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| **TEAM Lesson Plan Template** | |
| Teacher: Dr. Jason Alexander | |
| Subject/Grade: 8th grade science | |
| Lesson Title: Modeling an Expanding Universe | |
| **STANDARDS** | **Identify what you intend to teach.** State, Common Core, ACT College Readiness Standards and/or State Competencies; Enduring Understandings and Essential Questions. |
| 8.ESS1.1 Research, analyze, and communicate that the universe began with a period of rapid expansion using evidence from the motion of galaxies and composition of stars.  8.ETS1.2 Research and communicate information to describe how data from technologies (telescopes, spectroscopes, satellites, and space probes) provide information about objects in the solar system and universe.  This lesson emphasizes  Science and Engineering practice: Using Models  CCC: Pattern  Learning performance: Students will use a model to recognize expansion of the universe highlighting patterns. | |
| **OBJECTIVE(s)/Sub-Objectives** | **Connect prior learning to new learning.** Clear, Specific, Observable, Demanding, High Quality, Measurable, Aligned to Standard(s), and Integrated with other subjects, build on prior student knowledge  Student-Friendly (I Can Statement) |
| I can align a picture of a galaxy on a transparency with a another picture of the same galaxy.  I can represent the direction and distance of motion of a galaxy with an arrow.  I can represent the relationship between two quantities using a graph. | |
| **MATERIALS AND RESOURCES** | **Content-related:** Clearly supports lesson objective(s); rigorous & relevant; Incorporates multimedia & resources beyond the textbook. |
| **Activities & Materials**  **For class:** Projector/computer/screen to display images from PowerPoint presentation “ModelExpansion”  **Per group**: Rubber band cut into a strip; Pen and Pencil; Ruler; Paper copy of Galaxy Field 1; Transparency of Galaxy Field 2; Expanding Universe Worksheet (pgs 40 & 46 of CQEG), Transparency marker;  Worksheet from *Cosmic Questions Educator’s Guide*, pages 40-46: <https://www.cfa.harvard.edu/seuforum/exhibit/resources/CQEdGuide.pdf>  The *Cosmic Questions Educator’s Guide* was written by the Harvard-Smithsonian Center for Astrophysics and the Museum of Science, Boston. Used by permission.  **What if the technology is not working?** Skip the PowerPoint presentation and just use the hardcopy worksheets.  **Routine for distributing materials:** Pass out rubber bands and worksheets. | |
| **ACCOMMODATIONS/ADAPTATIONS** | **Learning styles and interests.** Anticipate learning difficulties, regularly incorporate student interests & cultural heritage; differentiate instructional methods. |
| **Modifications/Plans for Diverse Learners *(NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **Differentiation**  **\_\_x\_\_ Flexible Grouping** .  **\_\_x\_\_ Other**.  **Accommodations**  **\_\_\_ Preferential Seating \_\_\_ Extended Time \_\_\_ Small Group \_\_\_ Peer Tutoring**  **\_\_\_ Modified Assignments \_\_\_ Other**  **Early Finishers:** | |

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| **MOTIVATING STUDENTS/ANTICIPATORY SET** | **“Hook”: Engage students’ attention and focus on learning.** Personally meaningful and relevant. |
| Consider showing the universe expansion video at: <https://www.youtube.com/watch?v=9UQwwZfThDk> | |
| **INSTRUCTIONAL PROCEDURES** | **Step-by-Step Procedures-Lesson Sequence: Basic to Complex.** Lesson includes visuals, modeling, logical sequencing and segmenting (beginning, middle, ending); essential information; concise communication; grouping strategies; differentiated instructional strategies to provide intervention & extension; seamless routines; varied instructional strategies; key concepts & ideas highlighted regularly. |
