provide them with vegetables they need during the year.
-They are asked to read the letter to guess the design challenge for the unit and write down three questions to get more information about the challenge.
-The groups take turns to discuss their guesses and pose their questions to the teacher to help them get closer to the right guess.
- After discussion, the teacher presents the design challenge, using **GRASPS** Strategy.

Project Challenge Presentation
Scenario

Goal: to help your community get fresh vegetables they need.
Role: you are agricultural engineers
Audience: rural or urban communities
Situation: you are asked to develop a plan for the project, including initial budget, timeframe, required materials,and constraints
Product: you need to design an inexpensive, aesthetically appealing garden which allows the plants to thrive.

 - Throughout unit, the teacher uses the project graphic organizer below to help the students develop a plan for the project and raise questions about the design challenge.
-Students are asked to come up with preliminary thoughts about the challenge based on the information they are provided with in this phase.
-The teacher ends the activity with asking the students to watch a video about the design engineering process.
-The teacher discusses with the students how this plan is subject to modifications through the other phases of the design challenge based on new understanding and digging deeper into knowledge about the challenge.

Project Graphic Organizer Handout

Group: **Date:**

Solution

Obstacles

What I want
to know

The
problem

Materials

Questions
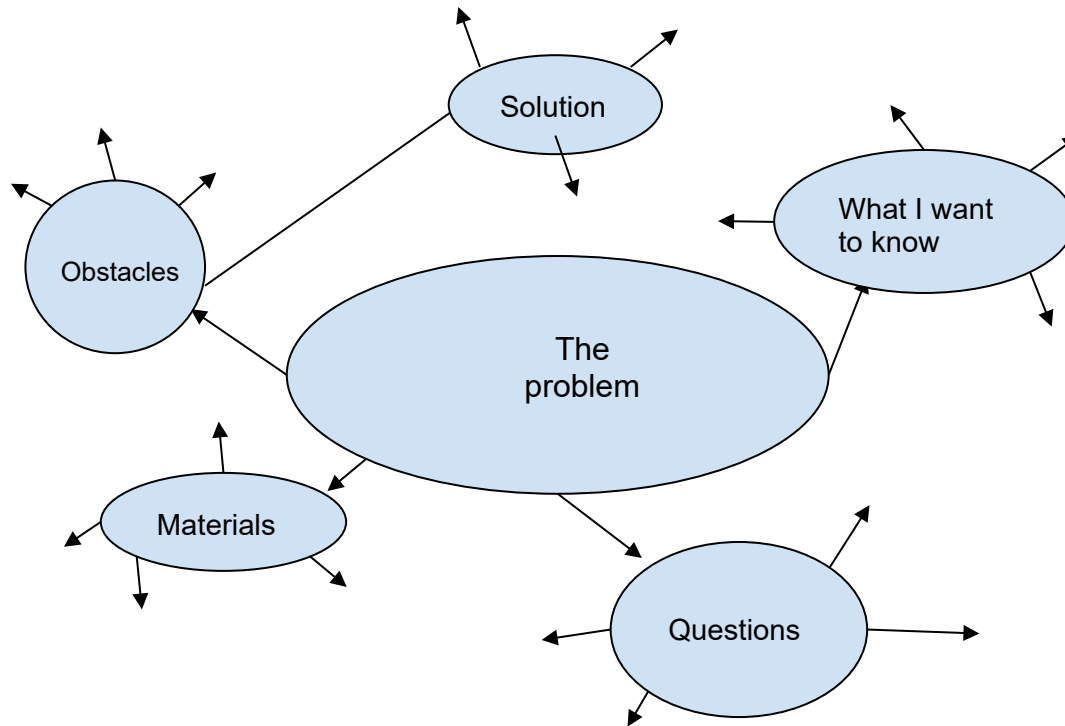
Phase 2 **Learn the Basics/Search**		
Activity 1: Plant Characteristics		
Activity Duration: 90 minutes	**Activity type:**	**Resources** [information text resource : flower parts](#)

Activity objectives:
- Name the different parts of a typical flower.
- Identify the characteristics and functions of the different parts of a typical flower.
- Identify the organs that make a flower male, female or unisexual.
- Name the reproductive organs in flowering plants.

Materials needed:
-Different types of flowers
-Magnifying glasses
-Microscope

Procedures:
-The teacher asks the students to work individually to observe different types of flowers with magnifying glasses and record their notes.
-Students work in pairs to brainstorm a list of all flower parts they observe. Then, they share the list with the class in turn while the teacher writes a list of all parts shared on the board.
-The class is divided into groups based on their learning styles to answer a worksheet in which they will label a blank flower diagram and identify the function of each part. They are asked to search the internet, read an information text or watch a video to do the task.

