Active Learning and Student Data Collection in the Middle School Classroom

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This curriculum unit is recommended for:
Science/Grade Seven

Keywords: Physics, speed, active learning, kinesthetic learning, cooperative learning groups, math integration

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This curriculum unit investigates how students can create their own data in order to take ownership of their learning. When students feel as if their learning is relevant they try harder and achieve at a higher level. Strategies described include active learning, cooperative learning groups, math and science integrated units, assessments, and kinesthetic learning. Students begin their unit by collecting distance and time data by video recording a car rolling down a track. From this students calculate and plot speed onto graphs. On the following days, students write stories and act out distance versus time graphs given to them by the teacher.

I plan to teach this unit during the coming year in to 120 students in seventh grade science

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Jennifer Thompson

Rationale

Every year, I tell my students that we will be using data in our science class, and every year I am met with a sea of blank stares and confused faces. I find that my students don't really understand what data is. They have been taught the definitions of qualitative data and quantitative data, but have not had much practice using these types of data. As the year winds on, I notice that most of my students quickly become comfortable with qualitative data, as it is more within their comfort level to observe. When I try to push more numbers, they rebel. The thought of using in a science room anything related to math makes them dig in their heels. There have been times in the past where I have asked students to graph their results and nearly every student would rather hand the assignment in blank and take the zero than even try. I have to remind them that you calculate an average the same way in science as you do in math, or reassure them that the graphs in science are read in the same way as you would in math class.

The drive behind this unit is to force students to realize that science depends on all types of data. Data are not just a random chart that your science teacher gives you. Data are numbers that the students can themselves extract from labs in which they design. The goal is for students to realize that data and science should be inseparable. Through this unit, my students will understand that nearly everything they touch could have data and numbers connected to it and that they can discover these numbers themselves. I also wanted my students to understand that data from their experiments will not always look as expected – and that is not a bad thing. These are all concerns and challenges that students will be forced to look at and analyze during this unit plan.

Student and School Background

This unit was designed for 120 students in a Title 1 school in Charlotte, NC. I teach half of our seventh grade population. Our student demographic is very diverse including 68% African American, 13% Caucasian, 11% Hispanic, 2% Asian, and 6% other. Economically disadvantaged students make up about 75% of the student population. Many of my students are homeless and many live with extended family or multiple families in one home. Students are grouped into classes based on their Language Arts and Math EOG scores. Approximately 40% of my students are on grade level in reading and math. Classes meet every day for 70 minutes, but the particular time block within the day in which I see my students changes each day.

Content Objectives

This unit is taught according to the North Carolina Essential Standards for middle school. Prior to this unit, students will need a working knowledge of standard 7P1.1 which expects students to be able to explain how the motion of an object can be described by its position, direction of motion, and speed with respect to some other object. Within this standard, students are expected to be able to calculate the speed of an object given distance and time. The activities of this curriculum unit have students responsible for two physics standards. Standard 7P1.3 states that students will need to illustrate the movement of an object using a graph to show the change in position over a period of time. Standard 7P1.4 states that students will need to interpret distance versus time graphs for constant speed and variable motion.

To teach these standards, the unit is broken up into six days. On day one and day two, students will collect distance and time data from small cars run down tracks, addressing standards 7P1.1 and 7P1.3. On day three and day four, students will create and act out a story based on a motion graph assigned to them, addressing standard 7P1.4. On day five, students will be given a story and will need to place the data they interpret from the story onto a graph, addressing standard 7P1.3.

Teaching Strategies

Active Learning

It has long been known to teachers that lecturing students does not end in students retaining information. Instead, if students are put in charge of their own learning, they can take ownership of their education. Active learning is the idea that students are "engaged in their own learning. [It has] students do something other than take notes or follow directions, placing the responsibility for learning squarely on their shoulders." [i] The difficulty for teachers is how to effectively plan for lessons such as these. Lessons that support active learning will be inquiry based and give students the opportunity to communicate and problem solve. The biggest key to active learning is that the students must "do something". [ii] Active learning, paired with cooperative learning, is the key to success in most of today's careers. The focus of science education must move beyond just memorizing a list of facts and move towards how to apply and analyze information. Active learning does not need to be a complicated model. It can be as simple as making time for student response during a short lecture. Within a short set of notes, a teacher could include higher level thinking questions about the content, have students turn to one another and discuss, and then share and discuss as a group.

