Assignment 2: Legacy of Learning Projects

Clarifying Common Misconceptions in Science Using Effective TELE Design

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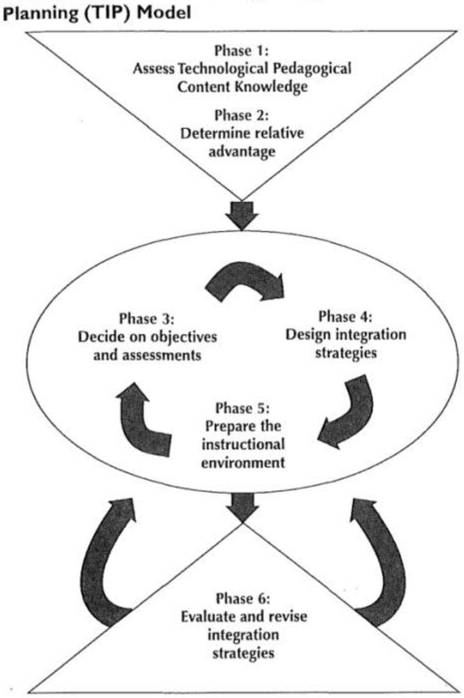
Introduction

In this day and age, technology has evolved to become an integral part of learning and education. The Washington K-12 Technology Learning Standards describes technology as a tool that "can be used to amplify and even transform learning and teaching" (Small, 2018). Echoing this sentiment, Kozma (2003) discusses how integration of technology in education should be focused on transforming educational practices as a way to improve learning outcomes. An effective technology-enhanced learning experience (TELE) is designed to create engaging and transformative learning environments that are based on pedagogy and allow for active learning and critical thinking. Furthering this sentiment, Kozma (2000) states that "designers should provide students with environments that restructure the discourse of …classrooms around collaborative knowledge building and the social construction of meaning" (p. 35). The Technology Integration Model (TIP) proposed by Roblyer & Doering (2012) offers a comprehensive framework that can "help ensure technology use will be meaningful, efficient, and successful in meeting needs" (p. 50). A diagram of the TIP model is shown below:

FIGURE 2.9 The Technology Integration Planning (TIP) Model



(Roblyer & Doering, 2012, Figure 2.9)

Effective TELE Design

When designing a TELE, it is important to start by defining the learning objectives and understand how using technology can help meet these objectives. Once learning objectives have been defined, technologies should be chosen that align with the learning objectives and require students to actively engage with their learning and collaborate with their peers. While introducing these technologies to students, is important to scaffold students by offering tutorials, demonstrations, or step-by-step guidance on how to use this technology effectively. Lastly, it is crucial to continuously assess the effectiveness of the TELE and make adjustments based on student feedback and performance. This ensures that the TELE design always meets the evolving needs of students.

For my TELE, I have prepared three lessons that aim to clarify common misconceptions in science students. The issue of scientific misconceptions is detailed in the next section, and I have chosen to tackle this issue because as a science teacher, I have often found many of these misconceptions in my own students. Without proper tools or technology, I found that it was difficult to clear up these misconceptions through simple diagrams or explanations. In addition to the TIP model, I centred my lessons around the theory of constructivism, which is a learner centred approach that emphasizes collaborative and hands-on learning. Furthermore, I integrated the T-GEM framework to promote scientific inquiry and teach my students the process of making predictions, testing them, and modifying them based on new evidence. This process aligns well with how sciencific research is conducted in academia. Rather than having all the correct answers, scientists must make hypotheses based off prior evidence and develop a procedure to test whether the hypotheses were correct based on the experimental data obtained. Scientists must then reflect on the experimental process through a meaningful discussion and suggest areas for further research. The specific technology I have chosen to integrate into my lessons is the PhET simulation software. Not only do these simulations allow students to visualize scientific concepts, it is also free and accessible to anyone with an electronic device that is able to connect to the internet. In my personal interview with my program director Mr. Chan, he emphasized the importance and effectiveness of integrating technology into the classroom but had concerns about the cost of certain emerging technologies such as virtual or augmented reality. PhET simulations provide a free alternative to these technologies that still allow students to visualize abstract concepts and experience them through hands-on learning.