Parts of a Flower

anther   receptacle
filament   sepal
ovary   stamen
petal   stigma
pistil   style

© edHelper

Source: https://i.pinimg.com/originals/0a/87/68/0a8768564a6c647f518b1054e01875d5.gif
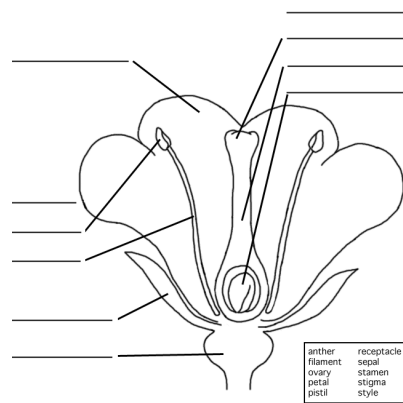
-The teacher asks the students to dissect their flowers carefully by removing each part. Then, they use the magnifying glasses or microscopes to have a look at each part, recording their data on the worksheet below:

A flower part I found	Description	How is it similar or different from another flower?

-Students work in pairs to share the observations of parts they find and take notes of similarities and differences.
-The teacher ends the activity with a class discussion about how the female and male parts were similar in each flower.

Activity 2:

Activity duration: 50 minutes	Activity type: individual- pair work	Resources plant pollination video

Activity objectives:
- Identify the types of pollination.
- Describe the methods of cross pollination.
- Define the meaning of fertilization.
- Explain the process of fertilization.
- Compare and contrast sexual and asexual reproduction in plants.
- Identify different means of asexual reproduction in plants.

Materials needed:
Different types of fruits
Colored construction papers
Wool balls
Tissue paper
Cotton
Markers
Glue
Procedures:

-Students are given a worksheet to fill the first column by reading questions and make their own hypotheses to answer them:

Questions	Make a hypothesis	Take notes	Conclusion
1-How are the plants pollinated? 2-Are there outside elements which help the plants get pollinated? 3-What are these elements? 4-How are plants fertilized?			

-Students work in pairs to discuss their hypotheses and then, share them with the class.
-The teacher asks the class to watch a video about plant pollination and take notes to verify their hypotheses based on the information they get from the video.
-Students still work in pairs to dissect a fruit to answer the following questions:
- -What part of the fruit is the ovary?
- -What part of the fruits are the ovules?
- -Compare the fruit structure of different fruits.
-Students work in groups to design models of flowers in which they label the different parts of flowers and show how they are pollinated differently.
-Each group presents their work to other groups, describing different parts of the flower, their functions and the type of pollination they choose.

Activity 3: What makes plants grow?

Activity duration: 90 minutes	Activity type: group- pair work	Resources
		- mode median mean range video - mode median mean worksheet - scientific method worksheet resource - scientific method video - experiment video - activity source 1 - activity source 2

Activity objectives:
- Explain the main components of photosynthesis process
- Compare the amounts of photosynthesis that occur under conditions of low and high light levels
- Calculate the mean, mode, median and range for the number of bubbles produced in the experiment
- Apply the scientific method steps to conduct an experiment

Materials needed:
- Scientific method printed worksheet
- Whiteboard
- 5 liters (about 1¼ gallons) of water
- aquatic plants/pond weed
- Funnel
- Test tube
- Blue tack to stick the funnel to the beaker to hold the plants underwater
- 500-ml beakers, 1 per team
- baking soda, a few tablespoons (sodium bicarbonate)
- Stop watch
- Desk lamp (light source) for each team
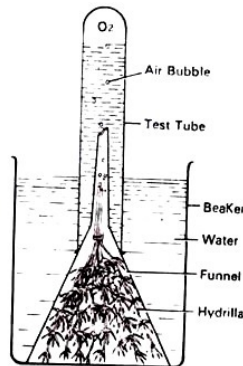
Source:

Procedures:

-Flipped classroom: Before the class , the teacher sends a video and worksheet on how to calculate and practice mode, median, mean and range. Students watch the video and then answer the worksheet as homework.

-The teacher starts the class by asking the students to define the meanings of mode, median, mean, range and give examples in their notebooks.

-The teacher asks the students to work in pairs to share their answers with their peers and then present them to the class to be discussed.

-The teacher introduces the main objectives of the lesson to the class and clarifies that they will need to calculate mode, median, mean and range in the experiment they will be conducting.

Stage 1: Form a hypothesis
-The teacher asks the class questions to assess their prior knowledge of how a photosynthesis process takes place. Students write down their answers for the questions below:
-What "things" are needed in order for photosynthesis to occur?
-Where in the plant does photosynthesis occur?
-Write down the equation of photosynthesis process.
-The teacher asks the students to watch a video to check their answers for any misconceptions or mistakes.
-The teacher passes out the scientific method worksheet and tells the students that they need to fill the worksheet throughout the class.

