5E Lesson Plan Template

Grade Level and Subject: 10th grade Chemistry	**Name of Teacher:** Ayesha Qadri
Length of Lesson: 5 block schedule class periods- Day 1: Introduction to making (90 mins) Day 2: Soap Making (90 mins) Day 3: Second Soap Bar (90 mins) Day 4: Designing Soap Dish (90 mins) Day 5: Gallery walk (90 mins)	**Title of Lesson**: Let's 'Make' Some Soap

Main Idea of the Lesson:

This main idea of the lesson was to introduce students to making and encourage them to take on a five-day maker lesson in their chemistry classroom. This lesson strongly connects with the concept of producing a tangible product in a chemistry class using skills such as observations, trial-and-error, peer feedback, and basic knowledge of the saponification process, acids and bases and transfer of energy. Students did not cover the acids and bases unit when this lesson was taught. Instead, this was a way to introduce the concept during a hands-on project in which students used an acid (oils) and a base (NaOH) to make soap. Students elaborated on this lesson to create a personal soap dish design using software and presented their knowledge of saponification and design by sharing their soap and soap dish desing with their classmates and members of their community.

State or National Standards for Lesson:

Texas Essential Knowledge and Skills (TEKS)

Chemistry (c) 2. (E) plan and implement investigative procedures, including asking questions, formulating testable hypotheses, and selecting equipment and technology, including graphing calculators, computers and probes, sufficient scientific glassware such as beakers, Erlenmeyer flasks, pipettes, graduated cylinders, volumetric flasks, safety goggles, and burettes, electronic balances, and an adequate supply of consumable chemicals; (G) define acids and bases…

Next Generation Science Standards (NGSS)

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-PS1-4. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy.

HS-PS1-5. Apply scientific principles and evidence to provide an explanation about the effects of changing the temperature or concentration of the reacting particles on the rate at which a reaction occurs**.**

Common Core State Standards

ELA/Literacy

SL.11-12.5 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.

Mathematics

MP.2 Reason abstractly and quantitatively.

MP.4 Model with mathematics.

HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.

Objective/s- Write objective/s in SWBAT form…

The SWBAT:

- Apply the saponification equation in lab and create soap from hypothetical procedures
- Explain the process of saponification
- Describe the pH scale, including the relationship between H+ and OH- ions and application to the soap making process
- Identify polar and non-polar regions of soap molecules and explain how this structure enables soap to function
- Measure pH of soap and determine soap's safe use
- Discuss how the transfer of energy takes place in the soap making process, including both heat transfer and chemical energy used in the bonding process
- Produce a second bar of soap after day one feedback
- Design a soap dish using an online software
- Present and share outcomes and products through a gallery walk

Evaluation

In the space below, write at least one question to match the objective you listed or describe what you will look at to be sure that students can do this.

What is the general equation of saponification?

What acid was used for your soap project? Base?

Compare and contrast polar and non-polar regions of soap molecules.

What was the pH of your soap? Is your soap safe to use?

What process did you use to make your soap?

What types of energy transfer occurred during the process?

What additives did you add? Why?

How can you use the designing aspect of this lesson in other classes? Personal life?

Engagement: Estimated Time: 90 mins

The teacher introduces the concept of *making*, identifies herself as a maker, and asks students to share examples of their own past creations. The teacher then provides students with basic information about the saponification process and its application in soap making. The students explore properties of the materials and tools they will be using. Students are presented with a rubric to guide their work. This rubric emphasizes the process of making as well as relevant science content.

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
The teacher introduces what making is to students and plays a video of a local Maker Faire. https://vimeo.com/111461414 The teacher mentions some history about making and the growing importance of it in education. The teacher asks students about their making history after sharing her journey in making. *Classroom Management Tip:* The teacher walks around as students think-pair-share about their own making experiences. The teacher introduces saponification by showing a short video at https://www.youtube.com/watch?v=wTuRmwSkuzQ and gets students to understand the reactants and products of the chemical reaction. This video also compares and contrasts polar and non-polar regions of soap molecules with visual and auditory explanations. The teacher encourages students to make their own soap recipe for next class.	Students watch and learn making and try to relate to it. Students share thought with each other and ask questions about the maker movement to the class. Students take note of the chemical reaction of soap and what ingredients they will be using to make soap while watching the soap making video. Students begin to think of their soap recipe.	Have you heard of the maker movement? Share your thoughts/ideas with your partner. Are there any classes/activities/hobbies you are a part of that involve making? What did you like about the making experience you had? How did it challenge you and what did you learn from that? Discuss the polar and non-polar regions of soap molecules and explain how this structure enables soap to function. What is the general equation of saponification? What basic ingredients are needed to make soap? How will you make your soap?