Common Misconceptions in Science

The salient issue I am focusing on for my TELE design is to clear up common misconceptions of scientific concepts in students using virtual simulations. A video titled “A Private Universe” (Annenberg Learner, n.d.) highlights how many students have misconceptions about scientific topics due to pre-existing knowledge and their experiences in the world. It focuses on a student named Heather, who is very bright and is typical of your "best student" in class. Before learning the topic, Heather was challenged to explain basic topics in astronomy such as how to explain the different seasons of the earth and how the phases of the moon work. She was interviewed again after she received a lesson on these topics from her teacher. While the lesson helped correct some of Heather's misconceptions, she held on to her own personal theories, which impacted her understanding of some of the topics. It was revealed that many of her misconceptions came from perspective drawings that are shown in her textbook. Heather came to realize and correct some of her misconceptions after playing around with a physical model of the Earth and the moon. Through this video, it is clear that teachers need to identify and correct students' assumptions to avoid creating further misconceptions. Smith et al (1993) echo this sentiment, stating that "students had ideas that competed, often quite effectively, with the concepts presented in the class (pg. 116). As students grow up, they often gain a conceptual understanding of the world through their experiences, but this often contradicts accepted scientific and mathematical theories. As teachers, one way to identify pre-existing knowledge is to ask probing questions prior to teaching the lesson. This can help teachers gauge student understanding and to plan the lesson accordingly to correct any misconceptions. After the lesson, teachers can ask the same questions in the form of an "exit slip", which can identify what students learned through the lesson and whether there are still misconceptions that need to be corrected with an additional lesson. These serve as diagnostic tools which can be used to better understand the conceptual understanding of students and where their errors are coming from (Confrey, 1990).

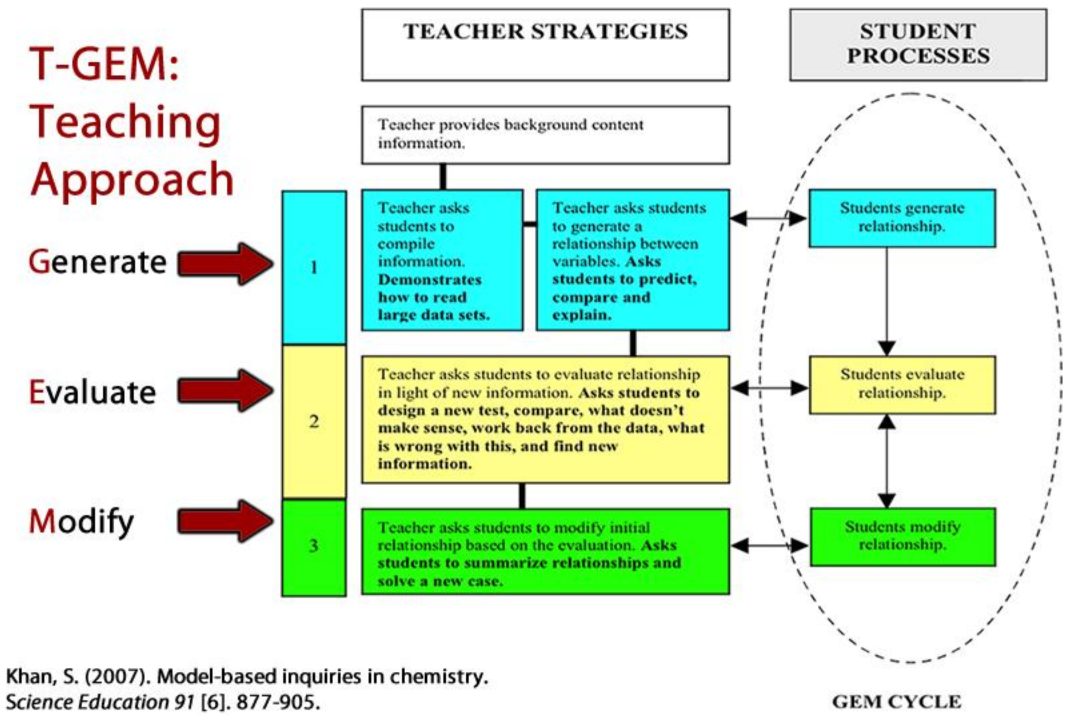
Throughout my teaching career, I have noticed that there are several common misconceptions in the field of science. One of the most prominent misconceptions centres around Newton's laws of motion and how an object in motion stays in motion unless an external force is applied. Several of my students had trouble understanding this concept and they often thought that a force must be continually applied to make an object move. According to Smith et al (1993), "students' misconceptions about force and motion are the result of day-to-day experiences in the physical world" (pp. 119-120). Another common misconception is in the topic of atomic theory and how we know exactly where electrons are within the atom. This misconception stems from the Bohr model that is taught to students in Science 8-10. The Bohr model shows electrons orbiting the nucleus much like how the moon orbits around the earth, leading students to think that is how electrons behave. In reality, electrons exist within specific regions around the nucleus known as orbitals which are calculated based on mathematical probability. Lastly, students also commonly have misconceptions about heat and temperature and how this relates to the substance being a solid, liquid, or gas (Erickson, 1979). Through the use of PhET simulations, I aim to give students a better representation of these three concepts and to clear up any misconceptions they may have.