Scientific Method Worksheet

Make a hypothesis	
Make a plan to test your hypothesis	materials : procedure:
Experiment, Observe and record	

Light intensity	Numbers of bubbles
	Mode= Median= Mean = Range=

	Other observations:
Conclusion	

-The teacher asks the class "what happens if we expose two plants to different amounts of light. What will happen to the plant that receives more light?
-Students give answers and the teacher asks the students, Where can you write your answers for those questions in the worksheet? The teacher explains to the class that before researchers start experiments, they first create a prediction about the expected outcome of the experiment.
-Students write their answers in the form of a hypothesis in the worksheet and examples are given as needed. (The plants that receive more light produce more oxygen than the plants that receive less light)

Stage 2: Experiment, observe and record data
-The teacher divides the students into five groups and explains that they need to move to the next step which is planning for the experiment.
-They are asked to watch a video of the experiment to list the materials and take notes of the procedures.
-The teacher models the experiment and the groups follow the steps:
- Add a solution of baking soda as a source of carbon dioxide in the beaker.
- Place the plant into the beaker of water and cover it with the funnel.
- Fill the tube test with water and put onto the funnel.
- For the first trial, place the lamp at five centimeters away from the beaker.
- Observe and count the numbers of bubbles come up in the test tube in 5 minutes.
- The second trial will be at 10 centimeters away and the last one at 15 centimeters away.

Stage 3: Interpret data and draw Conclusion
-Students work individually to calculate the mean, mode and median for the numbers of bubbles.
-The teacher draws a chart on the whiteboard in which each group writes the data they collected.
-Students are asked to revisit the hypothesis they make and draw conclusions in the worksheet.
-In a class format, the teacher discusses the conclusions they make based on the data they collected.

Activity 4: What affects plant growth?		
Activity duration: 90 minutes	**Activity type: group work**	**Resources**

30 minutes after three days to collect data about plant growth		

Activity objectives:
- Identify the environmental factors which affect plant growth.
- Evaluate the effect of a missing element on plant growth.
- Measure the growth rates of plants and display results on different types of graphs.
- Choose the appropriate type of grass for different playing fields.

Materials needed:

Small containers
Dry kidney beans/wheat seeds
potting mix
Masks and gloves
Ruler-pencils-markers
Potting soil-gravel
Paper bag- clear plastic bag
Freezer- water
Camera
Procedures:

Stage 1: -Students are divided in groups to make a powerpoint presentation of environmental factors affecting plant growth and how they are essential.
-The teacher discusses the presentation rubric with the class.

	Excellent	Developing	Unsatisfactory
Content			

Eye-contact			
Using visuals			
Time limit			
References			

-The teacher tells the class that after you find out the main elements important for plant growth, what do you think if we eliminated one of these elements? we're going to experiment exactly what happens to a plant when one of these elements is missing.

-Students are divided into five groups based on the elements they will eliminate: sunlight, temperature, moisture, air, and nutrients.

Stage 2:

-Each group is assigned two plants: treatment and control plant.

The sunlight group will put a paper bag over their treatment plant.

- The temperature group will place their treatment plant in a freezer.
- The moisture group will place their treatment plant in a windowsill and withhold water.
- The air group will place their treatment plant in a clear plastic bag and tighten the bag around the plant so no air is let in or out.
- The nutrient group will place their treatment plant in a windowsill and withhold plant food.

-Every three days, groups use the observation worksheet and cameras to record their observations, collect photos of the effects of the environment on plant survival.

Plant	Photo	Data	Date	Date
Height				
Color -leaves- roots				
Other comments				

Stage 3:

-Each group writes a report on their observations, bar graphs to represent data and recommendations for addressing this impact, which will be presented to the class. This report may be in any format they choose (presentation, poster or science report).
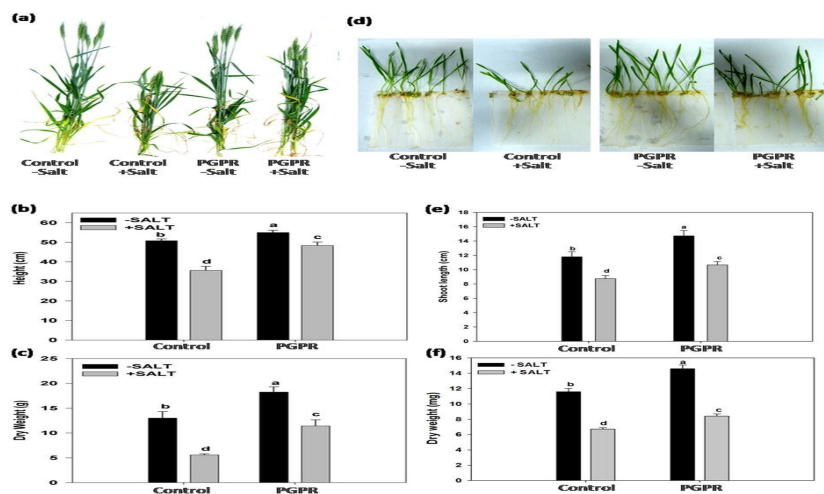
Example of data representation
Source: https://www.nature.com/articles/srep34768

Homework:
Students are asked to find type of grass planted for golf fields and give reasons for grass choice based on grass characteristics.

Activity 5: An aesthetic view of a plant		
Activity duration: 90 minutes	**Activity type: pair and individual work**	**Resources** **https://arttoremember.com/lesson-plans/fauve-flowers/** **https://www.youtube.com/watch?v=tVNsXKJWs0Y** **https://www.incredibleart.org/files/crit.htm**
Activity objectives:		

- Describe Fauvism and how it differs from other styles.
- Draw and create large flowers utilizing vivid, contrasting colors and detail.
- List the characteristics of Fauvism.