The teacher reminds students of the project overview and the rubric students will be graded with at the end.		

Maker Elements:
Maker Mindset: Habits of a maker mindset including persistence, reflection, and adaptability are demonstrated throughout the project

Resources Needed:
Maker Faire Video https://vimeo.com/111461414
Soap Making Introduction https://www.youtube.com/watch?v=wTuRmwSkuzQ
Let's Make Soap Grading rubric

Safety Considerations: N/A

Exploration: Estimated Time: 90 mins

Students select from a variety of materials to fabricate and personalize their soap using a variety of bases, oils, molds, and fragrances. Students are allowed to work collaboratively. The teacher encourages safe practices while using laboratory tools. Students are encouraged to seek feedback from others throughout the making process. Students engage in multiple iterations of soap making to refine their process and product. Students use a foldable to document observations from each round and write reflections.

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
Classroom Management Tip: The teacher prepares the lab in advance and assures each student has all the necessary materials (does take time). The teacher reviews the ingredients, lab safety, and possible errors students can make in lab. The teacher is hands off for most of the lesson and walks around to make sure students are following safe lab practices and properly handling all lab equipment. The teacher provides a hypothetical soap recipe and students follow it if they wish or follow their own soap recipe. (see sample recipe in resources) *Classroom Management Tip:* The teacher rarely answers questions and encourages students to use the "three before me" rule (ask three other students before asking the teacher) to promote peer interaction. The teacher handles the lye, NaOH, and monitors the handling of the lye and the fume hood for safe practice.	The students review lab safety and wear safety gear for the lab. The students work individually to make their soap. Students reason quantitatively about the ratios of chemicals being used in the provided soap recipe and make adjustments for their own creations. With teacher oversight, the students carefully add the lye to the water and not the other way around. This is done under a ventilated fume hood. The students are patient, as some parts of soap making can become frustrating. Students are documenting each step of the making process and writing reflections in their foldable. The students ask each other questions when confused and push forward.	What equipment will you use to measure your ingredients? Why is it important to add the lye to water and not vice versa? What is the importance of the ventilated fume hood? How will you make sure you soap hardens enough to be poured in the mold? Do you think your soap bar will harden? Why or why not? What other recipes could you have followed to make your soap? How does this lab relate to other labs you have done? What will you change for next lab, if anything? Why? Note: Students will ask many questions, but because the lab involves flames and strong bases, the teacher should refrain from answering them and focus on ensuring all students are safe. Ask students to use the "three before me" rule and enforce it.

Classroom Management Tip: The teacher watches class time, paces the students during the lab, and provides frequent visual and verbal reminders for remaining time. *Classroom Management Tip:* The teacher allows for at least 10 minutes of clean up time and makes sure each lab bench and all equipment are clean for next class. *Having clean equipment is important to ensure the pH is unaffected for the second round of soap making as remains in equipment are more difficult to remove (oils).*	The students use the hot process and add the lye water to the beaker with the correct volume of oil needed. The students take ownership of the lab and add additives such color, glitter, and fragrance in the proportions they believe are correct. The student stirs as appropriate and wait to see a trail from the stirring rod. Students also answer the concluding questions while waiting to see a trail in their beaker. Once the student sees the trail, the soap is ready to be poured in the mold. The student pours the soap in the mold and initials it. After students initial their mold, students begin to clean up their equipment and lab bench. Students finish recording observations, making processes and reflections on their foldables.	Get students to think and reflect on their lab experience and how they can learn from it for their second attempt at soap making!

Connections to NGSS:
In the creation of the bars of soap, students reason quantitatively about the ratios of chemicals being used in their soap recipe and describe changes in the outcome after they modify their recipe.