"Involving students actively in the science classroom enhances understanding and retention and reflects the nature of science."[iii] Scientists do things – scientists do not make the next great discovery by sitting in a lecture and daydreaming. They had to read, think, discuss, experiment, ask questions, and repeat all of those many times. Active learning also makes self assessment easier. The student knows what information he or she has mastered if the student can recall and use it in the classroom. As teachers engage with students who are actively learning, they also know immediately the level of student understanding without needing to wait for a test or a quiz. Other benefits of active learning include providing an opportunity for cooperative learning and a way for teachers to uncover misconceptions that students may have.

Although active learning can be snuck into lessons daily. If a teacher tends to run a more teacher-centered, lecture based classroom, there are simple ways to begin teaching with active learning in mind. While giving a lecture, stop at multiple points. Give students a question that applies to the world around them, yet makes them rely on the content that has just been addressed. Students will formulate an answer or solution to the problem in small groups and then share with the class. Once the teacher and students are comfortable with this method, the class can take it a step further and begin to debate and argue their answers as a class. For teachers who have classes which are afraid to speak up, there are many online resources that allow students to contribute an electronic response. The class can begin with their contributions, giving students the ability to "do something" behind the safety of a computer screen. Once the culture of the class begins to change, teachers can have students share their electronic answers and then begin to defend them. Over time, the electronic piece can be removed and students will be comfortable speaking with one another and to the group. All of these interactions can be referred to in future lessons.[iv] Once students and teachers have mastered this idea of active learning on a simple scale, then more challenging strategies can be used. The concept mapping of information learned in notes, or the information extracted from a reading, allow students to not only recall information, but apply it at a higher level.

Even after knowing simple ways to include active learning into lessons, teachers can be intimidated with how to manage a class of talkers. Teachers try so hard to keep a classroom managed properly so that students are quiet and attentive, so it can often be counterintuitive to a teacher on how to get their students talking appropriately. Although it is possible to switch to a more active learning environment midway through the school year, it is easiest to start at the beginning.[v] Begin on day one. If the concern is management, then be sure to practice with students the procedures involved in active learning. This could include the proper volume for interactions, where to go if they need help, how to respectfully listen and reply when other students are speaking to the class, or how to use certain programs within their technology. Begin with simple active learning strategies, many of which are described earlier in this section. Simple strategies will not only make it easier for the students, but less stressful on the teacher as they are learning how to run an active learning classroom. Whenever possible, make it personal to the students. Knowing the students and their strengths, and showing them through lessons that they are important individuals, will make them much more comfortable and willing to participate. They will feel as if they are truly part of the class and have a meaningful contribution to make.[vi] Keeping in mind that while a teacher is introducing active learning to their classroom, they will hear many wrong answers along the way. This is perfectly acceptable and often just as valuable as hearing the right answers. Wrong answers often reveal common misconceptions. If the above challenges have been tackled, and a safe classroom environment is in place, then all students can learn from the misunderstanding of one. Not only can the teacher steer the student in the right direction, but students can help each other find a path to the correct answer.[vii] Teachers need to maintain high standards and an inclusive classroom culture throughout the year for active learning to be successful. Finally, remember that a lot of student learning takes place outside of the classroom. Teachers need to be open to students bringing in different ideas, misconceptions, and experiences into their classes.[viii]