Materials needed:

- Paper
- Pencils
- Markers or crayons
- watercolors
- Botanical garden books
- Images of different paintings(impressionist, post- impressionist, Fauvism)

Procedures:

-The teacher shows the students three images of different paintings(impressionist, post- impressionist, Fauvism).

Source: https://www.musee-orsay.fr/typo3temp/GB/7212178035.jpg

Source: https://www.vincentvangogh.org/images/paintings/the-starry-night.jpg

Source: https://study.com/academy/lesson/fauvism-definition-art-characteristics.html

-Students look at the images to analyze them by answering the following questions:
- How would you describe the lines in this picture? The shapes? The colors? What does this painting show?

- How would you describe this painting to a person who could not see it?
- What do these two paintings have in common?
- How is this picture different from real life?
- What questions would you ask the artist about this work, if s/he were here?
- What title would you give to this painting? What made you decide on that title?
- Pretend you are inside this painting. What does it feel like?

-Students think individually of the questions and then discuss their analysis in pairs and the whole class.

-The teacher asks the class to watch a video about Fauvism, its characteristics and techniques they use for drawing and coloring.

-In groups, students discuss the list they write and share it with the class.

-The teacher asks the students to work individually to draw a garden, using Fauvism technique of coloring.

-Students apply a rubric to self-assess their paintings before hanging on the wall.

-The teacher organizes an art gallery in the class where students do peer-assessment to evaluate paintings.

Name: _____ Painting Title: _____

Painting Rubric	Rate Yourself	Teacher Rating
Composition and Design: 0-1 Art exhibits lack of planning in the design and composition. 2 Ideas are expressed with no unity in composition. 3 Composition demonstrates limited knowledge of the Principles and Elements of Design. 4 Artwork exhibits good composition and design elements. 5 Artwork exhibits masterful execution of the Principles and Elements of Design (Line, composition, space, movement, balance, emphasis, pattern, unity, color, contrast, rhythm, texture, value, form)		
Color: 0-1 Color choices do not represent the idea and application is poorly done. 2 Ideas could have been expressed better with other color choices and better application. 3 Color choices and application shows some knowledge of color theory and relationships. 4 Artwork exhibits good color choice. Color is effective in expressing the idea. 5 Color choice and application enhances the idea being expressed. Advanced color theory is demonstrated. The use of color is attractive and appealing.		
Technique: 0-1 Work exhibits critical errors in the use of materials or skills specific to the task. 2 Work exhibits the use of materials or skills with a few errors. 3 Work exhibits appropriate use of materials and skills with no errors. 4 Work exhibits some level of understanding in use of materials, techniques, and skill. 5 Work exhibits mastery of the materials, techniques, and skill.		
Creativity and Originality: 0-1 Artwork shows no evidence of creativity or originality. 2 Artwork includes an idea but lacks originality of idea or technique. 3 Artwork includes unique ideas. 4 Artwork includes several unique ideas and an exploration of multiple ideas. 5 Artwork includes many unique ideas with creative execution of ideas. Student has taken the technique being studied and applied it in his/her own way. The student's personality/voice comes through.		
Craftsmanship and Presentation: 0-1 Artwork is incomplete. 2 Artwork is completed with minimal effort and carelessly lacking in neatness. 3 Artwork is completed with minimal effort, little craftsmanship, and few finishing touches. 4 Artwork is completed with good effort, displaying craftsmanship, and meeting requirements. 5 Artwork is completed with substantial evidence of effort, finishing touches, and good presentation and craftsmanship.		

Engineering Design Milestone		
Duration:	**Activity type: (Group Work/ Design teams)**	**Resources**
Objectives:	Revisit initial design questions Conduct further research on the design problem as needed. Reflect on knowledge and skills acquired during phase 2. Connect acquired knowledge and skills to the design challenge	

<u>Materials</u>

Questions worksheet

<u>Procedures</u>
- Students are directed to look at the graphic organizer they created towards the end of phase 1.
- Students are encouraged to revisit the ideas and questions they have written, and think in what way their understanding of the problem has changed during phase 2.
- Groups are assigned to discuss the following questions:

What did we learn that could help us with the design solution?	Do we need to revisit our initial solution ideas? (why, where, what, who & how)	What questions we raised in milestone 1 were already answered?
--- --- --- --- --- ---------------------------------------	--- --- --- --- --- ---------------------------------------	--- --- --- --- --- ---------------------------------------
What questions do we still need to further investigate?	Do we have new questions that need further research	What existing solution could we make use of in our design?
--- --- --- --- --- ---------------------------------------	--- --- --- --- --- ---------------------------------------	--- --- --- --- --- ---------------------------------------

Phase 3 Explore Possible Solutions

Activity 1:

Activity Duration: 90 minutes	Activity type: pair and group work	Resources https://www.lib.umich.edu/papyrus_making/pm_intro.html

Activity objectives:
- Explore the agricultural techniques used by ancient Egyptians.
- Identify the tools they use to grow plants.
- Explain the main farming seasons.
- Create a facebook album to display the importance of a papyrus plant, environmental conditions for its growth.
- Illustrate the importance of a papyrus plant and its structure.

