TIES 2003

Teachers in Industry for Educational Support

Patterns, Patterns Everywhere!

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Curriculum Unit Overview

Summary

This curriculum unit was designed so that it could be used in collaboration with the Educational Outreach office located on Wright Patterson Air Force Base. It is essential that this unit utilize the services the Educational Outreach office, specifically their TECH Trek Mobile Research Laboratory (MRL). This unit utilizes the various magnification objects that are available on the bus, such as dissecting microscopes, compound-light microscopes, Intel play microscopes and a Personal Scanning Electron Microscope (PSEM). The format of this curriculum can be adapted for other subjects, but the actual activities may not be adaptable for all subjects and grade levels. This unit is specifically designed for students in grades 9-12, but can easily be adapted for students in lesser grades. The estimated time periods are given for each lesson and the total estimated time for all the activities in all three of the sections is 355 minutes (5 hours, 55 minutes). However, these estimated times are subject to change and are dependent upon the students. Also, the activities may be shortened if time is an issue. It is recommended that the teacher reserve the TECH Trek MRL for a week. However, it is important to note that in order to use the TECH Trek MRL, the teacher must be a TECH Trek Trained Teacher. One can become a TECH Trek Trained Teacher by attending a short training session.

Big Picture

As a hook activity, the students will be shown micrographs of various animals and structures and then asked to identify the object in the picture. Some of the objects in the micrographs should be easily recognized, while others should be a little harder to identify. Once the students have guessed what the objects are, the teacher can ask the students why scientists might want to magnify objects to such a high magnification. The teacher should encourage answers ranging from disease identification to the testing of metals by the Air Force for their airplanes. It may be the teacher's desire to lead the students into suggesting uses if the students are having a hard time coming up with any uses.

Preparation for the Unit

In order to prepare for this unit it is suggested that the teacher work with other teachers as well as the Educational Outreach department of Wright Patterson Air Force Base. Another teacher may be of help, especially if the teacher does not teach one or more of the subjects that are included in this lesson. It might be of use for a science, math and art teacher to work together to enhance this unit. Also, it is imperative that the teacher utilizes the Educational Outreach department of WPAFB, since they are the department that offers the services of the TECH Trek MRL. It is also important that the teacher be a TECH Trek Trained Teacher in order for this unit to be utilized. The TECH Trek MRL cannot come to the school unless there is a TECH Trek Trained Teacher on the bus at all times when there are students on the bus. However, the training for the bus is a short and painless experience. One may contact the Educational Outreach offices by calling 937-904-8626 or 937-408-5877 and asking for the WPAFB Educational Outreach TECH Trek Educator. One may also write the office at the following address: WPAFB Educational Outreach, Det 1 AFRL/WS, Bldg 45 Room 45, 2130 Eighth Street, Wright-Patterson AFB, OH 45433-7542.

Overview

On the following page is a summary of the unit including brief summaries of each Authentic Learning Task (ALT). This table provides an overview of the tasks in the unit sections and shows how the activities in the different teaching areas relate to each other.

Patterns, Patterns Everywhere!
Curriculum Unit Summary

Patterns in Math	Patterns in Science and Nature	Patterns in Art: All about Escher
ALT 1 - How big is a Bee's Eye? The students will use a PSEM to look at a highly magnified bee's eye. The students will measure and then calculate the surface area of one hexagonal lens of a bee's eye. Lastly, the total surface area of the bee's eye will be calculated.	**ALT 1 – Plants Have Patterns?** The students will use a dissecting microscope and a PSEM to view various magnifications of plant stems, roots, leaves and seeds. The students will relate the patterns that are observed to the survival and function(s) of the various plants.	**ALT 1 – Escher Tessellations** The students will view the various tessellations painted by Escher to achieve an understanding of the basic parts of a tessellation. The relationship of a tessellation and a pattern will also be explained using the art as an example.
ALT 2 – Sand Dollar Surface Area The students will use a PSEM to view a magnified version of the circular patterns found on a sand dollar. The students will measure and calculate the surface area of one of the circles in the pattern.	**ALT 2 – Plants now Animals and Patterns? Oh My!** The students will look at various animals under a dissecting microscope and a PSEM to determine the various patterns seen in animal life. Specifically, patterns of segmentation, symmetry and coloration will be viewed. The students will conclude how the patterns affect the life of the various animals.	**ALT 2 – Coffee Filter Tessellations** The students will use normal, everyday coffee filters and magic markers to create tessellations. The students must incorporate the basic principles of tessellations and patterns into their artwork.
	ALT 3 – Which is better, small or smaller? The students will use their observations from the previous two ALT's in this section to determine which microscope and thus magnification provides a better view of the patterns. The students will also relate how a change in magnification changes the patterns to make them more or less detailed.	**ALT 3 – Complex Tessellations** The students will create more complex tessellations that resemble the artwork of Escher. If the students are confident in their abilities they may paint the tessellations. However, if the students choose, they may use construction paper, scissors and glue to make student-created cutout tessellations.

