Lesson Plan for Implementing NETS•S—Template I

(More Directed Learning Activities)

Template with guiding questions

Teacher(s) Name: Jonathan Sabo

Position: Math Teacher

Grade Level(s): 10th – 11th Grade

Content Area: Mathematics (Analytic Geometry)

Time line: 7 class periods (each are 52 minutes long)

Standards (What do you want students to know and be able to do? What knowledge, skills, and strategies do you expect students to gain? Are there connections to other curriculum areas and subject area benchmarks?) Please put a summary of the standards you will be addressing rather than abbreviations and numbers that indicate which standards were addressed.

Math Standards:

MGSE9-12.F.BF.3: Identify the effect on the graph of replacing f(x) by f(x) + k, k f(x), f(kx), and f(x + k) for specific values of k (both positive and negative); find the value of k given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.

ELA Standards:

ELAGSE11-12SL5: Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

ISTE Standards:

1. Empowered Learner: Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.
   - 1c: Students use technology to seek feedback that informs and improves their practice and to demonstrate their learning in a variety of ways.

6. Creative Communicator: Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.
   - 6a: Students choose the appropriate platforms and tools for meeting the desired objectives of their creation or communication.
   - 6b: Students create original works or responsibly repurpose or remix digital resources into new creations.
   - 6c: Students communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
   - 6d: Students publish or present content that customizes the message and medium for their intended audiences.

Overview (a short summary of the lesson or unit including assignment or expected or possible products)

In this lesson students will be learning about transformations of quadratic functions. In the first three days of class students will be using graphing calculators to graph functions that have been transformed and describe the differences that are visible. Students will use this method to discover translations, dilations and reflections. After completing this discovery students will be able to describe transformations from a graph or from the equation of a quadratic function. After gaining an understanding of each of these transformations students will complete a lesson on Khan Academy to assess their knowledge. Data from this assessment will be used to differentiate later instruction. Students will use their knowledge of transformations to complete a marble slide activity on Desmos Graphing Calculator. Students will be required to transform and create new equations in order to complete this activity. On the last two days of this lesson students will summarize their knowledge by creating an infographic or presentation describing transformations of quadratic functions. Students will also include a real world example with their infographic or presentation.

Essential Questions (What **essential question** or learning are you addressing? What would students care or want to know about the topic? What are some questions to get students thinking about the topic or generate interest about the topic? Additionally, what questions can you ask students to help them focus on important aspects of the topic? (Guiding questions) What background or prior knowledge will you expect students to bring to this topic and build on?) Remember, essential questions are meant to guide the lesson by provoking inquiry. They should not be answered with a simple "yes" or "no" and should have many acceptable answers.

What types of real world applications can be modeled by quadratic equations?

How can real world applications be modeled by quadratic equations?

How can a quadratic equation in standard form be converted to vertex form?

Given an equation in vertex form, How can you determine if a vertical shift is taking place? How can you determine if a horizontal shift is taking place? How can you determine if a vertical dilation is taking place? How can you determine if a translation is taking place?

How can you use transformations to sketch the graph of a quadratic function?

How can transformations be identified from the graph of a quadratic function?

How can transformations be used to compare the graphs of real world problems?

Assessment (What will students do or produce to illustrate their learning? What can students do to generate new knowledge? How will you assess how students are progressing (*formative assessment*)? How will you assess what they produce or do? How will you differentiate products?) You must attach copies of your assessment and/or rubrics. Include these in your presentation as well.

Students will complete Khan Academy activities to show understanding of the content. They will produce an infographic or presentation in order to illustrate their learning. Students will generate new knowledge as they explore technology tools that will be used to create the illustration of their learning. The Khan Academy activities will be assessed based on each student's accuracy. Students will submit a report after completing each activity. The presentations will be graded based on a rubric created by the teacher. Differentiation will be provided throughout this lesson. As students are working through the discovery some students will have the ability to accelerate while I work one on one with others. Students will receive immediate feedback from Khan Academy and will be able to work until they reach mastery. Students will be placed into groups for their presentation based on their progress. Each group will have the opportunity to select a preferred format for their presentation based on the technology that they are most comfortable with. Each student will be graded for this lesson based on the attached rubric.

Resources (How does technology support student learning? What digital tools, and resources—online student tools, research sites, student handouts, tools, tutorials, templates, assessment rubrics, etc—help elucidate or explain the content or allow students to interact with the content? What previous technology skills should students have to complete this project?)

Students will be using technology in this lesson through discovery of new content, assessing their knowledge and creation of an explanation of their understanding. Chromebooks will be used each day in class for students to access the following tools. Desmos graphing calculator will be used for students to visualize the mathematical properties that exist. Khan Academy will be used to assess student learning. By completing the activities on Khan Academy students will be able to apply the properties that were discovered earlier in the lesson. Students will receive immediate feedback from the program and be allowed to see additional tips or videos explaining misconceptions. Students will submit a report that verifies that they have mastered the content. This allows me to quickly see which students are excelling and identify students who need additional help. Google Slides, Lucid Chart, emaze, Infogram, or another presentation tool that students are comfortable with will be used for students to create a presentation or graphic explaining the content. Desmos and Khan Academy really don't require prerequisite technology skills. The presentation tools require that students have basic word processing skills. They should be able to locate images and to upload them to their chosen platform in order to create a professional looking display.