Constructivism

Constructivism is a learning theory that emphasizes how learners actively construct knowledge through experiences and reflecting on those experiences. Although this theory was not directly covered in this course, many of the frameworks we discussed are centred around constructivist principles. Constructivism is based off the works of early theorists such as Jean Piaget and Ley Veygotsky (Fosnot, 2013). Piaget believed in cognitive constructivism which focuses on how learners construct knowledge through cognitive processes and interactions with the environment. He believed that learners go through distinct stages of development, and that learners cannot progress onto a higher stage. In order to gain new knowledge, learners must go through a process of equilibrium, which is where they assimilate new information into existing cognitive schemas. On the other hand, Vygotsky believed in social constructivism which focuses on the role of social and cultural interactions in constructing knowledge (Gajdamaschko, 2015). Rather than distinct stages, Vygotsky believed in continuous stages of development and that learners can reach a higher stage through interactions with a more knowledgeable other. This gap between what learners can do independently and what learners can do with proper support is known as the Zone of Proximal Development. This zone represents a learner's potential for development and includes tasks that are slightly beyond a learner's current abilities. Scaffolding stems from Vygotsky's theory and is an important teaching tool that describes the temporary support learners are given as they learn new skills or concepts. Teachers can use scaffolding to allow learners to achieve tasks within their Zone of Proximal Development. As learners become more comfortable with these tasks, support is gradually removed until the learner can achieve these tasks independently. This support allows students to explore new concepts in a safe environment and promotes exploration and active learning. The level of support given can be tailored for each student depending on their current abilities, allowing for individualized learning in the classroom. Vygotsky's emphasis of social interaction promotes the idea of collaborative learning. In addition to receiving support from the teacher, learners can receive support from their peers and learn from each other. Collaborative learning creates a dynamic environment where scaffolding can occur naturally through discussions and group activities. In addition, constructivism emphasizes reflection as an integral part of the learning process. Reflection encourages learners to think deeply about their experiences, understand their thought processes, and integrate new knowledge with existing knowledge.

T-GEM Cycle

The T-GEM cycle is an inquiry-based approach proposed by Khan (2007) that integrates technology with the concepts of scientific inquiry to enhance the effectiveness of science education. The T stands for technology while the GEM cycle represents the cycle of generating predictions, evaluating these predictions, and modifying predictions based on new evidence or information. The cyclical nature of the GEM cycle is shown by the new predictions generated during the modify stage. Technology can enhance the GEM cycle by providing more accurate representations for students to base their predictions on and an easier way to manipulate variables and analyze results. According to Khan (2010), benefits of using technology such as computer simulations in the T-GEM cycle include allowing students "to test assumptions, dynamically regenerate graphs, and view graphics at the molecular level" (p. 228). Furthermore, using computer simulations offer the "capacity to engage students in multiple GEM cycles in one classroom period, beyond what could be accomplished in the scientific laboratory" (Khan, 2010, p. 228). A visual flowchart of the T-GEM cycle is shown below:



Khan, S. (2007). Model-based inquiries in chemistry. *Science Education 91* [6]. 877-905.

The T-GEM cycle applies constructivist principles by encouraging students to actively engage in generating, evaluating, and modifying their understanding of the concepts. It also encourages students to reflect on their results and connect their newfound discoveries to prior knowledge. Furthermore, while T-GEM can be implemented individually, it can also involve collaborative activities where students discuss their hypotheses, share evaluation results, and work together to modify their models. This encourages collaborative learning and allows students to learn from each other.