Culminating Activity

The students will create a poster to incorporate the three sections of this unit. The poster will contain a border that demonstrates the artwork that was created during the Art section. This border will consist of examples of coffee filter tesselations, as well as, the painted or cut tesselations. The poster will also contain micrograph printouts from the plant and animal patterns that were observed in the Plant and Animal Sections. These micrographs will represent various magnifications in order to show the differences in patterns with a difference in magnification. Thirdly, the poster will consist of a micrograph (or drawing if a micrograph is not available) of the hexagonal bee's eye pattern or the circular sand dollar pattern. To tie the three sections together, the last component of the poster will be a page long poem or short story that compares and contrasts the patterns that are seen in math, science/nature and art.

Section One: Patterns in Math

ALT One: How big is a Bee's Eye?

Summary

The students will use a Personal Scanning Electron Microscope (PSEM) to look at a highly magnified view of a bee's eye. The students will observe that a bee's eye is made up of many hexagonal lenses. The students will measure and then calculate the surface area of one hexagonal lens of a bee's eye. Lastly, the total surface area of the bee's eye will be calculated by determining how many hexagonal lenses make up a bee's compound eye and then multiplying that number by the surface area of one hexagonal lens.

Competencies

1. The students will use the basic characteristics of a hexagon to determine the equation that must be used to calculate the surface area of a hexagon.
2. The students must show all of their work so that it can be determined whether they used the correct equation in the proper order to calculate a lens' surface area.
3. The students must determine a way to calculate the total surface of a bee's eye using the information that they learned concerning surface area and patterns.

Time

30 minutes

Materials

PSEM (TECH Trek MRL out of Educational Outreach department of WPAFB), Pen, Calculation worksheet, Bee's Eye PSEM specimen already prepared, Bee's eye micrograph (if available), Ruler, Unit Conversion Chart, Calculator, Calculation Worksheet

Instructions

1. In groups of four the students will use the PSEM to look at a magnified view of a bee's eye. The students will need to manipulate the magnification of the view to determine the best possible picture of the bee's eye.
2. In the PSEM program the students will use the ruler function to determine the length of one side of a hexagonal lens. The students may use this function to determine any other length needed to calculate the surface area of the hexagon.
3. The students will need to print a copy of the bee's eye with its measuring scale to help them in the calculation and counting of the lenses.
4. Students will need to calculate the surface area of one hexagonal lens on their worksheet. The students must show all their steps and the equation that will be used.
5. Once the surface area of one lens has been calculated, the students will need to determine a way to calculate the total surface area of the bee's eye. After the students have explained how they will do this on their worksheet, then they may calculate the total surface area.

6. If the Tech Trek bus is not available, then the students may use a micrograph of a bee's eye or other insect eye to determine the previous calculations. The micrograph will need to contain the measuring scale for the magnification that is viewed in the micrograph in order for the calculation to be appropriate to scale.
7. Lastly, the students will need to finish their worksheet that contains to further manipulations and calculations.

Evaluation/Assessment of Student's Competency

Student competency will be assessed on how well they have completed the calculations on their worksheet. This competency will be based on the equation that they chose to use to calculate the hexagon's surface area, as well as, on the actual calculations. The students will be further assessed on their competency by how well they can manipulate the equation to answer the two manipulation questions on their worksheet. Also, the reasoning of the students will be assessed based on how they chose to measure the total surface area of the bee's eye.

Closure

Once all the groups of students have completed this learning task, the teacher will discuss with the students on how they determined the surface area of the bee's eye. The teacher will then ask the students to name other geometric shapes, besides hexagons, that patterns may made of. This discussion will lead to the next learning task, which is to calculate the surface area of the circular geometric pattern that is found on a sand dollar.

Patterns, Patterns Everywhere: Section One, ALT One: Handout One (of Unit)

Calculating the Surface Area of a Hexagon

Student Name_____ Date_____

1. What is the equation that is used to calculate the surface area of a hexagon? What do all of the variables included in the equation represent?

2. What is the length of one side of a single bee lens? Label your units!

3. Using the equation from number one and the information you gleaned from the PSEM, calculate the surface area of the single bee's lens. Make sure you show your work!

4. How would you calculate the surface area of the whole eye of the bee? Remember, the calculation from number three is only one lens of the whole eye!

5. What is the total surface area of the bee's eye? Show your work!

6. Increase the length of one side of a bee's lens by 3.4 units. What is the surface area of one bee's lens? What is the total surface area of the whole bee's eye if there are 113 lenses in the eye? Show work!

7. Decrease the length (from the original value) of one side of a bee's lens by 2.5 units. What is the surface area of one bee's lens? What is the total surface area of the whole bee's eye if there are 99 lenses in the eye? Show your work!

Section One: Patterns in Math

ALT Two: Sand Dollar Surface Area

Summary

The students will use a PSEM to view a magnified version of the circular patterns found on a sand dollar. The students will measure and calculate the surface area of one of the circles in the pattern.

Competencies

1. The students will need to use their knowledge on the terminology and characteristics of a circle to determine the proper equation that must be used in order to calculate the surface area of a circle.
2. The students will use their equations to calculate the surface area of one circle in the circular pattern found on a sand dollar. The students will also use this knowledge to calculate the surface of other circles found in the area.

