How to Design a 5E Lesson Sequence for the NGSS

Refine Your Objectives

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List Your Objective(s) Here After You Complete This Task

Engage Your Students

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How Will You Present Your Phenomenon?

Frame Your Exploration

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How Will Your Students Discover The Content?

Support Meaning-Making

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What Questions And Observations Will Support Student Explanation?

Provide Practice

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How Will Your Students Solidify Their Understanding?

Embed Assessments

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How Will You Assess Understanding Throughout The Lesson?

SOMEWHERE TO START

When I started teaching, my students hated coming to science class. They had spent years stuck in desks, copying definitions, answering textbook questions, and spitting back facts. *Maybe* they did a lab once a month, but it was always a step by step recipe. And there was always a right answer. *That* was science.

Except I knew it wasn't. I knew there was a better way to teach science -- a better way to engage students, inspire their curiosity, and develop true understanding. Enter the NGSS.

Now here were standards that wanted students to *do* science. To practice science in order to understand science. But hello! These standards were different. They were hard. I wasn't sure how to use them – how to go beyond simply changing my *content* to actually changing my *instruction*.

NGSS = CHANGING CONTENT + CHANGING INSTRUCTION

It took me years of self-study and professional development -- attending workshops and conferences, reading every book and website publication I could find, collaborating with colleagues, and experimenting – so much experimenting! – to truly understand what the NGSS were all about. In a way, I was lucky – I had years! My school hadn't adopted the standards; they weren't part of our testing or evaluations. I had time to ease into it.

That's not the case for many teachers today, whose states have adopted these standards (or versions of them) and expect their teachers to run with them. For many of you, you have been tasked with not only adopting new instructional styles aligned to the NGSS but developing the very curriculum to use with them. That's a BIG job!

I created this guide for those of you in the thick of it. While this is just one piece of the puzzle, using an "explore before explain" framework like the 5E Model is a great way to align your instruction to support the type of student discovery intended by the developers of the Next Generation Science Standards*.

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The 5E Model

Engage

The purpose of the Engage stage is simply to catch the student's attention. It may be a situation or event, a problem or puzzle, or an interesting demonstration. The Engage activity, which may or may not be a full lesson in length, is designed to pique student interest and get them thinking about relevant content. It can also be a great opportunity for teachers to assess prior knowledge and identify misconceptions.

Key Points: student interest, activate ***prior knowledge****,* ***reveal*** *misconceptions*

Explore

In this phase, students are given the time and opportunity to "explore" their current understanding and demonstrate what they already know as they attempt to make sense of the Engage activity. Students are investigating phenomena, discussing their ideas, and beginning to formulate possible explanations. The teacher's role in this stage is to provide the appropriate background information and materials for students to carry out the activity. Then, the teacher becomes a facilitator -- listening, observing, and guiding students as they attempt to make sense of what they had observed.

Key Points: explore current understanding, ***attempt to make sense*** *of concepts, vocabulary is NOT assigned*

Explain

In the Explain phase, the concepts introduced in Engage are made clear and understandable. At this phase, scientific vocabulary is applied and the explanations formulated in the Explore phase are refined. The teacher's role is to guide students' attention to key aspects and elicit their explanations. The goal is to guide students to construct an accurate understanding independently, but when that is not possible, the teacher should clearly and explicitly present the key concepts. This can be done verbally or through videos, readings, websites, or other technologies.

Key Points: ***students*** *construct explanations, scientific terminology is used*

Elaborate

The goal of the Elaborate phase is for students to apply their understanding of the basic concepts to similar but new situations. The activities should be challenging but still within their reach. This is also the stage where students independently practice and apply what they have learned.

This stage is NOT intended as "extra fluff" or "side projects." It is the stage where students expand and cement their understanding through repeated practice and additional examples.

Key Points: students practice ***independently****,*

Evaluate

In the Evaluate phase, students are engaging in activities that are consistent with those presented in prior phases but with the goal of assessing their explanations. As with all assessment, teachers should have a clear understanding of evidence of student learning and what to "look for" in student work.

Key Points: formative and summative; both ***teachers AND students*** *assess student ideas; evidence and "look fors" are important*

Unit Objectives

Refine Your Objectives

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List Your Objective(s) Here After You Complete This Task

Step 1

Revisit the Evidence Statements.

1. Revisit the Evidence Statements for your Performance Expectations. Record everything your students must do and know.

2. Break each objective you have recorded apart so that it addresses only one skill and/or piece of content.

TIP: Complete this task on your computer. You can more easily color-code and cut/paste, which is helpful for Step 2.