Maker Elements:
Personal Relevance-You create an original product and can describe its connection to your outside values or interests
Iterative Design and Fabrication-You provide evidence of the evolution of the creation including brainstorming notes, drawings, and/or prototypes

Maker Mindset-Habits of a maker mindset including persistence, reflection, and adaptability are demonstrated throughout the project

Resources Needed:
Molds, additives (fragrances, glitter, color), lye, oils,
Equipment (1 of each for each student): graduated cylinder, spatula, thermometer, small and big beaker, weighing boat, tongs, hot plate
At each lab station: Bunsen burner, beaker brushes, vinegar, and DI water
Making Your Own Soap handout

Sample Soap Recipe
Coconut Oil-6 oz.=170 g
Olive Oil-26 oz.=737 g
Water-10 oz.=283 g
Lye-4.4 oz=124 g

Safety Considerations:
Consider collaborating with technology and engineering teachers to help establish best safety practices, to support the general use of tools, and for advice on managing technology-based projects. The International Society for Technology in Education (www.ISTE.org) provides useful standards for using educational technology in the classroom that can give additional direction to your project.

Students must be careful when working with the hot plate and Bunsen burner, as burns can result from a lack of caution. Because a lot of glass is around, students should be careful not to break beakers by stirring too hard or leaving beaker on the hot plate for too long. Students MUST add the lye to the water and not the other way around; this will help avoid serious issues. The ventilator must be on and students must do this step under the fume hood to avoid inhaling any fumes. All broken glass must go in the glass disposal. Safety is of utter importance and students are told of the lab safety techniques and consequences for failing to follow directions.

Explanation: Estimated Time: 90 mins

Students have made their soap bar and there will be mixed responses from students regarding the successes and needed improvements. Students collaboratively discuss the pH scale and its implications for their own processes of creating soap. Customized designs and soap recipes, including temperature settings and concentrations, are included in the conversations and initial results are shared. Students provide constructive feedback to each other and continue to refine their recipes. This stresses the importance of iteration in making and develops the habit of reflection and revision.

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
The teacher prepares student for the lab and mentions common errors and how to avoid them. The teacher reminds students of the pH scale and asks students to recall prior knowledge of the pH of acids and bases. The teacher encourages students to share the lessons learned from their first soap making attempt, their ideas regarding safe pH levels of soap, and if soap should fall into the category of acid or base. *Classroom Management Tip:* The teacher calls on students randomly using name sticks to ensure equitable participation throughout the discussion. The teacher encourages students to recall the engagement video and the discussion of H+ and OH- ions in the soap making process. The teacher takes a few minutes to offer hints and tips to a successful soap bar after watching students the previous day. She encourages students to think about how using a different type of oil would affect the hardening time.	The students review lab safety and wear safety gear for the lab. After a first attempt, students modify their soap recipe to decrease hardening time, adjust the pH, and customize their fragrance and color. Students engage in iterative design while creating their soap, switching from olive oil to coconut oil after encountering the unanticipated effect of slow hardening time. Students measure the pH of their soap bar using pH strips and evaluate if it is safe to use. The students carefully add the lye to the water and not the other way around. This is done under a ventilated fume hood. The students ask each other questions and provide suggestions for improvement of individual designs.	How have you modified your approach to making your second soap bar? Why is it important to add the lye to water and not vice versa? What is the importance of the ventilated fume hood? Describe the pH scale, including the relationship between H+ and OH- ions and application to the soap making process. What is the pH of soap? What other products have similar pH? What is the pH of your first soap? What can you infer from that regarding the quality of your soap? How can you quicken the hardening process? What types of energy transfer are taking place during the soap making reaction? Are endothermic or exothermic reactions occurring during the soap making process?

The teacher also prompts the students to think about the energy transfers that are taking place during the soap making process. She reviews endothermic and exothermic reactions and encourages students to recall both processes. *Classroom Management Tip:* The teacher circulates to ensure students are following safe lab practices and properly handling all lab equipment. *Classroom Management Tip:* The teacher continues to encourage students to use the "three before me" rule to promote peer interaction. The teacher handles the lye, NaOH, and monitors the handling of the lye and the fume hood for safe practice. *Classroom Management Tip:* As in the exploration, the teacher watches class time and paces the students. Once the lab work is mostly complete, the teacher fosters a group discussion where students are sharing results, comparing temperature settings and concentrations of chemicals used, answering questions posed by the teacher, and providing constructive feedback to their peers. *Classroom Management Tip*: The teacher allows for at least 10 minutes of clean up time at the	Student groups discuss how changing temperature or differing concentrations of various soap ingredients affect the chemical reactions involved in soap making and how these changes impact their final product. The students use the hot process and add the lye water to the beaker with the correct volume of oil needed. Students discuss how the transfer of energy takes place throughout the hot process. The students take ownership of the lab and add additives such color, glitter, and fragrance in the proportions they believe are correct. Student groups discuss the effect of temperature on the chemical bonds between oil, lye, fragrance, food coloring, and glitter used to make their bars of soap. Students discuss the types of heat transfer occurring throughout the bonding process. The student stirs as appropriate and wait to see a trail from the stirring rod. Students also answer the concluding questions while waiting to see a trail in their beaker.	If you were to make soap again, what would you change and why?