Time

20 minutes

Materials

PSEM (TECH Trek MRL out of Educational Outreach department of WPAFB), Pen, Calculation worksheet, Sand dollar PSEM prepared specimen, Sand Dollar micrograph (if available), Ruler, Unit Conversion Chart, Calculator, Calculation worksheet

Instructions

1. In groups of four the students will use the PSEM to look at a magnified view of a sand dollar. The students will need to manipulate the magnification of the view to determine the best possible picture of the circular pattern on the sand dollar.
2. The students will need to use the ruler function on the PSEM to determine the needed values of the equation components. The variables that are present in the equation will determine the values the students obtain.
3. Using the values and the equation the students will calculate the surface area of one of the circles in the pattern.
4. After the students have calculated the surface of the starfish circle, the students will then calculate the surface areas of two other circles. The teacher will need to determine what other circles the students will use for this calculation.

Evaluation/Assessment of Student's Competency

Student competency will be assessed on how well they have completed the calculations on their worksheet. If the students used the wrong equation to determine the surface area then this will be easily seen on their worksheets. The students will be required to show all work so that the teacher can evaluate whether or not the equation and the calculations are correct.

Closure

The teacher will start a discussion on the patterns that the students saw when using the PSEM. This discussion should include the fact that the students saw these patterns on living organisms. The students should then be led to discuss what other living objects they think will show patterns. The teacher will need to make sure that the students mention that not only animals, but other living organisms, such as plants and fungus, also show patterns. This will lead into the next section of the unit, which deals first with plant patterns and then with animal patterns. If the teacher wishes, he/she may want to lead the students to discuss what type of magnifying devices they will need to use to look at patterns in living or once-living organisms.

Patterns, Patterns Everywhere! Section One, ALT Two: Handout Two (of unit)

Calculating the Surface Area of a Circle

Student Name_____ Date_____

1. What equation will you use to calculate the surface area of a circle? What do all of the variables in the equation represent?

2. Look at the PSEM image of a sand dollar and find the circular pattern. Once you have found the circular pattern, determine the diameter of the circle using the ruler function on the PSEM. What is the diameter of the circle?

3. Using the information from question number two, determine the surface area the circle. Be sure to show all of your work!

4. Pick any two circular objects in the classroom and answer the following questions for each object:

a. What is the object?

b. What is the diameter of the object?

c. What's the Surface Area of the object?
Show all work!

a. What is the object?

b. What is the diameter of the object?

c. What's the Surface Area of the object?
Show all work!

Section Two: Patterns in Science and Nature

ALT One: Plants have Patterns?

Summary

The students will use a dissecting microscope and a PSEM to view various magnifications of plant stems, roots, leaves and seeds. The students will relate the patterns that are observed to the survival and function(s) of the various plants. Specifically the students will determine how the patterns help a plant to live and function. The students should be encouraged to print up any PSEM images of their choice.

Competencies

1. The students will need to use their knowledge on species relationships to determine how various patterns help a plant to survive and thrive.
2. The students will observe various examples of plant roots, stems, leaves and seeds and the patterns that are contained within and/or on the roots, stems, leaves and seeds. The students will use these pattern observations to determine why a plant would need and utilize the patterns in order to function.

Time

50 minutes (25 using the dissecting microscope, 25 using the PSEM)

Materials

PSEM (TECH Trek MRL out of Educational Outreach department of WPAFB), Dissecting Microscope, Pen/Pencil, Various specimens to be viewed under dissecting microscope (roots, stems, leaves, seeds), Prepared specimens to be used with the PSEM (roots, stems, leaves, seeds), Observation worksheet

Instructions

1. The students will be divided into groups of four. While one group is using the PSEM, the other group will be using the dissecting microscope.
2. When the students are using the PSEM they will need to look at the specimens on the specimen stage and observe the patterns that are seen in the various roots, stems, leaves and seeds that are provided.
3. While the students are looking at the PSEM images, they will need to answer the questions that relate to their observations that are contained on the worksheet. The students will be asked to describe the pattern that they see, where it is located and give a possible explanation as to why the plant would need to have that particular pattern.
4. When the students are using the dissecting microscope they will need to look at the whole specimens that are provided and observe the patterns that are visible using that magnification.
5. While the students are using the dissecting microscope they will need to answer the questions that relate to the use of the dissecting microscope. The students will be asked to describe the pattern, where it is located and why a plant might need that pattern in order to survive. For example, a student might suggest that the veins on a leaf help the plant to maximize food and water passage throughout the leaf.

6. Once the students have finished observing the patterns using both microscopes and once they have completed the worksheet, they will be asked to write a short answer response on how plants use patterns in life.

Evaluation/Assessment of Student's Competency

Student competency will be determined by the completion of their handouts and also on their responses to the short answer question. The students will need to provide at least four examples of patterns in plants (either in roots, leaves, stems or seeds) and then discuss, in complete sentences, how a plant would utilize those patterns in order to better survive and thrive. A rubric has been included to help in the evaluation of this response.