This unit integrates active learning over multiple days and activities. Keeping in mind the end goal of the lesson (students must know how to calculate speed, read speed off of a graph, and place speed onto a graph), I constructed creative ways students could accomplish these with no note taking involved. In the first lab activity, students will roll small cars down a track and video record the cars' travel. From the video, students will analyze distance and time data in order to calculate speed. Students will be placing these numbers on a graph too. Although students will have background knowledge on how to calculate speed, everything else about the experiment will be designed cooperatively within their lab group. This will allow students to communicate and problem solve. This is a good example of students owning their learning. Although the teacher will be there to loosely guide and provide materials, students will need to use their own minds to construct a solution to the challenge. These are not days in which students should be silently sitting in their seats. The class should have been exposed to active learning in the classroom and practiced this on a small scale before activities such as these are attempted. Students and their teacher should be comfortable with expectations on how to move around the room, collect supplies, speak out of turn, and discuss/disagree when challenges arise. If teachers are not yet comfortable with five full days of an "organized chaos" while students learn, then this unit could be divided into three different sections with time in between to regroup and reflect on how the previous day's lessons went.

Assessment

In today's classroom, the assessment portion of a lesson is often pushed harder by administrators than any other piece. Many teachers hear the word assessment and cringe because students are tested so heavily in today's classroom, but there are multiple ways to assess students that do not involve over-testing students. Assessments are as simple as "a tool for understanding what students are learning".[ix] An important piece to remember is, "If a topic, skill, or behavior is important enough to represent a learning goal, then students' progress toward the goal should be assessed." [x]

Students must be an active part of the assessment process. Simply taking a quiz and moving on, or answering some lab questions without revisiting them later, will not help improve a student's academic performance in that subject area. Assessments and analyzing assessments should be a natural fit in science. Science depends on data for discovery and its progression, and that is what teachers are using assessments for – to discover what their students do or do not understand and then formulate an appropriate plan. Formative assessments are what prove to be the most effective in assisting students to learn. Waiting until the midterm exam is often too late. Assessing students within the unit allows teachers to make corrective changes to plans to better fit the needs of their students. Feedback to students from teachers must accompany these assessments, whether that assessment was a multiple choice quiz, a project, or a short set of post-lab questions. When designing an assessment, two important pieces of information must be considered. First being "what kind of performance or behavior indicates understanding"[xi] and the second being "what specific criteria differentiate the levels of understanding"[xii]. Once assessments are seamlessly included within lessons and units, then students can start using data from these assessments to evaluate their own learning.

It is a dream for teachers to have students take a quiz, look at that quiz, and then have the students realize on their own what they need to go back and review. This is a very achievable dream with formative assessments which fit neatly into labs and class activities. For this to work, it is the teacher's responsibility to provide meaningful and timely feedback to students. This can be as simple as a grade for a quiz, a rubric for a project, or even one-on-one conferences with students to discuss the strengths and weaknesses demonstrated by the student up to this point in the unit. "From the instructor's perspective, assessment data should guide changes in instruction, curriculum and teaching behaviors." [xiii] Once teachers have provided feedback, they can judge the level of reteaching that is needed, if any. A teacher can decide whether they need to start from the beginning again, simply do another lab activity for practice, or move on to a new topic of study. It is important to share with students when these adjustments are made. If all students achieve a mastery level on a topic, it is helpful for the teacher to explain that we are moving onto new material because students have demonstrated they know the previous material. If more practice is needed, then the teacher should share why more practice is needed. Students should not feel as if a teacher adjusts plans based on how he or she feels that morning when they wake up. Planning should be deliberate, and based on assessment feedback, and students should be included in this teaching strategy. Sharing the plan with students is especially important in science. As mentioned at the beginning of the section, scientists make decisions based on data from their own experiments. This is a real life opportunity for students to see how observations, numbers, and other types of feedback affect a decision or plan.