Step 2

Order and bundle your objectives.
Create guiding questions.

1. Order your objectives to match your unit storyline. Break your long list of objectives into bundles by grouping the ones that are most closely aligned together.

2. Generate a few questions for each bundle of objectives. Think of it Jeopardy-style. If the objectives were answering questions, what questions do they answer? These questions may be helpful as you develop your **explore** and **explain** activities.

Step 3

Refine your objectives.

1. Refine your objectives so they explicitly describe what students should do AND know. Use action verbs, such as those identified in the Performance Expectation, Evidence Statements, and Science and Engineering Practices to ensure that students are truly *doing science* to learn science.

TIP: Use the NSTA's Science and Engineering Practices Matrix to better incorporate the SEPs into your objective statements.

Notes:

TEACHER TIP:
Whenever possible, choose terms from the higher order thinking skills identified in Bloom's Taxonomy. This will ensure you are challenging your students and going beyond rote memorization.

Engage Students Through Phenomena

Engage Your Students

How Will You Present Your Phenomenon?

Step 1

Choose your phenomenon based on the questions it generates.

Your engagement phenomenon is only as good as the questions it generates. While a phenomenon may be interesting and engaging, if it isn't driving your storyline forward – leading your students to discover the content you aim to teach – it's not going to work for your 5E lesson.

Consider your ideas for your engagement phenomenon and anticipate the questions students may ask when presented with the phenomenon. Which leads to questions most relevant to your standards?

Step 2

Determine how you will present your phenomenon.

Visual data, images, videos, texts, and demos can all make great **engage** activity formats. Check out the following pages for some of my favorite formats for the **engage** phase of the 5E Model.

TIP: Whatever you choose, it is important that your format does not explain the phenomenon students are observing.

Step 3

Engage your students with the phenomenon.

Even in the **engage** phase of the 5E Model, students are actively involved in their learning.

However you present your phenomenon, provide students opportunities to access prior knowledge, ask questions and generate hypotheses, make predictions, and generally express their ideas.

TIP: Use the NSTA's Science and Engineering Practices Matrix to identify how you might incorporate Asking Questions and Designing Solutions into your **engage** activity.

Notes:

Engage Students Through Phenomena

Activities For The **Engage** Phase

Engage

The purpose of the Engage stage is simply to catch the student's attention. It may be a situation or event, a problem or puzzle, or an interesting demonstration. The Engage activity, which may or may not be a full lesson in length, is designed to pique student interest and get them thinking about relevant content. It can also be a great opportunity for teachers to assess prior knowledge and identify misconceptions.

Key Points: student interest, activate ***prior knowledge, reveal*** *misconceptions*

Demonstrations:

Demonstrations are activities during which the teacher carries out a task and students observe what occurs. Demos are great to use when a phenomenon can be directly observed in action in the classroom. This is especially true when there are safety concerns to having students carry out the task. For example, if there is hot or boiling water, flames, or the use of harsh chemicals, you may not want your students involved in a hands-on manner. Activities that involve these safety concerns could make a great demo. Demos are also great if you have limited time to devote to the Engage activity. They typically don't take very long, and because they are often used with whole-group instruction, everyone will begin and complete the activity at the same time.

Lab Experience:

If your activity is free of safety concerns and you do have some time, I recommend converting demo activities into lab experiences. Lab experiences are *experiences* -- in the Engage phase, the intent is not to address things like hypotheses, variables, procedures, and conclusions. The goal is simply for students to experience something that sparks their curiosity -- don't muddle it up too much with the intricacies of actual experiments and investigations. Those aspects of a lab experience will come into play in later phases -- but considering your purpose here, they really just draw away from the ultimate goal of *engaging* your students.

Discussions:

Discussions can be a way to spark interest and draw out personal experiences. To engage students in a discussion, you can simply begin by asking, "Have you ever**...**?" "Tell me about a time when**...**" "Reflect on a time when**...**" "What do you think of**...**?"

You can also use surveys or polls to generate discussion: "How many students in our class have the same color eyes as their parents?" "How many students agree/disagree with this statement?"

Images:

Images are a simple and quick way to present a phenomenon and generate a discussion of student ideas and questions. Once you have your phenomenon, a quick Google search can give you any number of images that may fascinate and engage your students.

Engage Students Through Phenomena

Activities For The **Engage** Phase cont...