Closure

The students have now gained knowledge in how to effectively, and efficiently use a PSEM and a dissecting microscope to observe patterns in plants. The students should be asked whether or not plants are the only living organisms to contain patterns that help organisms to prosper and live. The teacher will need to make sure the discussion leads to and then centers on the patterns viewed in animals. The teacher can remind the students of the patterns they viewed in the bee's eye and in the sand dollar as examples. The teacher will then explain that patterns not only help plants to survive, but they also help animals to survive. Coloration and camouflage examples can be used as obvious examples of patterns. The teacher may want to also discuss how patterns are important to segmentation and symmetry, or the teacher may wish to have the students discover these patterns on their own. This discussion will lead into the next section, which looks at segmentation, coloration and symmetry patterns found in and on animals.

Patterns, Patterns Everywhere! Section Two, ALT One: Handout Three (of unit)

Plant Patterns Observation Handout

Student Name _____ Date _____

Directions: You will be viewing four different plant parts under both a dissecting and a PSEM microscope. Answer the following questions as directed.

1. Name of object one: _____
   a. View the object under the dissecting microscope and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

   b. View the object under the PSEM and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

2. Name of object two: _____
   a. View the object under the dissecting microscope and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

b. View the object under the PSEM and answer the following questions:
   - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

   - Why would these patterns be important for the overall survival of the plant?

3. Name of object three: _____
   a. View the object under the dissecting microscope and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

   b. View the object under the PSEM and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

4. Name of object four: _____
   a. View the object under the dissecting microscope and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

   b. View the object under the PSEM and answer the following questions:
      - Briefly describe all of the patterns that are visible. There may be more than one pattern, so be sure to describe them all! Be sure to mention where each pattern is located.

      - Why would these patterns be important for the overall survival of the plant?

Patterns, Patterns Everywhere! Section Two, ALT One: Rubric One (of unit)

Plant Patterns Writing Prompt

Patterns are found everywhere in nature, even in plants. You have just viewed four plant parts and have described all of the patterns that were visible in those objects. Using this information write a short answer response that describes how each of the patterns of your choice affects the life processes of a plant. The following bulleted points are the criteria that must be included in your short answer response:

- You must include four patterns in your response. These four patterns may come from whichever plant parts that you choose.
- Make sure to indicate where the plant pattern is located. Be as specific as possible (ex: the veins of a leaf)
- Be sure to use complete sentences and correct grammar.
- For each of the four patterns that you chose mention why that pattern is essential for the life process of the plant. Why does the plant need that pattern in order to survive?

Plant Patterns Grading Rubric

Student Name(s):

Score	Description
4	Student writes a thorough response by including all of the four major criteria. The student includes four patterns in his/her response and explains where each pattern is located and the importance of the pattern for survival of the plant. The response contains less than three grammar/sentence structure errors.
3	Student writes an adequate response to the writing prompt. The student does not include all of the four major criteria in his/her response. One or two of the criterions are not included or thoroughly explained. The response contains three to five errors in sentence structure/grammar.
2	The student writes a response that is incomplete. The student response omits two or three of the major criteria in his/her response. If the student does include the criteria, they are not adequately explained and may appear confusing in their explanations. The response contains six to eight errors in grammar/sentence structure.
1	The student writes a response that is unclear and grossly confusing. The student response only includes one of the four major criterions or the response is vague in its descriptions. The student response contains nine or more errors in sentence structure/grammar.
0	Response is completely illogical or irrelevant. The student does not try to include the criteria in his/her response. The response contains nine or more errors in sentence structure/grammar.
Blank	Student does not write a response.

Comments:

Section Two: Patterns in Science and Nature

ALT Two: Plants now Animals and Patterns? Oh My!

Summary

The students will look at various animals under a dissecting microscope and a PSEM to determine the various patterns seen in animal life. Specifically, patterns of segmentation, symmetry and coloration will be viewed. The students will conclude how the patterns affect the life of the various animals viewed. The students should be instructed to print up any PSEM images of their choice.

Competencies

1. The students will observe the various patterns of segmentation that exist in animal life.
2. The students will observe the various patterns of coloration that exist in animal life.
3. The students will observe the various patterns of symmetry that exist in animal life.
4. The students will discuss how patterns of symmetry, segmentation and coloration affect the everyday life of animals. These patterns are used in species survival and the students will need to use their knowledge of species interactions to determine how each pattern affects animal life.

Time

50 minutes (25 using the dissecting microscope, 25 using the PSEM)

Materials

PSEM (TECH Trek MRL out of Educational Outreach department of WPAFB), Dissecting Microscope, Pen/Pencil, Suggested Specimens for both microscopes: starfish, butterfly wings, sand dollars, segmented worms, pill bugs and feathers, Observation handout

Instructions

1. The students will be divided into groups of four. While one group is using the PSEM, the other group will be using the dissecting microscope.
2. When the students are using the PSEM they will need to look at the specimens on the specimen stage and observe the patterns that are seen in the various animals.
3. While the students are looking at the PSEM images, they will need to determine whether the patterns are patterns of coloration, segmentation or symmetry. There may be more than one type of pattern observed in the same animal, so the students will need to be sure they have included all visible patterns.
4. Once the students have determined the pattern type, they will need to decide how the pattern affects the life of the animal.
5. When the students are using the dissecting microscope they will need to look at the whole specimens that are provided and observe the patterns that are visible using that magnification.
6. While the students are using the dissecting microscope they will need to determine the type of pattern that is visible. Again, an animal may contain more than one pattern so the students will need to be sure all visible patterns are observed and recorded.