There are no tests or quizzes written for this unit, yet there is room for assessment in each activity. Within days one and two (measuring distance and time to calculate speed and plot on a graph), students should be assessed on their ability to calculate speed when given distance and time, and their ability to place these numbers on a graph. Teachers will need to review student work with a keen eye to spot where student mistakes and weaknesses are taking place. Be sure the students show their work. Students may understand how to solve for speed, but not know how to graph. Teachers will likely see a range of math abilities begin to appear among their students, and the activities will allow for reviewing of everything from graphing and dividing to analyzing an equation and measuring with a ruler. Teachers should not just rely on the student worksheet for assessment purposes. Teachers must also engage in conversations with each of the students in the room to assess student's strengths and weaknesses. Days three and four (reading a graph and creating a story to match) use the graphs as an assessment tool, as well as the accuracy of the calculation of speed. Day five (reading a story and creating a graph/acting out the story) assesses similar skills and concepts as the previous activities. It is imperative to the success of students that the teacher evaluates in a timely manner these questions, graphs, and discussions they had with their students. Prior work should be returned to the student with feedback before the next activity begins.

Integrating Math and Science

Math and language arts have been the emphasis in elementary and middle school education for years. They are the two most heavily tested subjects and in the mind of many students, the only two that count for grades. Children are very capable of learning math at a young age, but struggles arise due to a negative association with math. Starting early, with high quality and positive lessons, is the key to reverse their negative feelings. Math even helps student success in language, vocabulary, grammar, and inference skills. [xiv] For preschool and elementary students, play is more readily integrated into a child's day. There are endless ways in which math can be found during free play time during a child's day; patterns, shapes, and counting to name a few. These types of experiences do not need to end with elementary school. Middle school science teachers can set up opportunities to allow their students to "play" by guiding students to the mathematical application of the activity. Although starting early is important, the quality and engagement of those lessons cannot dwindle when students enter middle school. Middle school is a tough time for students, but a very important time to continue inspiring students academically. Integrating math into science is one way to keep the engagement in math. This also allows teachers the opportunity to build on the basic mathematical concepts in which students learn in math class. Math emphasis and math interventions are very important to the population of students for whom this unit plan was initially designed. Students from low income backgrounds can be up to three years behind their peers in math.[xv]

With the importance of math being clearly demonstrated, where do we go from here? In order for students to deeply learn any content, they need to see that it is relevant. Students ask all the time, "Why do I need to know this? I'm never going to use it again!" Unfortunately, more often than not, that is a true statement. Science and math teachers have a beautiful opportunity to make their content relevant to students by showing them how the two subjects interact seamlessly with one another. "Students must see mathematics, as well as science, as relevant components of their world. Mathematics should no longer be seen as a discipline studied and applied for mathematics sake, but rather, because it will help make sense of their world. "The 'doing' of mathematics and the 'doing' of science create a new way for students to look at the world [in a way] that develops depth." [xvi] The purpose of integrating math into science is to give students an opportunity to apply math to real life situations and situations that a student deems as being relevant.

There are five different types of integration that can be used within the classroom as described by Davidson, Miller and Metheny. The first type of integration is "discipline specific integration". Many middle school science curricula are already set up to allow for this. For example, seventh grade science in North Carolina consists of units on weather, physics, cells, human body, and genetics. Throughout the year, teachers have opportunities to connect these topics to one another. A teacher might choose to revisit levers of simple machines as they teach the musculoskeletal system. This could go across grades as well. During an eighth grade environmental impact lesson, teachers could recall weather information the students learned in seventh grade. The second type of integration is "content specific integration". This may be what comes to mind when most teachers think of integrating mathematics into a science lesson. If teachers ask their students to calculate an average, or determine the speed of an object, then they are using content specific integration. The third type of integration, "process integration", is used when students are conducting the experiments themselves. "By conducting experiments, collecting data, analyzing the data, and reporting results, students experience the process of science and perform the needed mathematics."[xvii] For process integration to be successful, students must be the ones designing the experiments and collecting the data. This can be difficult for teachers to facilitate because it means allowing students to make their own mistakes and sometimes look at data that is not clean or pretty. The fourth type of integration is "methodological integration". The fifth type of integration is "thematic integration". Although very common in early education, this type of integration can be appropriately applied to all grade levels and academic abilities. For example, in seventh grade science, a unit on weather might consist on lessons about hurricanes. From hurricanes, a teacher could develop lessons about how hurricanes form, historically significant hurricanes, and how they have changed our weather prediction processes. Meteorologists look at data to predict hurricanes (air pressure, water temperature, wind speed). They plot and track hurricanes on a map with latitude and longitude labeled. Thematic integration does not need to be limited to just one classroom. Teams of teachers can band together to teach a unit with involves thematic integration.