PhET Simulations

PhET simulations is a free educational resource that offers over 150 simulations on scientific concepts in STEM fields. According to Perkins (2020), these simulations support “learners as they naturally and productively ask questions, conduct experiments, discover cause-effect relationships, reflect on results, and test their ideas; and it is grounded in education research to address known student difficulties” (p. 43). PhET simulations has become so impactful in STEM education that there have been numerous studies done on the effectiveness of using PhET simulations in STEM classrooms. Taibu et al (2021) explored the impact of using PhET simulations with college level students. Their results showed a significant improvement in laboratory skills and student engagement both quantitatively and qualitatively. On the other end of the spectrum, Diab et al (2024) explored the effectiveness of using PhET simulations to enhance learning in elementary school students. The authors emphasized the “value of simulation-based learning in fostering critical thinking and problem-solving skills” (Diab et al., 2024, p.1). According to their results, the “PhET group’s superior performance in applying their knowledge highlights how interactive simulations facilitate deeper comprehension and engagement with the material” (Diab et al., 2024, p. 13). Furthermore, the authors highlight the potential of integrating PhET simulations as a supplement to traditional teaching methods, such as lectures, rather than as a replacement. They recommend starting with a lesson to provide foundational knowledge, followed by the PhET simulations to deepen understanding and promote inquiry-based learning. To explore how simulations can best be integrated into a classroom, Adams et al (2008) conducted a study to determine the correct level of guidance teachers should give during interactive simulations. They found “that exploration of the simulations under no guidance or with driving questions promotes students to explore the simulations where they gain physical insight into the phenomena via their own questioning (Adams et al, 2008, p. 4). If students are given the answers beforehand, it reduces the chance for exploration and short-circuits the entire learning process. As a result, the ideal amount of guidance would be to give students only enough background to get them started in the right direction and to let students explore on their own. Teachers can then scaffold learning individually if any students are having difficulties with the simulation.

Lesson Plan: States of Matter

Learning Objectives

- Students will understand the four states of matter: solid, liquid, gas, and plasma
- Students will clear up misconceptions of heat and temperature by understanding how these concepts relate to the KMT
- Students will understand the Kinetic Molecular Theory (KMT) and how this relates to the three states of matter we see in everyday life (solid, liquid, gas)
- Students will understand how phase changes occur

Age Group/Subject: Science 8 (Chemistry)
Time: 90 minutes

Materials:
- whiteboard and markers
- projector
- class set of computers or tablets
- PhET simulation "States of Matter: Basics" (https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.html)
- guided worksheet on the PhET simulation

Roles:

Teacher: The teacher's role is to provide foundational knowledge and to guide students during interactive activities through probing questions and an appropriate level of scaffolding. The teacher should also demonstrate how the simulation works and evaluate student learning through formative or summative assessments.

Students: the students' role is to be active learners who collaborate with their peers to share ideas and support one another. The students should also be inquirers who are ready to ask questions, develop predictions, and test these predictions through the simulations. Finally, students should also reflect on their own learning and be able to identify and give feedback on what parts of the lesson worked well for them and what areas of improvement there are for the lesson.

Lesson Plan Design:

This lesson plan was designed based off constructivist principles of inquiry-based learning and supports active engagement from students. Furthermore, it encourages collaborative and social learning by asking students to share their findings with peers. It also implements the T-GEM model by requiring students to generate hypotheses, evaluate these hypotheses using the simulation, and to modify their hypotheses based off the results. This lesson incorporates the PhET simulation "States of Matter: Basics" to allow students to visualize the movement of molecules and how this relates to temperature, phase changes and the KMT.