Khan Academy Assignments:

Shift Functions

Scale & Reflect Parabolas

Desmos Marble Slide Activity:

Marbleslides: Parabolas

Instructional Plan

Preparation (What student **needs, interests, and prior learning** provide a foundation for this lesson? How can you find out if students have this foundation? What difficulties might students have?)

This lesson comes towards the end of the quadratics unit of Analytic Geometry. Students should have a basic understanding of converting quadratic equations to vertex form and creating sketches of them by hand. Students will now have the opportunity to use technology to create a graph of these functions and see how a quadratic function can model a real world application. I will find out if students have this foundation from the previous test leading into this lesson. One difficulty comes from the prerequisite skill of converting quadratic equations between vertex form and standard form. Another difficulty will come from using the presentation tools to create a presentation demonstrating their knowledge. Students will be put into groups for this part of the lesson and are encouraged to use tools that they are comfortable with.

Management Describe the classroom management strategies will you use to manage your students and the use of digital tools and resources. How and where will your students work? (Small groups, whole group, individuals, classroom, lab, etc.) What strategies will you use to achieve equitable access to the Internet while completing this lesson? Describe what technical issues might arise during the Internet lesson and explain how you will resolve or **trouble-shoot** them? Please note: Trouble-shooting should occur prior to implementing the lesson as well as throughout the process. Be sure to indicate how you prepared for problems and work through the issues that occurred as you implemented and even after the lesson was completed.

Students will work individually on the discovery and assessment portions of the lesson. I will have a class set of Chromebooks available so all work will be completed in the classroom and each student will have their own device. Throughout the discovery students will participate in a whole group discussion to clarify what they have discovered. On the presentation portion of the lesson, students will work in small groups to create their presentation. Most work requiring Web 2.0 tools will be completed during class time allowing equitable access for all students. The Chromebooks will be made available before and after school for students who need additional time. The most likely technical issue that could arise would be the loss of wireless internet access. I will be prepared with a graphing calculator that can be projected on the board. This will allow for students to see the graphs. I will have a paper version of the assessment prepared. If the internet is not working during the first day of presentation work sessions students will brainstorm ideas for their presentations on paper. On the second day, students will use a presentation tool that does not require the internet, such as Microsoft PowerPoint. If any of the individual tools are unavailable on the day that they are needed I will have a list of alternate tools prepared. If students are unable to access computers at all during the presentation portion of the lesson, then students will be required to create a paper presentation of their knowledge.

Instructional Strategies and Learning Activities – Describe the research-based instructional strategies you will use with this lesson. How will your learning environment support these activities? What is your role? What are the students' roles in the lesson? How can you ensure **higher order thinking at the analysis, evaluation, or creativity levels of Bloom's Taxonomy**? How can the technology support your teaching? What authentic, relevant, and meaningful learning activities and tasks will your students complete? How will they build knowledge and skills? How will students use digital tools and resources to **communicate and collaborate** with each other and others? How will you facilitate the collaboration?

This lesson will begin with a discovery of transformations. Students will be graphing different functions in order to explain what causes a transformation to happen. Students will be given the task of describing the transformation in their own words. At this point of the lesson, I will only be helping students with technology issues and allowing them to create explanations in their own words. After the discovery, students will participate in a discussion where they analyze and defend their findings. I will serve as a moderator of the discussion and ensure that the final conclusion is mathematically accurate. Technology is supporting this part of the lesson by providing the students with a visual of the property being learned.

During the assessment portion of the lesson students will work individually to demonstrate their understanding. Technology allows for students to receive immediate feedback on their progress. Students are able to retain much more by receiving descriptive feedback on their work.

In the presentation portion of the lesson, students will collaborate with small groups and create a presentation. Students will begin by creating a Google document that allows them to begin brainstorming and sharing ideas. I will use this to monitor the level of involvement of each member of the group. In the presentation students will create a real world application that relates to a quadratic equation. This presentation and application problem will be shared on a class wiki page. Students will use their chosen presentation tool in order collaborate on their final product. A majority of the work will be completed in class, but students are encouraged to use Google documents for all communication outside of class.

Differentiation (How will you differentiate **content and process** to accommodate various learning styles and abilities? How will you help students learn independently and with others? How will you provide extensions and opportunities for enrichment? What assistive technologies will you need to provide?)

Different parts of the lesson will provide separate methods of differentiation. During the discovery, students are able to work at their own pace. This allows for some students to accelerate and attempt more complex problems while some students will have the chance to receive one on one assistance. Students who need additional support will receive teacher provided notes as well as instructional videos that provide an additional perspective. During the assessment students are able to receive immediate feedback on their progress. Students can either move on or receive instruction from different representations such as videos or written hints. During the presentation portion of the lesson, students are put into groups based on the assessment portion of the lesson. Students are able to choose their method of presentation based on their level of comfort. Part of the presentation is to create an application problem that is related to a quadratic equations. Students who have accelerated through other parts of the lesson will have the opportunity to create multiple application problems or explore their problem deeper.