This curriculum unit integrates math and data analysis into each day. Prior to the curriculum unit, students will be exposed to a large amount of content specific integration, as students will need to be using numbers given to them in an equation to calculate the speed of an object. Within this unit, students will be completing lessons designed with process integration in mind. On days one and two, students will be measuring distances, recording times, and using an equation to calculate the speed of an object. The distances and times are data points the students can generate rather than be, given on a practice worksheet by the teacher. Generating their own data, in a fun way, allows students to take ownership of their procedure and data. On days three and four, students read distance and time measurements off of a graph to create a story. On day five, students will do the opposite – read a story and use their knowledge distance, time, and the equation for speed to place the story onto a graph. Due to the literacy component of days three through five, most students do not notice all of the math which they are covertly getting in their lesson. One of the most common questions many teachers hear from students is, "When am I ever going to use what I learn?" or "Why are we doing math in science?" This unit should give students a practical way to apply math, talk about math, and generate data of their own.

Kinesthetic Learning

A common complaint among middle school teachers is that the students cannot sit still and focus. That is certainly an area of struggle for many students within that age group. It can be very helpful to give students a constructive way to move during the class. Moving from one station to another does not count, and neither does standing up and stretching. Although these strategies may help students stay a bit more focused, it may not help those strong kinesthetic learners in your classrooms. As an instructor, it is easier and quicker to plan lessons that are more visual and auditory based, but by broadening the lesson to reach more learners, students are more likely to retain the information which limits the need for reteaching and interventions after the fact. Research has "indicated that many students do not become strongly visual before third grade, that auditory acuity first develops in many students after the sixth grade, and that boys often are neither strongly visual nor auditory even during high school."[xviii] Teachers tend to teach more to auditory and visual learners even if there are not many in the classroom. Science instructors have the perfect opportunity for students who learn better by touching and doing to be successful. "These boys and girls tend to acquire and retain information or skills when they can either handle manipulatives or participate in concrete, real-life activities."[xix]

This unit integrates kinesthetic learning into the first four days of activities. On days one and two, students will set up tracks, run cards down tracks, and set up recording equipment (Chromebooks, cell phones, other digital devices). Students will be constantly on the move in ways that directly relate to the content they are learning. On days three and four, students act out the motion of a distance versus time graph. Students will find many ways to do this. For example, a graph may show that an object begins moving slowly, then stops, then speeds off. Students may choose to show this by creating a scene where they are slowly walking down the hallway, stop to get a drink of water, then realize that they are late to class and run down the hall to their classroom.

Cooperative Learning

Cooperative learning is one of the many buzz words that is thrown around in the educational community, but not all who use the word know exactly what it means. “Cooperative learning is grounded in the belief that learning is most effective when students are actively involved in sharing ideas and work cooperatively to complete academic tasks.” [xx] It goes beyond dumping students into groups to complete an assignment. Although group work is still better than straight lecture based and teacher centered instruction, cooperative learning can be turned into a richer way to teach if a few small changes are made. When planning a cooperative learning exercise, there are five essential elements: positive interdependence, promotes interaction, individual accountability, interpersonal and small group skills, and group processing.[xxi] Positive interdependence promotes an idea of students depending on one another for success. Success comes as a team. Promoting interaction between students produces, “interaction by helping each other, exchanging resources, challenging each other’s conclusions, providing feedback, encouraging and striving for mutual benefits”.[xxii] Individual accountability, puts into place a check to be sure that although students are in groups, all members should be contributing and achieving. Interpersonal and small group skills might be one of the more difficult pieces. As teachers, we want our groups to get along and rush to solve conflicts when they arise. This element allows students the time to work these out on their own. At first, students may need more support and guidance with this piece, but the goal is for students to be able to discuss and solve disagreements on their own. The final element, one most often skipped over, is group processing. Students must have time built in to assess their progress and evaluate their strengths and weaknesses as a group.[xxiii]

Students need a time to discuss and give feedback on wrong answers as well. Although ignoring wrong answers and only acknowledging correct ones seems to be a tradition in many classrooms, not recognizing why a wrong answer is a wrong answer could be missing a strong teachable moment in the classroom. Wrong answers often reveal commonly held misconceptions.