Lesson Activities:

1. Introduction (Generate) - 15 minutes

- Start with a brief discussion on everyday examples of different states of matter (ex: ice, water, steam).
- Go around the room and ask students to generate ideas on how substances change between solid, liquid, and gas and to write these ideas down in their notebook
- Explain the significance of understanding states of matter in science and daily life.
- Introduce the PhET simulation “States of Matter: Basics” and show a brief demonstration on how to use the simulation

2. Exploration (Evaluate) - 25 minutes

- Divide students into small groups and allow students to freely explore the simulation
- Hand out the worksheet “States of Matter”
- Once students have completed the worksheet, conduct a class discussion on the answers and ask students to make arguments for their answer if there are any discrepancies
- Have the class come to a consensus on the answers to the worksheet and provide feedback to deepen understanding of the concepts

3. Conceptual Understanding (Modify) - 30 minutes

- Ask the students to summarize their findings from the last activity and to reflect on the answers they didn’t answer correctly
- Teach a short lesson on the key concepts of KMT and states of matter
- Conduct a class discussion to address any misconceptions and clarify complex concepts such as phase changes
- Ask students to come up with further questions on states of matter and the KMT and to generate new hypotheses based on these questions
- Allow students to test and modify their predictions using the simulation

4. Application (Demonstration) - 10 minutes

- Conduct a simple experiment to demonstrate changes in states of matter (e.g., melting ice, boiling water).
- Summarize the key points of the lesson and highlight the importance of understanding states of matter in chemistry

5. Reflection - 10 minutes

- Hand out an “exit slip” which asks them to reflect on what they learned about states of matter and the KMT and to identify any areas of confusion they may still have
- For homework, students will be asked to research more on states of matter. They will be asked to share any new knowledge or questions at the start of the next class

Worksheet: States of Matter

For this activity, you will be exploring the basic states of matter: solid, liquid, and gas. We will be the following PHeT simulation for this activity:
https://phet.colorado.edu/en/simulations/states-of-matter

PART I: States of Matter

Predictions

These steps should be done prior to clicking into the simulation

1) Draw a picture of a solid, liquid, and gas in your notebook (your diagram should include around 10-20 particles).

2) Answer the following questions:

i) In which state do you think particles will move the fastest?

ii) Is there a state where the particles are not moving at all?

iii) What do you think would happen to the speed of the particles if the temperature was increased or decreased?

Experiment

1) Start by selecting "Neon" under the list of atoms and molecules. Click through the different phases (solid, liquid, and gas) and draw a diagram of each of these states in your notebook (include around 10-20 particles per diagram)

2) Click through the other atoms and molecules (Argon, Oxygen, and Water) and make note of any differences you see between these and neon.

3) Adjust the temperature by adjusting the Heat/Cool button at the bottom of the simulation. Make note of the changes that happen as you increase or decrease the temperature of the reaction vessel.

4) Answer the following questions and compare these answers to your initial predications:

i) How do the diagrams you drew during the prediction stage differ from the diagrams of the different states in the simulation?

ii) In which state do the particles move the fastest?

iii) Is there a state where the particles are not moving at all?

iv) How does increasing or decreasing the temperature of the reaction vessel affect the speed of the particles?

PART II: Phase Changes

Predict

Answer the following question before clicking into the "Phase Changes" portion of the simulation.

1) Based on your observations from part 1, predict how a substance changes from a solid to a liquid, and vice versa.

Experiment

1) Start with solid Neon and try adjusting the temperature settings. What can you do to make solid Neon change from a solid to a liquid, and then to a gas?

2) Reset the simulation and start with gaseous Neon. What can you do to make gaseous Neon change from a gas to a liquid, and then to a solid?

3) Explain how heating affects the speed of the particles and how this relates to phase changes between states.

4) Explain how cooling affects the speed of the particles and how this relates to phase changes between states.

5) Play around with the temperature settings. Is there anything you can do to make the particles completely stop moving?

What further questions arise through your experiment with the simulation? How can you use the simulation to generate hypotheses and test these hypotheses?

Lesson Plan: Understanding Atomic Theory

Learning Objectives

- Students will understand how the atomic theory was developed through history and how each scientist contributed to our modern understanding of the atom
- Students will understand the basic principles of quantum theory and how this relates to the atom
- Students will understand that electrons reside within orbitals and clear up any misconceptions about how electrons orbit based off the Bohr model
- Students will explore the shapes of molecules and how the VSEPR theory contributes to our understanding of these shapes

Age Group/Subject: Chemistry 11
Time: 90 minutes

Materials:
- whiteboard and markers
- projector
- class set of computers or tablets
- molecular model kits
- PhET simulation "Molecule Shapes" (https://phet.colorado.edu/sims/html/molecule-shapes/latest/molecule-shapes_all.html)

Roles:

Teacher: The teacher's role is to provide foundational knowledge and to guide students during interactive activities through probing questions and an appropriate level of scaffolding. The teacher should also demonstrate how the simulation works and evaluate student learning through formative or summative assessments.