Reflection (Will there be a closing event? Will students be asked to reflect upon their work? Will students be asked to provide feedback on the assignment itself? What will be *your process* for answering the following questions?

- Did students find the lesson meaningful and worth completing?
- In what ways was this lesson effective?
- What went well and why?
- What did not go well and why?
- How would you teach this lesson differently?)

This lesson will end by giving the students the opportunity to share their presentation and real world application with the class. We will use our learning management system for students to provide peer feedback on each other's presentations. Students will reflect on how each group's presentation would be helpful to them for mastering the content. We will also have a discussion about the real world application that each group provides so students can gain a much better appreciation for the importance of learning the content. I will also provide feedback on each groups work. Students will use the feedback received from peers and myself to polish their presentation for future classes to view. I created a survey using our learning management system where students had the opportunity to provide feedback on how they felt about the lesson. I will use this feedback to build on the strengths of the lesson for future implementations.

Closure: Anything else you would like to reflect upon regarding lessons learned and/or your experience with implementing this lesson. What advice would you give others if they were to implement the lesson? Please provide a quality reflection on your experience with this lesson and its implementation.

For the most part, students did find this lesson as meaningful and worth completing. Some of the things that they appreciated most was the use of technology to discover the properties instead of providing direct instruction for the entire lesson. They also appreciated the link to real world applications which provided them a reason to want to learn about the lesson.

This lesson was more effective than how I have taught it in the past. I have never used discovery to teach this material in the past and I feel that this was an effective method. The technology really gave the students an opportunity to visualize what is happening instead of simply being told this is going to happen. I also noticed several students using the technology to experiment and discover new things. This showed me that they were interested in using the technology.

The discovery portion of the lesson went incredibly well. A majority of the students were engaged throughout. I feel that the visual provided by the Desmos graphing calculator really promoted a lot of mathematically rich discussion. Students really felt empowered as they were able to discuss some of their own experiences as they manipulated graphs to discover the transformations. The marble slide activity also went well. This activity promoted a great deal of competition. Desmos allows the teacher to immediately view any work that has been submitted by a student. This allowed me to project their work on the board and discuss effective ways of completing the activity. Students really enjoyed being able to see their work displayed for the entire class to see. This gave me the opportunity to shine a spotlight on one particular student who has struggled so far this year.

The part of this lesson that did not quite go as well as I planned was the presentation portion. This was the first time that I have had students create this type of presentation for a math topic. I simply told students about the tools that were available for them to use for their presentation. Most of my students gravitated toward Google Sheets to create their presentation. I was really hoping for a variety of products from each individual group.

There a few changes I would make to this lesson before implementing it again. In order to get a variety of final presentations I need to spend a little more time highlighting some of the technology tools that are available. It is difficult to sacrifice the extra class time, but I feel that the reward in the long run would be worth sacrificing one day of class time. Helping students develop the skill of creating quality artifacts to demonstrate their learning could have many benefits. These artifacts could be used by the student to study important content. The artifact could also be shared to a broader audience which would benefit many more students. I also think it would be beneficial for students to conduct research on the topic that was learned in class. Conducting research would give students a different perspective than what was discussed in class. I look forward to making these changes and having the opportunity to teach this lesson again someday.

Quadratic Transformation Lesson Rubric

	0	2	3	4
Khan Academy Lesson – Shift Functions	Student is not able to complete consecutive problems correctly.	Student completes 2 consecutive problems correctly.	Student completes 3 consecutive problems correctly.	Student completes 4 consecutive problems correctly.
Khan Academy Lesson – Scale and Reflect parabolas	Student is not able to complete consecutive problems correctly.	Student completes 2 consecutive problems correctly.	Student completes 3 consecutive problems correctly.	Student completes 4 consecutive problems correctly.
Presentation Organization	Presentation is not clear to class due to poor organization.	Presentation is difficult to understand.	Presentation is clear to class.	Presentation is clear to the entire class and maintains their interest.
Content Knowledge	Presentation shows no evidence of content knowledge.	Presentation shows some knowledge, but has more than 3 errors.	Presentation shows clear understanding of content, but includes 1 or 2 errors	Presentation shows clear understanding of the content with no errors.
Visual Appearance of presentation	Presentation includes no supporting images or diagrams.	Presentation includes images or diagrams that are not related to the content.	Presentation includes images or diagrams related to the content.	Presentation includes images or diagrams related to the content that gain interest from the audience.
Real-world application	Presentation does not include a real-world application problem.	Presentation contains a real-world application problem that does not relate to the content.	Presentation contains a real-world application problem that is related to the content.	Presentation contains a real-world application problem that is related to the content and a clearly explained solution.
Collaboration	Student can provide no evidence of collaboration with their group.	Student can provide limited evidence of collaboration, but has not contributed an equal share of the work.		Student can provide clear evidence of collaboration with group members.