| ***Introductio*n**  Arrange students in groups and have them count off to identify group roles. Ask “What are some ways to visualize our expanding universe?” Have holders use a pen to draw six dots about 1cm apart on a rubber band strip. Explain that the dots represent galaxies. Instruct the holders to pick a galaxy and hold the rubber band there, perhaps by pressing on the dot with the pen. Have the Stretcher pull on each end of the rubber band and keep the rubber band stretched. Ask students to discuss what they observe. Measure the distance from the fixed galaxy to the first three galaxies to one side of the fixed galaxy. All four group members will work to make these measurements.  Gently release the rubber band. Choose a different galaxy and hold the rubber band there. Have the Stretcher pull on each end of the rubber band and keep the rubber band stretched. Ask students to discuss what they observe. Measure the distance from the fixed galaxy to the first three galaxies to one side of the fixed galaxy.  Regain the whole group’s attention and have them consider the questions in the “Discussion Notes” section of the worksheet: Are the galaxies moving away from each other? Is there a center of the universe?  Did the galaxies move in the same amount of time? Did the galaxies move the same distance? Which galaxy(ies) moved faster? Are the galaxies themselves expanding?  Is there any pattern to how far apart the galaxies appear to be (after stretching)? (linear function of initial distance from fixed galaxy)  **Middle**  (Decide if students should put their names on the Galaxy Field transparency; It is possible to assess their work without looking at the transparency, but if they misunderstood something, looking at the transparency may be helpful. Provide the appropriate instructions). Monitor students as they complete the activity and record results on the worksheet. Ask questions to prompt them as necessary.  **End/Closure**:    Have students turn in their worksheets and the Galaxy Fields. Discuss what the models show us in one dimension and in two dimensions. Point out that the actual expansion occurs in three dimensions.  **Motivating Students**  \_x\_ Relate to Real World  \_x\_ Verbal Reinforcement The teacher will monitor students’ work throughout the activity to provide reinforcement.  **Presenting Instructional Content**  \_x\_ Lecture/notes There is a brief presentation in the middle to show students how to use the transparency as an overlay.  \_x\_ Discussion The activity alternates between hands-on use of the models in small groups and whole-group discussion of what the models represent well and what they do not represent well.  \_x\_ Video \_x\_ Hands on \_x\_ Guided Practice The worksheet provides guided steps for students to complete the hands-on activity.  ***Instructional strategies:***  ***Input -* Hook (Set)**  **Modeling and Guided Practice *–*** The worksheet lays out steps for students. The teacher will monitor their work and ask questions to prompt them if they are stuck.  **Check for Understanding (CFU) –**  ***What am I doing for students that progress at different rates?***  Encourage students to help each other within their groups. If one group is significantly ahead of another, ask one group to help the other. If necessary, provide help with the algebra (“the algebra” here is graphing and finding the unit rate.).  ***What do I do if they get it?***  If students handle the activity smoothly, ask them to repeat the activity with a single battery (requires a foil-covered dowel) in the car and compare speeds. Have them compare the speed of the car going uphill or downhill to the speed on a level surface (requires a ramp, foam board perhaps.  ***What do I do if they don’t get it?*** | |
| **QUESTIONING/THINKING/PROBLEM SOLVING (embedded throughout)** | **Balanced mix of question types.** Utilizes Blooms Taxonomy/Webb’s Depth of Knowledge; high frequency; purposeful & coherent; require active responses; balance based on volunteers/non-volunteers, ability, & gender; lead to further inquiry & self-directed learning.  **Implement four types of thinking (Analytical, Practical, Creative, & Research-based) & Teach/Reinforce problem-solving types**. Provide opportunities for students to generate ideas & alternatives; analyze, evaluate & explain information from multiple perspectives& viewpoints. |
| **Questioning** These questions will occur throughout the activity as prompts based on groups’ or individual students’ progress.  **Knowledge:**  Are the dots moving away from each other in the rubber band model?  **Comprehension:**  What do the dots represent in the rubber band model?  What units are used for time in the question [from the worksheet]?  **Application:**  Is there a center of the universe?  Did the galaxies move in the same amount of time in the rubber band model?  Did the galaxies move the same distance in the rubber band model?  **Analysis:**  Which galaxy(ies) moved faster in the rubber band model?  Are the galaxies themselves expanding?  