In this unit, students will be working in cooperative learning groups to complete all five days of activities. Students will remain in these groups the entire unit unless the teacher feels that it is in a particular student’s best interest to make a switch. Groups will be made in one of two ways depending on the class.

Classroom Activities

Day One and Two

Objective

Students will be able to use position and time data, which they collect themselves, to calculate speed. Students will be able to use position and time data, which they collect themselves, to construct a graph to represent the motion of a small car.

Activity Overview

Students will race small cars down tracks. The cars used in this activity are approximately 6 inches long and 3 inches wide. The size of the cars and tracks does not matter. Anything that rolls and anything that can be modified into a track will give the same effect. While racing, students will record the trials on their Chromebook, phones, or other digital device. Students will revisit the recording, collect the time and distance data at several different points, and produce a graph. There are many correct methods which students could use to be successful in this lab. Before making final runs and collecting the final set of data they will use for their graph, students should pitch to their teacher their methods of how they can gather this information from the materials provided. For example, some students may want to put tape markers at known distances and then read the time off of their video. The teacher must remember to be as hands off as possible, only guiding students if they become overwhelmed, need particular materials, or need help with group communication. See appendix 2 for a possible worksheet to give to students.

Student assessment

Students will show mastery of the topic when they have accurately measured distance and time. They should have accurately placed distance and time on their graph as well as calculated the speed between each point and the average speed of the entire trip.

Day Three and Four

Objective

Students will be able to interpret a distance vs time graph in order to tell a story about the object in motion.

Activity details

Students will be assigned a simple distance vs time graph showing the motion of an object and create a story from that graph. The graph they will be given includes the object stopping, changing directions, and changing speed. From this graph, students will create a story about what could have been happening to that moving object. For example, they could imagine that the moving object is a student, or a car, or a pet. Students will be expected to annotate the graph, complete a written story from those annotations, and then act out and record the story. At the end of their recording, students will show how their story aligns to their graph. Any type of graph can be used. A Google search for "distance versus time graphs" yields many choices. This day's activity can be differentiated based on the type of graph you select and how many changes in the speed are displayed on the graph.

Student assessment

Students will show mastery of the topic when they have successfully annotated the graph. Students should show that they know that a horizontal line means stopped motion. They should show that the steeper the line the faster the speed and when a line changes its direction that means the object changes direction as well. The assessment piece of today would be their graph annotation.

Day Five

Objective

Students will be able to place distance and time data onto a graph based on an assigned story.

Activity details

This activity is the opposite of the prior two days activity. Students will be assigned a story and must create a graph based on the story. Providing sufficient time is available, students will also act out the story given to them. As they are acting out the story, they should be able to point to the graph to demonstrate where they are along their distance versus time graph. For example, if a student is standing still as part of the story they should be able to point to a horizontal line on the graph they drew. Examples of possible stories can be found in appendix 3.

Student assessment

Students will show mastery of the topic when they have successfully plotted the distance and time data found within the story provided. This will include successfully interpreting the speed, changes in speed, stopped motion, and change in direction.

Pilot Run Results

I was lucky enough to do smaller sample lessons from this unit with my students prior to the publication of this curriculum unit. Students very much enjoyed this unit and were even talking about it outside of the classroom. We did an abbreviated version of the first activity (days one and two – rolling cars down tracks to collect distance, time and speed data) with only one day to complete. Students also completed a shortened version of the second activity (days three and four – reading a graph, writing a story, and acting out the story). This activity was completed in only one day so the students were only able to write their story, not act it out as planned. I was not able to complete the last activity (day five – reading a story and placing it into a graph) before submitting my curriculum unit.