Materials needed:
Reading comprehension worksheet
Features of informational text worksheet
Posters
Markers
Procedures:
Pre-reading:
Think pair-share
-The teacher asks the class to think individually of the questions below:
-What made ancient Egypt successful?
-How did agriculture begin? And how?
-Students work in pairs to discuss their answers. Then, they share their answers with the whole class.
During reading:
-The teacher asks the students to work individually to analyse the text characteristics by answering the worksheet below:

FEATURES OF FACTUAL TEXT

Purpose	To inform			
Examples	Newspapers Catalogues	Textbooks Brochures	Magazine articles Reports	Information books Research articles
Characteristics	Titles Tables	Headings Diagrams	Subheadings Graphics	Boldface words Contents
Organisation	Any factual text may be organised using several different text structures			

Types of organisation	Description / categorisation	The author describes the topic by listing characteristics, features, and examples. Focus is on one thing and its components. How something looks, moves, works etc a definition or characterisation.
	Sequence	The author introduces items or events in numerical or chronological order. Describes the order of events or how to do something or how to make something.
	Compare / contrast	The author describes how 2 or more things are alike and / or different.
	Cause - effect	Effect = what happened; Cause = what made it happen The author lists one or more causes and the resulting effect or effects. The purpose is to explain why or how something happened, works or exists.
	Problem - solution	The author states one or more problems and one or more possible solutions to the problem. What's wrong and how to fix it. It may also include the advantages or disadvantages of each solution.
	Position - reason	State an opinion, theory, or hypothesis and offer evidence to support it. Why a point of view should be supported; what's wrong with an idea.

Source: https://cer.schools.nsw.gov.au/content/dam/doe/sws/schools/c/cer/localcontent/comprehension_handbook.pdf

Agriculture was the foundation of ancient Egypt. The ability to grow crops was extremely important for the people of this region in North Africa. Basic farming practices took root about 8,000 years ago, but there is some evidence that some early agriculture had taken place even 2,000 years before that. In a good season, Egypt's fertile fields produced enough food to feed every person in the region, and better years produced additional food. This extra food was kept in storage facilities owned by the government. It could be used for trade or saved for times when food was less plentiful.

A bad growing season was always the result of a shallow flooding by the Nile. Even in years of heavy rain, crops still depended on the Nile flooding. As a result, the yearly flood became an important part of ancient Egyptian culture and mythology. Among the most famous myths is the story of the death and resurrection of the god Osiris. It is thought to represent the Nile's importance as a source of life. The yearly flooding was the most important event for Egyptian agriculture, but people still needed to work the land. Fields had to be plowed and seeds planted, while water needed to be transported to the field. These needs led to the invention of

the ox-drawn plow and improvements in irrigation. The invention of irrigation meant that water could travel from rivers and creeks to fields by moving through man-made ditches or canals.

Once a field was plowed, workers used tools, such as hoes, to break up the clumps of soil. With the ground properly prepared, seeds were hauled to the field in baskets. Workers filled smaller baskets or sacks from these larger containers. Then they walked the fields, flinging seeds into the soil.

Some plants were grown to make things other than food. Papyrus, for example, was used to make paper. Additionally, papyrus was made into sandals, rope, toys, boxes, baskets, mats, window shades and even small fishing boats. Another plant was the castor oil plant, which was crushed and made into lamp oil or consumed as a health tonic. One of the most important crops was called emmer. This grain was used in the production of bread, a daily part of the Egyptian diet. It was also used to make beer, the most popular drink. After papyrus, emmer was probably the most important crop grown in Egypt.

Source: http://www.hannasd.org/cms/lib2/PA01001586/Centricity/Domain/205/Egyptian%20Agricultures.pdf

-The teacher asks the class to go back to the reading to answer the questions below:
- How did the Nile flooding contribute to growing crops in Ancient Egypt?
- What kinds of tools were used to grow plants?
- How did the irrigation system develop in Ancient Egypt?
- What is emmer and what was it used for?

-Students work in groups to draw a graphic organizer to summarize the text and identify the topic sentence of each paragraph and supporting details.

-Groups take turns to present their posters to other groups.

Post-reading:

-The teacher divides the class into groups to create an album on facebook about agriculture in ancient Egypt, the use of a papyrus paper, its structure, environmental conditions for growing this plant.

-Students are asked to give feedback on each other by commenting on the photos online.

-The teacher introduces the concept of digital print to the class by asking them to watch a video.

https://www.youtube.com/watch?v=6TUMHpIBveo

-Students watch the video to answer the questions below:

-What is a digital footprint?

-How does your digital footprint affect social media?

-What are your responsibilities when you use social media?

Activity 2: Planting Methods		
Activity Duration: 120 minutes	**Activity type: individual and group work**	**Resources:** https://www.teachhub.com/classroom-activities-how-hold-classroom-debate

Activity objectives:
- Debate hydroponic planting as methods of planting.
- Explore different methods of growing plants.
- Do a research paper on the pros and cons of hydroponic and soil planting.
- Support evidence of how they feel about the topic.