Videos:

Videos are another simple way to engage students. Videos may present a demo you cannot carry out live in the classroom, they may outline a problem that needs solved, describe a current event (news broadcast, for example), or simply discuss the phenomenon students will be investigating. Videos can also be simulations. For example, NOAA has a great video that shows the location of every earthquakes that occurred between 2001 and 2015. This short video is a great starting point for a unit on plate tectonics.

Models, Graphs, and Data:

While it could seem like models, graphs and data may not be the most engaging of activities, presenting students with graphs or other visual representations of data *can* be used to spark conversations about a concept or phenomena. This is going to work best if the data lends itself to a visual representation and is particularly surprising. For example, a graph that shows the fluctuations in Earth's climate - and particularly its significant warming in recent times - can spark some great questions related to climate change (across Earth's history as a whole) and human impacts. Along those lines, a visual representation of the distance between planets or the sizes of planets could be a bit "mind blowing" in terms of understanding the scale of our solar system. Likewise, a pedigree that shows the inheritance of a deadly genetic variation is both engaging on the authenticity front as well as puzzling on the *why does that happen* front.

Challenges:

When your content lends itself to it, a challenge can be an amazing way to involve your students in the phenomenon. Challenges in the Engage phase should be quick - students aren't necessarily participating in an entire design process or investigation. Remember, the purpose is just to spark interest, generate questions, and tie to prior knowledge. Perhaps students are given the task to communicate a message across the room to a partner without speaking or writing. Perhaps students are asked to determine how many jumping jacks they must do to reach a target heart rate. By engaging in these activities and then comparing their solutions or answers to others, students can begin tying what they know to the content to be learned.

Frame Activities To Support Exploration

Frame Your Exploration

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How Will Your Students Discover The Content?

Step 1

Identify an investigative phenomenon your students can explore.

The investigative phenomenon for your **explore** phase may or may not be the same as that of your **engage** phase. If you presented a complicated phenomenon in **engage**, you may want to choose a new phenomenon for **explore**. In **explore**, the phenomenon must be simple enough to lead directly to the discovery of the objective you are addressing. Students must be able to directly access the phenomenon – for example, by conducting investigations, observing examples, or analyzing data.

Step 2

Choose the Science and Engineering Practices that students will use to discover the concepts.

Determine what Science and Engineering Practice(s) will help students make sense of the phenomenon and develop their understanding of the concept. These will likely align to the SEPs you incorporated into your objectives, but you may find additional SEPs are more relevant to this phase of the learning.

Will they conduct an investigation or analyze data to discover a relationship? Will they build models to determine how something works?

TIP: Check out the following pages for some of my favorite formats for the **engage** phase of the 5E Model.

Step 3

Remove explanatory information.

The NGSS is all about "exploring" before "explaining." All too often, the activities we engaged our students in provided too much information – a step by step procedure, the "things" we wanted students to notice, the meaning we wanted students to make.

For the **explore** phase, all of this information should be removed. Don't provide the steps, don't provide the categories, don't build their model – challenge them to develop their own, to "figure it out," to make mistakes and learn from them.

Strip your activity to the bare minimum. What is the least amount of information your students need to begin the task? Yes, students may balk at the approach at first, but ultimately, they will rise to the challenge.

*Always provide a way for students to document their observations and ideas. For the **explore** phase, graphic organizers are a great way to guide students without inhibiting the freedom of discovery. Additionally, you may want to also include analysis questions that more explicitly guide student meaning-making through the activity.

TEACHER TIP:
Identify questions and observations you might make in order to provide support and scaffolding as students adjust to this approach. Use them only as necessary.

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Frame Activities To Support Exploration

Activities For The **Explore** Phase

Explore

In this phase, students are given the time and opportunity to "explore" their current understanding and demonstrate what they already know as they attempt to make sense of the Engage activity. Students are investigating phenomena, discussing their ideas, and beginning to formulate possible explanations. The teacher's role in this stage is to provide the appropriate background information and materials for students to carry out the activity. Then, the teacher becomes a facilitator -- listening, observing, and guiding students as they attempt to make sense of what they had observed.

*Key Points: explore current understanding, **attempt to make sense** of concepts, vocabulary is NOT assigned*

Investigations:

Investigations: Investigations are a great Explore activity, because they are very "hands on" and when done well, are also very "minds on" -- meaning, they are naturally going to require students to use their brains. Explore investigations can be formal experiments, or they can be more like "field investigations" where students are simply collecting data in the form of both measurements and observations.