Students: the students' role is to be active learners who collaborate with their peers to share ideas and support one another. The students should also be inquirers who are ready to ask questions, develop predictions, and test these predictions through the simulations. Finally, students should also reflect on their own learning and be able to identify and give feedback on what parts of the lesson worked well for them and what areas of improvement there are for the lesson.

Lesson Plan Design:

This lesson plan was designed based off constructivist principles of inquiry-based learning and supports active engagement from students. Furthermore, it encourages collaborative and social learning by asking students to share their findings with peers. It also implements the T-GEM model by requiring students to generate hypotheses, evaluate these hypothesis using the simulation, and to modify their hypotheses based off the results. This lesson incorporates the PhET simulation "Molecule Shapes" to allow students to visualize orbitals and how they contribute to the shape of molecules.

Lesson Activities:

1. Introduction (Generate) - 15 minutes

- Start with a brief discussion on what students already know about atoms and atomic theory. Ask the students to make a KWL chart (Know, Want to know, Learned) to record their ideas. Students will revisit this chart at the end of class and reflect on what they learned.
- Introduce the history and development of the atomic theory, highlighting key scientists like Ernest Rutherford, Niels Bohr and Erwin Schrödinger
- Talk about each scientist's contributions and ask students to generate ideas on how each scientist's work either built on or challenged existing ideas at the time
- Introduce the PhET simulation "Molecule Shapes" and show a brief demonstration of how to use this simulation
- Based on this brief demonstration and building on existing knowledge, ask students to generate a model of the atom and draw this in their notebook

2. Exploration (Evaluate) - 25 minutes

- Teach a short lesson on quantum theory and atomic orbitals. Discuss how electrons reside in orbitals and address any existing misconceptions students may have from their understanding of the Bohr Model
- Introduce the VSEPR theory and how lone pairs repel more than bond pairs
- Divide students into small groups and allow them to explore the simulation freely
- Once students have had the chance to explore the simulation, provide guiding and probing questions for students to answer such as "What is the shape of ______?" or "Why do lone pairs repel more than bond pairs and how does this affect the shape of molecules?"
- Students will be asked to share and discuss their answers to the guiding questions amongst their groups
- Using newfound knowledge from the simulation, have students evaluate the model of the atom that they previously generated

3. Conceptual Understanding (Modify) - 20 minutes

- Teach a lesson on the various shapes of molecules based on VSEPR theory. Introduce the concept of electron domain geometry, VSEPR geometry, and bond angles.
- Ask each group to share their findings with the class and address any misconceptions that students may still have
- Have students summarize their findings from the simulation and class discussion in their notebook.
- Now that they have more newfound knowledge, ask students to modify their original model of the atom.

4. Application (Model) - 20 minutes

- Divide students into the same small groups as before. Using the molecular model kits, give a list of molecules for students to build. This gives students a chance to physically build models that they previously built in the simulation.
- Each student in the group will build their individual models and share them with the group. If there are any discrepancies, students will discuss which model is correct and come up with a group consensus
- Give feedback on each group's model and share the correct answers with the class
- Ask students to choose their own molecules to build models for. Students will write down a brief explanation of each model in their notebook

5. Reflection - 10 minutes

- Revisit the KWL chart and have students fill in the "Learned" section. Have a short class discussion on how their understanding of quantum theory and the atom has changed.
- Exit Ticket: Ask students to write a brief reflection on what they learned about the development of atomic theory and the nature of scientific knowledge. As part of their reflection, students will be asked what further questions they have on quantum theory and what areas of further research could be done on this topic
- For homework, students will be asked to review their notes and prepare for a formative quiz in class the next day. The purpose of this formative quiz is to gather feedback on any misconceptions and to determine what concepts of quantum theory students may still need more clarification on.

Lesson Plan: Newton's Laws of Motion

Learning Objectives

- Students will understand Newton's three laws of motion
- Students will clarify any existing misconceptions on forces and motion
- Students will be able to predict the outcome of various scenarios using Newton's laws
- Students will be able to apply Newton's laws to real-world scenarios
- Students will be able to evaluate the impact of different forces (ex: friction, gravity) on the motion of objects
- Students will be able to draw a free-body diagram to model forces on an object

Age Group/Subject: Physics 11
Time: 90 minutes

Materials:

- whiteboard and markers
- projector
- class set of computers or tablets
- PhET simulation "Forces and Motion: Basics" (https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_all.html)

Roles:

Teacher: The teacher's role is to provide foundational knowledge and to guide students during interactive activities through probing questions and an appropriate level of scaffolding. The teacher should also demonstrate how the simulation works and evaluate student learning through formative or summative assessments.