Materials needed:
Ball
Printed research rubric
Procedures:
Stage1:
Think-pair- share
-The teacher provokes the students' thinking about different methods of growing plants by asking the questions below:
-How is soil important to plant growth?
-Does soil planting cater for urban areas?
-Can a plant survive without soil? If so, how does it occur?
-Students think individually to answer the question, then discuss and share their answers with the others in-group and the whole class.
-The teacher asks students to watch a video about hydroponic planting. They take notes to answer the questions below:
-What is hydroponic planting?
-How does it differ from soil planting?
-What are the pros and cons of hydroponic planting?
-Which method is best for planting?

-The teacher discusses the answers with the students and divides the class in two teams based on the method of planting they choose.
-Students prepare for the debate by doing a research paper on the method of planting they choose. The paper must include
-Evidence and statistical data.
-Suggested solutions to the drawbacks of the method.

-The teacher explains that students must abide by academic integrity and avoid plagiarism.
-The teacher reviews the citation rules with the students through this video.
-Students use a plagiarism checker before submitting the paper to the teacher.
-A citation tool can also be used by the students to help them cite sources properly.
Rubric

Research Report Rubric

Name: _____ Topic: _____

Teacher's comments: _____

Content and Details	Content is very informative and accurate. Report has many supporting details and is interesting to read.	Content is informative and mostly accurate. Report has adequate details.	Content is not always re-lated to the topic. Many in-accuracies. Few supporting details.	Content is not relevant or accurate. No details.
Organization	Report is well organized with a strong beginning, middle, and ending.	Report shows adequate organization. It has a begin-ning, middle, and ending.	Report is poorly organized and confusing at times.	Report has no organization.
Writing Mechanics and Readability	Report has few or no errors in spelling, punctuation, and/or grammar. Report is easy to read.	Report has a few to several errors in spelling, punc-tuation, and/or grammar. Report is readable.	Report has many errors in spelling, punctuation, and/or grammar. Report is difficult to read.	Report is unreadable.
Notecards	Notecards are completed and labeled correctly.	Most notecards are com-pleted and labeled correctly.	Some notecards are com-pleted and labeled correctly.	No notecards.
Bibliography	Bibliography is completed and written in correct form.	Bibliography is done but incomplete in parts. Some errors in form.	Bibliography is incomplete. Many errors in form.	No bibliography.
(Other)				

Source: http://flood-rescue.com/img/4th-grade-research-paper-writing-rubric.jpg

Stage 2:
-The teacher gives instructions before running the debate:
-Each student goes to the side of the classroom where their position is either for or against the topic.
-The teacher moves desks so that each side is facing each other.
-Students sit on their desks and take turns tossing a ball to discuss their position on the topic. Only the student with the ball can speak.
-The debate starts with the team who supports hydroponic planting, followed by a student from the opposing team.
- This pattern is repeated for the second speaker in each team. Finally, each team gets an opportunity for rebutting the arguments of the opponent.
-The teacher as the judge takes notes during the debate.
Stage3:
-The teacher allows time for debriefing and discussion.

-In case of allowing audience to attend the debate, they are given an opportunity to ask questions and to contribute their own thoughts and opinions on the arguments presented.

Phase 4
Plan for Action
Engineering Design Milestone

Activity Duration: 90 minutes	Activity type: Group work	Resources http://www.stemie.org/wp-content/uploads/2018/02/HS_Lessons_branded_K12CEISMC.pdf

Activity objectives:
- Select materials to be used for the design
- Give feedback on other teams' ideas.
- Apply a brainstorming technique to generate ideas about the challenge.

Materials needed:
Printed brainstorming rules poster
Markers
Flip chart paper
Sticky notes
Procedures:
Stage 1:
-The teacher presents the design challenge description with details and discusses the rubric for the design challenge.

Design challenge description worksheet

Challenge	Materials
Design a garden for your community that will be home to a variety of vegetables. You need to choose one of the planting methods: soil or hydroponic planting based on the needs of your community. The design should be aesthetically pleasing, including labels, planning for ongoing plant documentation using blog, use materials provided, minimize the risks of the planting method, and optimize the area allowed to grow the plants.	<u>Hydroponic planting</u> 2L empty plastic soda bottle bucket or plastic tub (growing container) Reservoir for the nutrient solution Growstones Choice of wick material (string, rope, yarn, any absorbent material) Choice of seeds Hammer Nails Scissors Anchor Mix <u>Soil planting</u> Wood to build garden beds Choice of seeds Rakes Spades Soil

Engineering Challenge Rubric

Student will be able to	Novice 1	Apprentice 2	Proficient 3	Distinguished 4
Create new design & the cost.	Usual design with high cost.	Usual design with lower cost.	Unusual design with high cost.	Unusual design with lower cost.