Content challenges: Before beginning this unit, be sure to speak with the math teachers on your grade level and the previous grade level. I was told that students had already covered graphing, knew how to label the x and y axes, and how to plot points. I should have given students some sort of graphing activity or pre-assessment to see their level of comfort. I had to walk my students through how to complete their first graphs instead of having it completely independent as described in this unit. This could have been easily solved before the lab had I known.

Tips on materials: Ideally, this is run with long tracks to run small cars (either purchased from a science supplier or the toy store). Longer tracks allow students to run over a longer distance which tends to yield more accurate numbers. At my school, we only had two foot long tracks available and no cars. My students completed the lab by rolling tennis balls down the track instead. Their numbers were slightly skewed, but I believe that was because of the shortness of the track and being able to collect accurate data.

Student groupings: there are several schools of thoughts on how to group students. I do think it is important in this particular unit to keep the student groups the same for the entire five days of the unit. Students could be grouped according to their comfort and ability in math. This would allow the teacher to differentiate and push the higher groups to the next level, while being able to help the few groups that need more assistance during the lab design and graphing. Students could be heterogeneously mixed so that they can help each other. This type of grouping would only work if there is a classroom climate that encourages students to help one another, not simply copy off of one another. For this pilot run, I allowed students to choose their own groups. I had hyped the lab up to my kids for several days before we began and told them to keep in mind who they would want to work with in order to be successful. I found this strategy to work wonderfully with my classes. Students had time to think about their groups and not choose on the spot. I was still able to help the groups that needed assistance and even saw students helping one another within their own groups without my prompting.

Appendix 1: Implementing Teaching Standards

7P1.1: Explain how the motion of an object can be explained by its position, direction of motion, and speed with respect to some other object.

Students need to demonstrate that they can describe the location and motion of an object not only in words, but in numbers as well. Students learn that when describing the motion and direction of an object with words a reference point is needed. Students also learn that to calculate the speed of an object you need to know the distance in which it traveled, and how long it took to get there.

7P1.3: Illustrate the motion of an object using a graph to show a change in position over a period of time.

Students need to be able to place distance on the y axis of a graph and time on the x axis of a graph. This can be from numbers they collect, as in this unit, or numbers given by the teacher.

7P1.4: Interpret distance vs time graphs for constant speed and variable motion.

Students build on standard 7P1.3 while mastering this standard. When distance and time are plotted on a graph, students will use those values to calculate speed. Students at a higher math level can make the connection that the speed is actually the slope of the line on the graph.

Appendix 2: Laboratory Worksheet for Day One and Day Two Activity

Purpose:
To collect distance and time data. To plot this distance and time data on a graph. To calculate speed.

Materials:
- 1 track
- 1 car
- Recording device
- Books (to prop up one end of track)
- Tape

Procedure:
Note to students: Remember that you have a lot of freedom of choice in this lab! The procedure below is a guideline. Use all of the knowledge and confidence that you have to reach our goal!
1. Find a space in our room where you can work undisturbed. Be sure you have lots of space!
2. Choose FIVE distances along and beyond your track. Mark these with a piece of tape.
3. Write down the distance from the start on the piece of tape. For example, if your first piece of tape is 20 cm from the start, write "20cm" on the tape.
4. Set up your recording device so that you can see all of your pieces of tape in one shot.
5. Place your car at the top of the track. As soon as one group member lets go of the car, another group member should hit start on the recording device. Hit stop after your car crosses the last piece of tape.
6. Play back your video in slow motion until you have enough information to fill in the data table below.
    a. You are looking for the time at which your car crosses each piece of tape.
    b. Record them in the data table below.
    c. Place the distance and time on your graph.

Data table:
Note to students: Be sure to record the units you used. Be sure to show your work!