7. Once the students have determined the pattern type, they will need to decide how the pattern affects the life of the animal.
8. When the observation worksheet has been completed the students will need to work on their group plays. The information concerning the structure of the play is contained within the evaluation section.

Evaluation/Assessment of Student's Competency

In order to evaluate student competency, the students (in their groups) will be asked to create and perform a play. The play must center on any two animals of their choice, preferably ones that have been viewed (is the teacher's choice), and how the patterns that those two animals contain affect their everyday life. Student creativity is encouraged. In order to encourage student creativity, the teacher might wish to give as minimal instructions as possible. The play must last for 2-3 minutes and contain factual information that they have learned and observed. A rubric is provided to evaluate this performance.

Closure

In order to set the stage for the last learning task in this section, the teacher will need to start a discussion that ties in the images that they have observed thus far on both the dissecting microscope and the PSEM. Since the last activity is a comparison between the two microscopes and how their magnifications change the pattern, the teacher may want to encourage the students to discuss how each microscope affected the pattern that was observed. For example, some patterns may have only been visible with the PSEM, while others may have only been visible with the dissecting microscope. This discussion will put the students in the mindset to relate magnification with the field of view.

Patterns, Patterns Everywhere! Section Two, ALT Two: Handout Four (of unit)

Animal Patterns Observation Handout

Student Name_____ Date_____

Directions: View each of specimens under the dissecting microscope and then fill in the table.

Name of Animal	Brief Description of Pattern and/or A small drawing of the pattern	Pattern Type: Symmetry, Coloration or Segmentation	How does the pattern affect the life of the animal?

Directions: View each of the provided specimens using the PSEM, then complete in the table.

Name of Animal	**Brief Description of Pattern and/or A small drawing of the pattern**	**Pattern Type: Symmetry, Coloration or Segmentation**	**How does the pattern affect the life of the animal?**

Patterns, Patterns Everywhere! Section Two, ALT Two: Rubric Two (of unit)

Animal Patterns Play Criteria

Directions: In your groups, you must create and then present (act out) a play that incorporates the information that you have just observed concerning patterns and animals. You will be graded by your inclusion of the following criteria:

* The play includes two animals
* The play includes at least one pattern from each of the two animals and it is mentioned how each pattern affects the life of the animal that contains the pattern.
* Students use creativity to create the play. The play may be a comedy, a mystery or take whatever format the students desire as long as it is school-appropriate.
* The play lasts at least 2-3 minutes.
* All of the group members participate in the presentation of the play.
* The play contains facts that were just learned/observed.

Animal Patterns Play Scoring Guide

Student Names:

Criteria	Points Possible	Points Earned
Play includes two animals (preferably ones observed in the learning activity)	**10**	
One pattern from each animal is mentioned	**4**	
It is mentioned how each pattern affects the life of the animal that contains the pattern	**6**	
Play is creative and original	**5**	
Play lasts at least 2-3 minutes	**5**	
All group members participate	**5**	
Play contains facts that were observed/learned	**5**	

Total Points Earned _____/40 Points = _____%
Comments:

Section Two: Patterns in Science and Nature

ALT Three: Which is better, small or smaller?

Summary

The students will use their observations from the previous two learning tasks in this section to determine which microscope, and thus magnification, provides a better view of the patterns. The students will also relate how a change in magnification changes the patterns to make them more or less detailed.

Competencies

1. The relation between magnification and the size of the field of focus will be determined using the observations from the two previous learning activities. The students will need to explain what happens to the size of the field of focus as magnification increases and how this has an effect on the pattern that is observed.
2. Using their observations the students will compare and contrast the views given by both the dissecting microscope and the PSEM to determine which microscope is best to view each pattern. The students will need to justify their conclusions.

Time

60 minutes (30 minutes to do the work, 30 minutes to present findings)

Materials

Observation worksheet from the two previous learning activities, Pen/Pencil, Paper, micrographs of any objects that may have been printed, teacher given micrographs for assessment

Instructions

1. In their groups, the students will pool their observations from the two previous learning activities and conclude the relationship between magnification and the size of the field of the focus. The students may use any micrograph printouts that they wish to support their conclusion.
2. Once the students have come to their conclusion of what relationship exists between magnification and the size of the field of focus, they will need to support their conclusions with examples from the specimens that they have viewed.
3. Next, the students will need to determine which microscope, the dissecting microscope or the PSEM, is the best microscope for viewing each of the patterns that were observed in the previous two activities. A brief justification will need to be made for each conclusion.
4. Lastly, the students will determine which microscope, the dissecting microscope or the PSEM, is best for viewing patterns in or on living organisms. The students will need to justify their conclusions with examples.