The art criteria	Gust green color.	Green color with good distribution.	Many colors.	Many colors with good distribution.
Recording data and its analyzing	Recording data without organization and analyzing calculations	Recording data and organized it	Recording data organized it and analyzed it by hands.	Recording data organize it and analyzed it using SPSS program or any thing like this program.
Reflection	Student does not provide a good reflection on the Engineering Design Process, and does not relate the process with prior knowledge.	Student provides a reflection on the Engineering Design Process, but does not completely relate the process with prior knowledge.	Student provides a good reflection, which relates his/her prior knowledge of kidney functions with the Engineering Design Process.	Student provides an elaborate reflection, in which he/she discusses how the natural world can be replicated in the designed world using Engineering Design Process.
Group work	Student does not collaborate with peers, and does not give feedback or participate within his/her group.	Student works with group members, but does not show willingness to communicate and collaborate with peers.	Student works well with his/her group, participating and giving feedback throughout the Engineering Design Process.	Student shows leadership qualities, facilitating the Engineering Design Process for his/her peers, showing good communication skills and collaboration.

Stage 2:
-The teacher asks the students to revisit their project plans to define the need, target user, method of planting, cost,materials,requirements, constraints and how to overcome them.
-Before students start brainstorming, the teacher reminds the students of some brainstorming rules to create positive and motivational brainstorming environment.

BUILD ON THE IDEAS OF OTHERS **DEFER JUDGEMENT** **STAY FOCUSED ON TOPIC**

FAIL EARLY AND OFTEN **BE VISUAL** **ONE CONVERSATION AT A TIME**

THINK USER-CENTRIC **GO FOR QUANTITY** **GO FOR WILD IDEAS**

Source: http://blog.awwapp.com/design-thinking-productive-brainstorming/
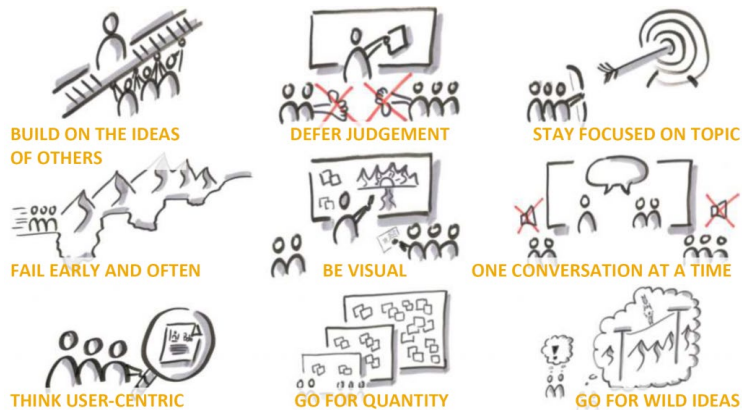
-The teacher encourages the students to choose one of the brainstorming techniques to generate, select, categorize and improve ideas.

- Mind-mapping (using diagram to visually organize information)
- Reverse brainstorming(start brainstorming by finding ways to cause the problem and then, think of solutions)
- Fill the gap (start with a statement of where you are. Then write a statement of where you'd like to be.)
- SWOT analysis(identifies organization strengths, weaknesses, opportunities and threats.)
- Starbursting(At each point of the star, write one of the following words: who, what, where, when, why, and how.)
- Slip writing(Ask students to write down their ideas on index cards anonymously and then ideas are shared to be assessed by other students in the group)

Source: https://business.tutsplus.com/articles/top-brainstorming-techniques--cms-27181

Stage 3:

-The teacher asks the groups to hang their charts on the wall and invite to walk around to and look at each other's ideas.

-The teacher asks the students to use sticky notes to write their feedback on other teams' ideas.

-The teams are given time to discuss feedback from their peers and respond to the following questions:

- Which idea do you prefer personally?
- Which idea do you think is most likely to succeed?
- Which idea seems out of reach,but would be amazing if it is applicable?

Activity 2:		
Activity duration: 120 minutes	Activity type: Individual and group work	Resources: https://mathactivities.club/product/math-project-school-garden-using-math-and-science/?utm_medium=social&utm_source=pinterest&utm_campaign=tailwind_smartloop&utm_content=smartloop&utm_term=7633520

Activity objectives:
- Calculate the area the plants need and the volume of 3D shapes.
- Sketch the final prototype for the garden.
- Choose the type of plants which they grow.

Materials needed:
Paper
Rulers
Pencils
Markers
**Procedures:**
-The teacher asks the groups to map out a plan for the garden, including planting patterns, dimensions, and spacing that will best suit your choices and the type of plants they can grow.
Stage 1:
-Each group creates a crop planting calendar. They are guided to access the Egyptian Export Center to find the type of plants they can grow.
Example of crop planting calendar
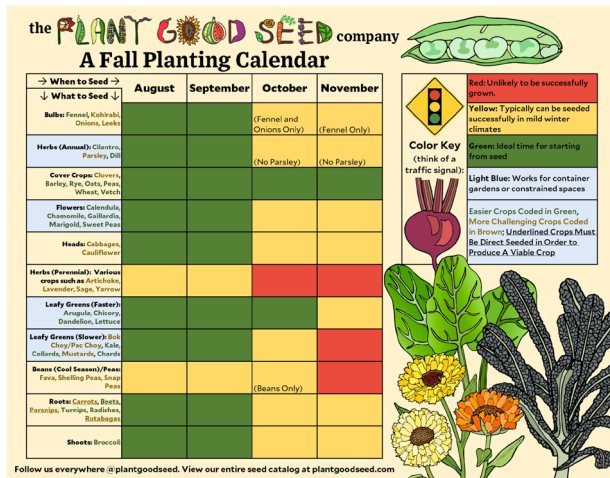
Source:

Stage2:
-The teacher makes sure the garden is divided up evenly between the groups and that they need to fit all the plants in the space available.
-The groups calculate the area of the garden and containers they will use by multiplying length by width.
-In case of having irregular shapes, they break up the shape up into bits so they are easier to calculate, like in the example below:
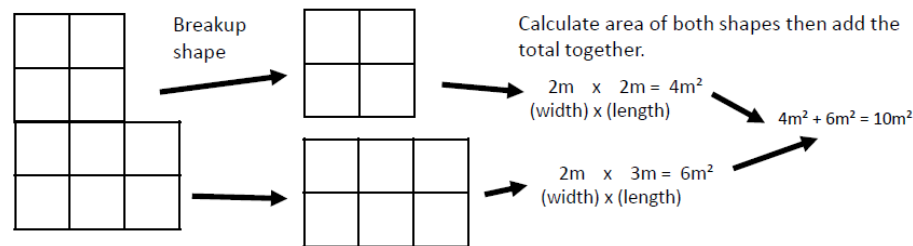
Source:
-The teacher introduces the calculation of volume of 3D shapes to calculate the volume of garden containers.
-The teacher divides the class into groups to watch a video to come up with the formula of measuring the volume.
Stage3:
-The teacher asks the groups to use their project plans of determining the need, the audience, budget, constraints and solutions to sketch their prototypes to visualize their ideas in greater detail.

Sketch your design below, and make sure to indicate a description of how it works.

Stage 4: (Reflection conclusion)
-Students present their sketches to other groups and get feedback.
-Students are given time to work on the final sketch and make changes.

Phase 5 Build, Test, Redesign, communicate	

Duration: 90 minutes	Activity type: (Group Work/ Design teams)	Resources https://stemazing.org/wp-content/uploads/2017/07/2LitreBottleHydroponicSystem.pdf
Objectives:		

- Build a garden system to grow vegetables
- Redesign to solve problems

Materials needed
Design materials selected by teams

Procedures

Stage1:Build a prototype
- Each team assembles materials required for constructing the garden system.
- As a gallery walk activity, a representative (or two) of each group is asked to remain at the team station to present the prototype to other teams, while other members tour the other groups stations to get introduced to their garden systems, and provide them with suggestions.

Stage 2: Test & redesign
- During this stage, students use an observation log to record data about plant growth to assess and evaluate their garden system according to the rubric.
- Students decide on what they need to modify based on their test as well as other teams feedback.
- Students make the necessary modifications to their design.

<table>
<tr><td colspan="2" align="center">Phase 6
Communicate & Reflect</td></tr>
</table>

<table>
<tr><td colspan="3" align="center">Engineering Design Milestone 6</td></tr>
<tr><td>Duration:</td><td>Activity type: (Group Work/ Design teams)</td><td>Resources</td></tr>
<tr><td colspan="3">Objectives:
1. Present the final designs and describe the process.
2. Communicate with other teams to get feedback.
3. Reflect on the full design process.</td></tr>
<tr><td colspan="3"><u>Procedures:</u>

Stage 1: Group reflection & preparation for the presentation

In their design teams students are expected to prepare for their design presentation as follows.</td></tr>
</table>

a) <u>Teams need to collectively think of the following questions:</u>

1. How did we decide on the initial design?
2. How was the initial design different from both the prototype and the final product?
3. What helped us decide on the final solution?
4. What knowledge do we believe was essential for us to arrive at our final product?
5. What challenges did we face as a group?
6. To what extent do we think we succeeded to meet the design requirements?
7. What do we need to consider for future designs?
8. How can we improve future group work?

b) <u>Teams get to prepare a powerpoint (or a poster) presentation that includes the following:</u>

1. Summary of the problem/ design challenge.
2. Essential knowledge needed for the design/ the idea behind the design.
3. Context & target audience.
4. Description of the model/ design.
5. Strengths and weaknesses in the design
6. Team's evaluation of the process.

Stage 2: Presenting and communicating feedback

1. Groups take turns doing their whole class presentations (8-10 minutes per group).
2. Each presentation can be followed by questions and answers from the rest of the class.
3. Presentations can also be done as a gallery walk activity.

Stage 3: Individual reflection.

After presentations and team feedback, students sit individually work on the following:

1. How do you feel about the entire process?
   …………………………………………………………………..……………………………………………………………
2. To what extent are you satisfied with your participation within the design teams?
   …………………………………………………………………..……………………………………………………………
3. I think our design is able/ not able to solve the problem identified at the beginning of the project because

....

4. My favorite part of the design was

....

5. If we started the process again, I would

....

6. Next time I work in a group I want

....