Is there any pattern to how far apart the galaxies appear to be (after stretching)? [stretched distance is directly proportional to initial distance from fixed galaxy. Allow students to think through this; they may need to measure the initial distances and compare to the stretched distances]  **Synthesis:**  What does the rubber band model help us understand about the universe? [ this model shows how galaxies that are further away are moving away faster ]  What is a big drawback of the rubber band model? [ it is a one-dimensional model of a three dimensional universe ]  **Evaluation:**  **Thinking**  **\_x\_ Practical –.**  **\_x\_ Creative–.**  **\_x\_ Analytical –.**  **\_x\_ Research-based –.**  **\*What am I going to do to give Students an opportunity to?**  **1. Generate variety of ideas:**  **2. Analyze problems from multiple viewpoints:**  **Problem Solving *Note: Teach 2 or more types of problem solving (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **\_x\_\_** **Abstraction** The 1 and 2-dimensional models are abstractions of the actual universe. The graph is an abstraction of the motion of galaxies.  **\_x\_\_ Observing and experimenting** Students observe the models to draw conclusions about motion in an expanding universe. | |

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| **GROUPING** | **Maximize student understanding & learning** Varied group composition (race, gender, ability, & age); clearly understood roles, responsibilities & group work expectations; accountability for group & individual work; student opportunities for goal setting, reflection & evaluation of learning. |
| * Heterogeneous groups of three or four * Roles. Reader/recorder; Holder (holds rubber band and worksheets); Stretcher/marker (stretches rubber band and marks transparency with straightedge and marker); Measurer (measures distances) * The teacher will have students count off within groups. Student 1 becomes the reader/recorder, student 2 becomes the holder, etc. The teacher will demonstrate each role for the students. * Transition. Students should begin class in their groups and remain in the groups throughout. * Product. Students will complete a worksheet. | |
| **ASSESSMENT** | **Formative and/or summative assessment.** A variety of assessments, including rubrics, measure achievement of objectives and informs instruction. |
| ***Assessments: aligned with state stds; measurement criteria; measure student performance in more than 2 ways (project, experiment, presentation, essay, short answer, multiple choice test) (NOTE: Clearly identify where you will use each of these in your lesson; do not just check the box!)***  **\_\_x\_ Worksheet** Students will submit the worksheet for assessment.  **\_\_x\_\_ Exit Ticket** See below  *\****Students should achieve \_\_\_\_\_% mastery of this objective: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** | |
| **CLOSURE** | **Reflection/Wrap Up.** Summarizing, reminding, reflecting, restarting, connecting. |
| * ***Review/Summary: wrap up what has been learned and accomplished in the lesson (even if they are in the middle of an exercise, it is still important to summarize to the point where they are now). Ideally involve students in this synthesis.*** * ***Preview for next lesson:*** Previously, we looked at emission spectra from hydrogen and helium. Today we looked at models of the expanding universe. Tomorrow, we will combine these two ideas. Emission spectra from hydrogen viewed from faraway look different in a very specific way. This difference provides evidence that our expansion model is a correct way to view the universe. * ***Upcoming assignments: remind them of any upcoming assignments.***   ***Today we…. Turn to your partner and…. Let’s review our I Can statements……***  **Here is your exit ticket for today**: Fill in the blank: If Galaxy B is three times as far away as Galaxy A, then Galaxy B is moving away from us \_\_\_\_ times as fast as Galaxy A.  **Follow-up Activities/Extension *These may be designed to create a longer or more intense lesson. For example, if the class is able to cover the material in a lesson much faster than expected, extensions may prove helpful. Extensions may also be useful in various parts of a lesson where the teacher (and class) decides they should spend more time on a skill or topic.***  ***Reflection: You must reflect on every lesson you teach.*** | |

**NOTES:**

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