Evaluation/Assessment of Student's Competency

The evaluation for this learning activity will take the form of a modified group practical. A practical is a hands-on test that student takes by moving from station to station. In this practical, however, the students will not be moved around. Rather each group will be given a set of three pictures: one taken by a digital

camera from a dissecting microscope and the other two will be PSEM micrographs. The pictures/micrographs will each contain the same organism, but with different magnifications. As a group the students will need to decide which magnification shows the best, most precise and detailed pattern. The students will also need to be able present their findings (as a group) along with the conclusion as to what happens to the size of the field of focus when the magnification is increased. Even though the majority of the patterns are best viewed with a PSEM, the teacher should include a few patterns that are best seen with a dissecting microscope (coloration patters for example). The teacher should also take care to include a few sets where the higher magnification is best and then a few sets where a medium magnification is best. A rubric has been provided to help score this evaluation.

Closure

As in the previous activities a discussion will serve as the closure for this lesson. The teacher should take care to discuss with the students the proper relationship between the size of the field of focus with an increase in magnification just in case a few groups may have been mistaken in their logic. It is highly encouraged that if a group is false in their reasoning that the teacher guide them into finding their fault, rather than just correcting it strait forward. This will give the students more ownership in their learning. After any misconceptions have been cleared the teacher should then discuss and review the many patterns that are seen in life. It is recommended that the teacher go beyond the realm of living organisms and even point out the patterns in the classroom and everyday life. Once the students have an understanding of some of the patterns in everyday objects, the teacher can ask the students to name ways in which represent patterns. Possible answers may include quilts, bedspreads, clothes, artwork and so forth. To lead into the next section of this unit the teacher will need to tie in these representations to explain that artists and painters have long since incorporated patterns into their work. Eventually the teacher will need to lead this discussion to explain about Escher and how he depicted patterns in his artwork.

Patterns, Patterns Everywhere! Section Two, ALT Three: Rubric Three (of unit)

Practical Presentation Criteria

To tie up the information that was learned in the observation of patterns in both the plants and the animals, as a group you will take a pattern practical. As a group, you will be given three printouts of different magnifications. Two of the printouts are micrographs from the PSEM, while the third printout is a picture taken from a dissecting microscope. As a group you will need to decide and then present your findings on the following areas of interest:

* Of all of the three magnifications, which one shows the most precise, detailed and therefore the best pattern? Why?
* What happens to the size of the field of view as the magnification increases?
* Have all of the group members participated in the presentation?
* Do your answers use sound logic? Is your logic confusing and hard to understand?

Practical Presentation Scoring Guide/Rubric

Student Names:

Criteria	Points Possible	Points Earned	Comments
Students mention which magnification shows the best picture of a pattern	**5**		
Students explain why the magnification shows the best view of the pattern	**10**		
All of the students in the group participate	**5**		
Students describe what happens to the size of the field of view of an object as the magnification increases	**10**		
Students use sound logic in their reasoning (reasoning is not confusing or unclear)	**5**		

Total Points Earned _____/35 Points = _____%

Section Three: All About Escher

ALT One: Escher Tessellations

Summary

The students will view the various tessellations painted by Escher to achieve an understanding of the basic components of a tessellation. The relationship of a tessellation and a pattern will also be explained using the artwork as an example.

Competencies

1. The students will be able to identify the basic characteristics that comprise a tesselation.
2. The students will be able to explain the relationship between a tessellation and a pattern.
3. The students will be able to observe the various forms that a tessellation may take by observing Escher's artwork.

Time

15 minutes

Materials

Resource book(s) to show examples of Escher's artwork, Possible printouts or pictures of Escher's work, any other tessellations or patterns that can be seen in other artwork

Instructions

1. The students will have explained to them the basic characteristics of a tessellation and view artwork made by Escher as examples of tessellations.
2. The students will identify the various patterns that tessellations may use.
3. The students (if provided by the teacher) will observe other artwork that depicts patterns of different forms.
4. The students may wish to identify other places where patterns may be used, such as in floor tiles, etc.

Evaluation/Assessment of Student's Competency

In order to evaluate student competency, the teacher will give the students a brief oral quiz. The quiz may take the form of a question and answer session, or if the teacher chooses it may take the form of a more formal turn-in-a-paper quiz. The questions should center on the characteristics of tessellations and patterns and the identification of various patterns in artwork.

Closure

In order to bring this learning task to a closure the teacher may want to review, one last time, the basic characteristics of a tessellation. To introduce the next learning activity the teacher may wish to explain that now that the students can identify tessellations, they will be making their own simplistic coffee filter tessellations.

Section Three: All About Escher

ALT Two: Coffee Filter Tessellations

Summary

The students will use normal, everyday coffee filters and magic markers to create tessellations. The students must incorporate the basic principles of tessellations and patterns into their artwork. This means that the students' artwork must resemble a tessellation.

Competencies

1. The students will use the basic principles of tessellations to create their own simplistic coffee filter tesselations.

Time

20 minutes

Materials

Coffee Filters (plain white ones will probably work best), magic markers of various colors

Instructions

1. The students will each be given a coffee filter and then be instructed to pick the colors of markers of their choice.
2. Using the magic markers, the students will create a pattern on their coffee filters. The students should be able to quickly see that the markers will bleed and soak up into the coffee filters.
3. The students will continue this procedure until they achieve a pattern that resembles a pattern and that takes up the whole coffee filter.
4. Since these tesselations don't take up too much time, the students may be instructed to complete one as a practice, or they may just choose to do more than one. It will take a few minutes for them to dry completely.