Distance	Time	Speed Calculation Work	Speed

Graph:

Use your graph paper to create a distance vs time graph. Place distance on the y axis and time on the y axis. Be sure to label and include the units. Be sure to give your graph a title. Be sure to give your graph a one sentence description and write this below your graph.

Post-lab Questions:

1. Did your car travel at a constant speed? Use the information from your table and graph to justify your answer.

2. What are the possible errors that could have occurred in your lab? (*Remember…this is not a bad thing! Even the best scientific research has errors to account for.)*

Appendix 3: Stories for Day Five Activity

Story One: The bell rang! You run out of your classroom and down the hallway for 100 feet in 5 seconds until you see your friends. You stand there and catch up on all the gossip for 20 seconds. You then continue down the hallway for another 20 feet in five seconds. The late bell has rung! You run back up the hallway to your classroom which is 80 feet away. You are only 8 seconds late to class.

Story Two: A cheetah is chasing a gazelle on the savannah. Beginning at its home, the cheetah ran for 600 yards in 30 seconds, then stopped to enjoy its meal for five minutes. It then slowly trotted back to its home for four minutes.

Teacher Resources

2013. "Math in the Early Years." *The Progress of Education Reform* 1 - 7 .

This article focuses on the importance of math at a young age. It compares the importane of early math instruction to early reading instruction.

Davidson, David M, Kenneth W Miller, and Dixie L Metheny. 226 - 230. "What Does Integration of Science and Mathematics Really Mean?" *School Science and Mathematics* 1995.

This resources goes into detail about the different ways in which you can integrate different contents. It gives general overviews followed by examples for the science and math classrooms. It shares ideas that are appropriate for all grade levels.

Dunn, R, and J Dunn. 1994. "The Importance of Recognizing Tactual and Kinesthetic Learners." *Teaching Young Children Through Their Individual Learning Styles* 111 - 113.

This is a short article, originally printed in 1994 and reprinted in 2010, on tactual and kinesthetic learners. It gives an overview of the benefits of this type of learning and shares the developmental stages of most students and when they reach different types of learning styles.

Handelsman, Jo, Sarah Miller, and Christine Pfund. 2007. *Scientific Teaching.* New York: W. H. Freeman and Company.

I found this to be the most helpful source I used. It focuses on strong ways in which to teach science and the information applies to any grade levels. For this paper, I realied heavily on the information on active learning and assessment to support the vision for my curriculum unit.

Zakaria, Effandi, and Ikasan, Zanaton. "Promoting Cooperative Learning in Science and Mathematics Education: A Malaysian Perspective." *Eurasian Journal for Science, Mathematics and Technology Education* 35-39.

Although from a different country, this resource is still very applicable to any classroom. It describe the components of cooperative learning and provides examples of what this may look like in the classroom.

Notes

[i] Scientific Teaching p. 23
[ii] Scientific Teaching p. 27
[iii] Scientific Teaching p. 26
[iv] Scientific Teaching p. 33
[v] Scientific Teaching p. 39
[vi] Scientific Teaching p. 40
[vii] Scientific Teaching p. 42
[viii] Scientific Teaching p. 44
[ix] Scientific Teaching p. 47
[x] Scientific Teaching p. 57
[xi] Scientific Teaching p. 49
[xii] Scientific Teaching p. 49
[xiii] Scientific Teaching p. 50
[xiv] http://www.du.edu/kennedyinstitute/media/documents/math-in-the-early-years.pdf
[xv] http://www.du.edu/kennedyinstitute/media/documents/math-in-the-early-years.pdf
[xvi] Davidson, D., Miller, K., Metheny D. 1995
[xvii] Davidson, D., Miller, K., Metheny D. 1995
[xviii] R. Dunn, K. Dunn, J. Perrin 2010
[xix] R. Dunn, K. Dunn, J. Perrin 2010
[xx] E. Zakaria, Z. Iksan 35
[xxi] E. Zakaria, Z. Iksan 36
[xxii] E. Zakaria, Z. Iksan 36
[xxiii] E. Sakaria, Z. Iksan 37