end of class and makes sure each lab bench and all equipment are clean for next class.	Once the student sees the trail, the soap is ready to be poured in the mold. The student pours the soap in the mold and initials it. After students initial their mold, students begin to clean up their equipment and lab bench. Students complete the concluding questions and turn them in after lab.	

Connections to NGSS:
After a first attempt, students modify their soap recipe to decrease hardening time, adjust the pH, and customize their fragrance and color.
Students engage in iterative design while creating their soap, switching from olive oil to coconut oil after encountering the unanticipated effect of slow hardening time.
Student groups discuss how changing temperature or differing concentrations of various soap ingredients affect the chemical reactions involved in soap making and how these changes impact their final product.
Student groups discuss the effect of temperature on the chemical bonds between oil, lye, fragrance, food coloring, and glitter used to make their bars of soap.
Students compare the results of their soap making with other groups and discuss how differing concentrations of chemicals impact the color, fragrance, hardness, and pH of their final product.
Students discuss how the transfer of energy takes place throughout the soap making process

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Iterative Design and Fabrication-You provide evidence of the evolution of the creation including brainstorming notes, drawings, and/or prototypes
Collaboration and Community-You collaborate and connect with others to get design ideas, solicit feedback, or make improvements
Sharing Work-Products are presented publicly and you are able to clearly share ideas about your process and product with others
Maker Mindset-Habits of a maker mindset including persistence, reflection, and adaptability are demonstrated throughout the project

Resources Needed:
Molds, additives (fragrances, glitter, color), lye, oils,
Equipment (1 of each for each student): graduated cylinder, spatula, thermometer, small and big beaker, weighing boat, tongs, hot plate
At each lab station: Bunsen burner, beaker brushes, vinegar, and DI water

Making Your Own Soap handout

Safety Considerations:
Students must be careful when working with the hot plate and Bunsen burner, as burns can result from a lack of caution. Because a lot of glass is around, students should be careful not to break beakers by stirring too hard or leaving beaker on the hot plate for too long. Students MUST add the lye to the water and not the other way around; this will help avoid serious issues. The ventilator must be on and students must do this step under the fume hood to avoid inhaling any fumes. All broken glass must go in the glass disposal. Safety is of utter importance and students are told of the lab safety techniques and consequences for failing to follow directions.

Elaboration: Estimated Time: 90 mins

Students are introduced to the use of graphic editor software and laser cutters for making self-designed soap dishes. Graphic editor software is used to make precise measurements for laser cutting customized soap dishes. These designs are based on personal preference and utility, with each design being unique to the individual. Students are given the option to show their designs on the computer or meet the teacher outside of school to laser cut their dish.

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
The teacher introduces the objective of a customized, personal soap dish and passes around three laser cut soap dish designs for students to see. The teacher briefly shows how to use the graphic editor software, Method Draw. *Classroom Management Tip:* The teacher posts the Method Draw link to the classroom website and writes the URL on the board. Students show a thumb up when they have successfully reached the site. The teacher lists a few points to think of when designing the soap dish and encourages peer interaction to generate ideas. The teacher encourages students to go above and beyond with their design and challenges students to think of the design in a 3D form, the layout of the design, measurements, etc. The teacher walks around and guides students with their design. If laser cutting resources are available, the teacher provides times for students to come in	Students fire up their laptops and visit the graphic editor software. Students play with "Method Draw" software and begin to put a soap dish together. Students create a design for a soap dish using graphic design software and explain both the structural and aesthetic choices of the design. Students are aware of important points such as measurements, shape of soap dish, etc. Students use their creativity to make the soap dish unique and personal to them. Students interact with one another and help each other learn how to use the software and offer tips to fix errors and minimize frustrations. They use the teacher as a last resort. Students complete the "Designing Your Customized Soap Dish" handout and turn it in.	How can you make the soap dish unique to you? What are some challenges you faced designing your soap dish today? What was the easy part? Hard part? How did you overcome those challenges? What did you learn today? How can you use these designing skills to benefit you in other classes and/or your personal life?