Evaluation/Assessment of Student's Competency

It will be to the teacher's discretion on how to evaluate student competency. The teacher may choose to walk around the class and just examine the artwork for competency or the teacher may choose to use a simplistic rubric to evaluate student competency. The main concept the students need to exhibit is that a tessellation is made of pattern(s) that can be manipulated by the artist. An example of a very simplistic scoring guide/rubric has been included.

Closure

Once student competency has been satisfactorily achieved the teacher should lead in and direct the students to making more complex tessellations.

Patterns, Patterns Everywhere! Section Three, ALT Two: Rubric Four (of unit)

Coffee Filter Tessellations Scoring Guide

Student Name:

Criteria	Points Possible	Points Earned
All of the coffee filter is covered by the tessellation	**5**	
The tessellation contains at least two colors	**5**	
The tessellation contains an easily distinguished pattern	**5**	
The pattern is original – student uses creativity	**5**	

Total Points Earned _____/20 = _____%

Comments:

Section Three: All About Escher

ALT Three: Complex Tessellations

Summary

The students will create more complex tessellations that resemble the artwork of Escher. If the students are confident in their abilities they may paint a tessellation of their unique design. However, if the students choose, they may use construction paper, scissors and glue to make their tessellations instead of paint. These student-created tessellations will take the form of cut out designs that the students may choose to use.

Competencies

1. The students will use the basic characteristics of patterns to create a more complex tessellation.
2. The students will use a design that they created themselves to make the tessellations. The design must be one of their own and not one that has been observed thus far.

Time

40 minutes

Materials

Construction paper of various colors, scissors, glue, tape, paints of various colors, paintbrushes, towels, water bowls, a sink or bucket to dispose of used water, aprons

Instructions

1. The students will get the chance to choose which kind of tesselation they may want to make. If students are confident in painting abilities they may paint, but if they are not they can use construction paper and scissors and glue to make the tessellation.
2. Before the students make any tesselations, they will need to make up their own design for their tessellation.
3. If the students choose to paint they may start painting their tessellation as soon as they have drawn a preliminary design of their tessellation.
4. If the students choose to use the construction paper, they will need to draw their tessellation shapes on the construction paper. Once the shapes have been drawn the student can then cut them out and paste/tape them on another sheet of paper.
5. As an alternative the teacher may wish to have colored pencils and plain paper to use to make the tessellation.

Evaluation/Assessment of Student's Competency

Student competency will be evaluated using a simplistic scoring guide/rubric. The rubric has been included, but may be manipulated if the teacher chooses to do so.

Closure

Since this learning task ends the whole unit, the teacher may wish to review all the concepts that have been learned thus far. The concept of tessellations and patterns and where they can be found in life may want to be reviewed before the students start on their culminating activity. The teacher may also want to review the concepts of how to calculate the surface area of both hexagons and circles that were learned in the first section. Lastly, the teacher may wish to review the types of patterns, and their importance, that was observed in the science and nature section of the unit. This review will serve nicely to set the students up for the culminating activity, which ties and then extends the three sections of this unit.

Patterns, Patterns Everywhere! Section Three, ALT Three: Rubric Five (of unit)

Complex Tessellation Scoring Guide/Rubric

Student Name:

Criteria	Points Possible	Points Earned
Students turn in a preliminary drawing of the tessellation	**10**	
Students show creativity and originality in design	**10**	
Tessellation shows a distinguishable pattern	**10**	
Tessellation is neat and tidy	**10**	
Student has cleaned up his/her mess before finishing	**10**	

Total Points Earned _____/50 = _____ %

Comments:

Transfer Activity

Summary of Activity

The students will create a poster to incorporate the three sections of this unit. The poster will contain a border that demonstrates the artwork that was created during the Art section. This border will consist of examples of coffee filter tessellations, as well as, the painted or construction paper tessellations. The poster will also contain micrograph printouts from the plant and animal patterns that were observed in the Plant and Animal Sections. These micrographs will represent various magnifications in order to show the differences in patterns with a difference in magnification. Thirdly, the poster will consist of a micrograph (or drawing if a micrograph is not available) of the hexagonal bee's eye pattern or the circular sand dollar pattern. To tie the three sections together, the last component of the poster will be a page long poem or short story that compares and contrasts the patterns that are seen in math, science/nature and art.

Competencies

1. The students will use the knowledge, pictures and artwork that they have acquired concerning patterns to create a poster that represents the three sections of this unit.
2. The student will create a short story or poem that compares and contrasts the various patterns that were viewed throughout the unit.