Students: the students' role is to be active learners who collaborate with their peers to share ideas and support one another. The students should also be inquirers who are ready to ask questions, develop predictions, and test these predictions through the simulations. Finally, students should also reflect on their own learning and be able to identify and give feedback on what parts of the lesson worked well for them and what areas of improvement there are for the lesson.

Lesson Plan Design:

This lesson plan was designed based off constructivist principles of inquiry-based learning and supports active engagement from students. Furthermore, it encourages collaborative and social learning by asking students to share their findings with peers. It also implements the T-GEM model by requiring students to generate hypotheses, evaluate these hypotheses using the simulation, and to modify their hypotheses based off the results. This lesson incorporates the PhET simulation "Forces and Motion: Basics" to allow students to visualize and experiment with Newton's Laws and how they apply to real-life scenarios.

Lesson Activities:

1. Introduction (Generate) - 15 minutes

- Start by asking students to think about everyday scenarios where they observe forces and motion (ex: driving a car, riding a bike). Write their responses on the whiteboard.
- In pairs, ask students to briefly discuss how they think forces are involved in each of these situations
- Divide students into small groups and hand out various objects such as toy cars, balls, or books. Ask students to perform simple actions with the object such as pushing or pulling
- Ask students to write down their observations in their notebook. Provide guiding questions such as “How does an object start moving and stop moving?” and “What happens if you drop an object onto the ground?”
- Invite students to share their observations with the rest of the class

2. Exploration (Evaluate) - 25 minutes

- Teach a short lesson on Newton’s three laws of motion. Invite students to think about how these laws can apply to the scenarios they tested above.
- Introduce the PhET simulation “Forces and Motion” and provide a short demonstration on how to use the simulation
- Divide students into small groups and allow them to explore the simulation freely by manipulating the variables. Ask students to write down their observations in their notebook
- Once students have had the chance to explore freely, give guiding questions for students to answer using the simulations. Some examples of guiding questions include: “How does changing the mass affect the acceleration of an object”, “How does the magnitude of forces affect the movement of an object”, and “How does friction impact the motion of an object”
- Students will test and evaluate their predictions from the previous section using the simulation
- Students will share their answers to these guiding questions amongst their groups

3. Conceptual Understanding (Modify) - 20 minutes

- Teach a lesson on friction and explain the difference between static and kinetic friction
- Discuss the concept of gravity and how this is different for each planet
- Using their newfound knowledge, ask students to modify their predictions and generate new predictions that they test using the simulation. Students will be asked to share these predictions with the rest of the class and teachers will write these predictions on the whiteboard
- Have a class discussion to come up with ways to test these predictions using the simulations
- Each group will pick 2-3 of the predictions and test them by manipulating the variables in the simulation

4. Application (Model) - 20 minutes

- Teach students how to draw a free-body diagram to show the forces acting on each object for different scenarios
- Divide students into pairs and assign a different scenario to each group. Each group will be tasked to draw a free-body diagram for the scenario and explain the various forces acting on the object
- Each group will then be asked to share their scenario and the free-body diagram that they have drawn to the rest of the class. Their peers will have a chance to give feedback on their free-body diagrams and come up with a class consensus on the correct diagram
- Teachers will give feedback on the answers that the class came up with and clarify any common misconceptions that students may still have on this topic

5. Reflection - 10 minutes

- Exit Ticket: Ask students to write a brief reflection on what they learned about the Newton's Laws of Motion and how these can apply in different real-life scenarios. As part of their reflection, students will be asked what concepts from the lesson they understand well and what concepts they need further clarification on.
- For homework, students will be given a worksheet to practice drawing free-body diagrams for various scenarios.
- Inform students that there will be a short formative quiz at the beginning of the next class. The purpose of this quiz is to help students understand how well they understand the concept of forces and motion. Based on the results on this quiz, teachers can give individualized support to certain students who may be struggling.

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