after school to assist with the laser cutting process to complete their soap dish designs. The teacher provides the big picture of the maker lesson and helps student think of the big takeaways, what they learned, how they made their soap and soap dish, and the skills from this lesson they learned that can be used in other classes and everyday life.	Students try their best to complete their soap dish design or at least have a general layout of it to present during the gallery walk. Students begin to prepare for their presentations and use the questions, feedback, and points of revision mentioned to prepare for the lab.	

Connections to NGSS:
Students create a design for a soap dish using graphic design software and explain both the structural and aesthetic choices of the design.
Students create digital models of their soap dish using graphic design software and share these designs as part of their class presentation

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Collaboration and Community-You collaborate and connect with others to get design ideas, solicit feedback, or make improvements

Resources Needed:
Computers
Method Draw software (free)
http://editor.method.ac/
Designing Your Customized Soap Dish handout

Safety Considerations:
For those students who choose to come in after school to participate in the laser cutting activity to complete their soap dish, proper laser cutter safety must be reviewed and implemented. The teacher operating the laser cutter will be trained for use and students will be able to assist while wearing the proper eye safety.

Evaluation: Estimated Time: 90 mins

Formative evaluation occurs through the use of a rubric that was provided for students at the start of the lesson. The teacher uses this rubric to make notes on student progress at each stage of the 5E learning cycle. Students also use this rubric to self-evaluate and reflect on their work throughout the project. Additionally, students conduct presentations showcasing their soap and dish designs. The presentations include an explanation of their personalized making process as well as a discussion of the chemistry content. The audience is comprised of people from a variety of sectors within the community. After presentations, the teacher revisits the rubric and uses it to provide a summative evaluation for each student.

What the teacher does:	**What the student does:**	**Possible questions to ask students – *think like a student and consider possible student responses***
The teacher sets up the room for the gallery walk and gives five minutes for students to prepare their presentations and their talking points. The teacher invites member of the community, other teachers, makers to the class as the audience to the student presenters. As students begin presenting and community members start asking questions, the teacher walks around and checks on students to check their understanding. *Classroom Management Tip:* It can be useful for the teacher to offer encouragement to nervous students and assurance to everyone. The teacher can acknowledge the hard work all students have put into the project and remind them of that during the presentations. The teacher also asks questions and makes sure students are going around and filling out the slips of questions.	Students prepare to talk about their soap and soap dish. They reflect on what making is, what it means to them, and how it came out during this project. Students walk around and listen to their peers present and complete a slip for each peer they hear present when time is called to switch. Students turn in their slips and work on their project foldable for the remainder of the class.	Questions to be included on the half slips of paper for gallery walk: How has this project helped shape your idea of making? What were the challenges of this project? How did you overcome them? What was the most fun part of the project? What was the most frustrating part of the project? What are some changes you would make if you did this project again? How and why? What skills did you develop during this lesson? How can these skills be used in the future either in your everyday life or in your classes and outside interests? Would you embark on another maker lesson again? Why or why not? What do you hope to gain from it?

Classroom Management Tip: The teacher watches class time, paces the students during the presentations, and provides frequent visual and verbal reminders for remaining time. When half of the class has presented, the teacher tells students to switch. Those that were presenting now go around and ask their classmates the questions on the slip and students who were asking questions now presented their lesson products. At the end, the teacher tells students to turn in their slips all stapled together for a grade as part of the project rubric. The teacher reminds students of the project rubric and gives students time to work on the project foldable (project foldable can be due as decided by the teacher).		

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Collaboration and Community-You collaborate and connect with others to get design ideas, solicit feedback, or make improvements
Sharing Work-Products are presented publicly and you are able to clearly share ideas about your process and product with others

Resources Needed:
Gallery walk slips, Soap dish design, and Soap bars (If available: Laser Cutter with trained operator, appropriate eye safety and materials for cutting soap dish)