Time

70 minutes

Materials

Micrographs that depict patterns that were seen in the math and science sections, drawings of hexagons/circles with a scale to show the work done to calculate the surface area, completed coffee filter tesselations, completed painted or construction paper tessellations, glue, tape, scissors, construction paper, white computer paper, posterboard or butcher paper, markers, pens, pencils

Instructions

1. The students will need to pick up a piece of butcher paper or posterboard to design their posters. It will be to the teacher's discretion on whether or not to complete this activity individually or in groups. Groups may be best since the first two sections were done in groups of four.
2. Using their tesselation examples, both coffee filter and paint/construction paper, the students will create a border for their poster.
3. Once the border has been completed, the students will use the micrographs and/or drawings to make up most of the rest of their poster. It is suggested that the students leave a space in the middle of the poster for their short story/poem.
4. Once the poster has been designed, the students will need to create a one page poem or short story that compares and contrasts the pattern examples that they have observed throughout the unit.
5. Once all the posters have been designed, the students will present their posters to their classmates.

Evaluation/Assessment

A rubric/scoring guide will be used to evaluate this activity. The students should be exposed to this scoring guide ahead of time so that they know what components they will need to include in their posters. The scoring guide has been included, but may be manipulated if the teacher chooses to do so.

Patterns, Patterns Everywhere! Transfer Activity: Rubric Six (of unit)

Usage Note: If the student earns all of the possible points, circle that number in the points possible column. However, if the student does not earn all of the possible points, cross out the number and write in how many points the student does earn.

Culmination Poster Scoring Guide

Student Name(s):

Criteria	Points Possible	
* Poster contains a tessellation border ➢ Coffee filter tessellation ➢ Complex tessellation	**20**	
* Two micrographs of animals present		**10**
* Two micrographs of animals present		**10**
* A micrograph or drawing of a hexagon is present	**5**	
* A micrograph or drawing of a circle is present	**5**	
* Poem/Short Story is present ➢ One page in length ➢ Compares/Contrasts at least four Patterns observed		**25**
* Poster Presentation ➢ All students participate (if in groups) ➢ Each part of poster is explained	**15**	
* Poster is aesthetically pleasing – orderly and neat	**10**	

Total Points Earned _____/ 100 Points = _____ %

Comments:

Appendix One: Patterns in Math, Section One

- The following references were used in this section and may provide help for the instructor:
  - Geometry: Integration, Applications, Connections. Published by Glencoe/McGraw Hill. New York, New York. Copyright 1998. **This book was helpful in determining the equations to use for calculating the surface area of a hexagon and a circle.**

- The following is a list of specimen materials that were used for this section. The specimen identification letters and numbers are given to facilitate easy finding by the TECH Trek Educator.
  - ALT One: Bee AI 28, AI 29
  - ALT Two: Sand dollar AE 03, AE 04, AE 05

Appendix Two: Patterns in Science and Nature, Section Two

- The following book was used as a reference for this section and may prove helpful for the instructor:
  - The Usborne Complete Book of the Microscope. Authored by Kirsteen Rogers. Published by Usborne Publishing Ltd. Copyright 1998.

- The following contains a list of suggested specimens for each authentic learning task for this section. The specimen identification letters and numbers are given to facilitate easy finding by the TECH Trek Educator.
  - ALT One: Seeds (air borne) P25; Seeds P29, P30; Pine Seed P26; Leaf (corn) P45; Blade of Grass P48; Fig Root P52; Pumpkin Root P56; Pumpkin Stem P57; Geranium Stem P60; Dicot Stem P61; Clover Root P62; Stem P65
    - **These are only suggested specimens – all, a few, or none of them may be used based upon the discretion of the instructor.**

  - ALT Two: Starfish AE 01, AE 07, AE 08; Monarch Butterfly Wings AI 25; Butterfly/moth wing AI 37, AI 38, AI 39, AI 42, AI 43, AI 44, AI 45, AI 46, AI 47, AI 48; Sand Dollar AE 03, AE 05; Segmented Worms (identification number not classified at time of creation); Pill Bugs AC 01, AC 02; Feathers AV 10, AV 11, AV 12, AV 13, AV 14
  - Specimens to be used for the microscopes other than the PSEM will need to be collected as whole specimens by the instructor/students and then prepared as needed.

- The following is a list of vocabulary for this section:
  - ALT Two
    a. Symmetry – a consistent overall pattern of structure. There are two types of symmetry – radial (similar parts branch out in all directions from a central point – starfish) and bilateral (animals have two similar halves on either side of a central plane – humans, insects)
    b. Segmentation – Refers to a body composed of a series of repeating similar units

Appendix Three: Patterns in Art: All About Escher, Section Three

- The following resources were used in the creation of this section and may be a help when instructing the students:
  - Escher on Escher: Exploring the Infinite. Authored by M.C. Escher. Published by Harry N. Abrams, Inc. New York. Copyright 1989.
  - M. C. Escher: His Life and Complete Graphic Work. Authored by F.H. Bool, J.R. Kist, J.L. Locher, and F. Wierda. Published by Harry N. Abrams, Inc. New York. Copyright 1982.

- The following is a list of vocabulary for this section:
  - ALT One
    a. M.C. Escher – An artist famous for his artwork that depict various patterns and tessellations
    b. Tessellation - A design that is made by forming or arranging small squares in a checkered or mosaic pattern. However, a tessellation can be made with almost any shape, not just a square. Escher was known to use lizards and other animals besides shapes of various kinds.