Simulations:

Simulations can be another great tool to use in the Explore phase. Simulations are similar to investigations, except that they allow us to study topics that are too difficult to bring directly into the classroom. Simulations can be very elaborate programs or simple, quick activities. Simulations don't have to be computer-based either. Students can participate in hands-on activities in the classroom that model natural phenomenon.

Engineering Design Challenges:

Engineering design challenges can be another way to engage students in Explore activities, particularly when the standard directly ties into those engineering practices. That said, you can use an engineering design challenge even when it doesn't. In an engineering design challenge, students are given a problem, time to develop a solution, and the opportunity to test and revise their solution.

Creating Models:

Creating models is an amazing Explore activity when it is done well. In the Explore stage, models are three dimensional representations of a phenomenon that students can manipulate to determine what best explains the phenomenon.

Card Sorts:

Card sorts are one of my favorite Explore activities because they are just so simple! They are perfect for concepts that relate to grouping, comparing, or contrasting. Card sorts can even be used to create hierarchies - looking at the movement of energy and matter - or food webs. Card sorts require students to identify patterns -- looking for similarities and differences -- and through that process, they begin to understand the concept being studied.

Frame Activities To Support Exploration

Activities For The **Explore** Phase cont...

Observation Stations:

Like card sorts, observation stations are another simple Explore activity that work well with grouping, comparing, or contrasting phenomena. Any content where you can provide examples that help students make sense of the concept work well with card sorts and observation stations, although observation stations also have that hands-on, "live in class" component that card sorts do not.

In an observation station activity, students rotate through various stations - spending no more than 5-10 minutes at each, typically - that present an object or phenomena. These can be short videos, images, or actual three dimensional objects. Students will record observations of the phenomena or object and potentially answer a reflection question or two.

Models, Graphs, & Data:

Like using models, presenting students with graphs and/or data can be a great way to integrate science practices into your Explore activities. One option is for students to compile data themselves, and it is not always necessary for students to complete an entire investigation to do this. There are many resources on the web that students could use to collect data -- such as sites that document earthquake locations or databases of stars. Students can use these sites to compile data that they then analyze and interpret to draw conclusions about phenomena.

Alternatively, you can provide students with data and ask them to identify patterns and generate questions and ideas about what they observe.

Provide Opportunity For Meaning-Making

Support Meaning-Making

What Questions And Observations Will Support Student Explanation?

EXPLAIN: part one

Engage students in productive science talk to guide meaning-making.

The **explain** phase is really broken into two parts: student meaning-making and teacher-directed instruction. It is VITAL that the student meaning-making part comes first. This is done by engaging students in discussions and/or writing tasks that transform their observations and ideas developed during the **explore** phase into more cohesive scientific understandings of the content presented.

Questions To Elicit Student Observations

List some questions you might ask students to elicit the observations and ideas they developed during the **explore** activity. Develop the questions sequentially to guide students toward understanding.

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Observations To Develop Student Understanding

If students struggle with questioning, make observations of your own that may support student understanding of the concepts. This is not always necessary, but it is helpful to have some of these observations at-the-ready to support student meaning-making even when they get stuck.

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EXPLAIN: part TWO

Utilize student ideas to provide instruction.

After students have developed their ideas through discussion, use those observations and examples to provide the scientific explanation of the phenomenon. As students provide an example or an explanation, assign the appropriate scientific vocabulary. Reframe student explanations concisely to clarify the scientific concepts.

Determine how students will document their new understandings.

Students have made meaning from their observations, and now you have provided new vocabulary and concise scientific explanations. Students need to record this information in some way. Consider how your students will document their new understanding. Will they develop a two-dimensional model of the phenomenon they investigated and record annotations that explain how it works? Will they construct a written explanation using evidence from their **explore** activity to support their claims? Will they obtain and communicate information from another source – a text, a video, or a simulation – to improve their understanding?

Tie your activity to a Science and Engineering Practice – ideally the practice you identified in your objective statements.

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Provide Opportunity For Meaning-Making

Activities For The **Explain** Phase

Explain

In the Explain phase, the concepts introduced in Engage are made clear and understandable. At this phase, scientific vocabulary is applied and the explanations formulated in the Explore phase are refined. The teacher's role is to guide students' attention to key aspects and elicit their explanations. The goal is to guide students to construct an accurate understanding independently, but when that is not possible, the teacher should clearly and explicitly present the key concepts. This can be done verbally or through videos, readings, websites, or other technologies.

*Key Points: **students** construct explanations, scientific terminology is used*

Discussion:

There are different ways you can involve students in these "Explain" discussions. You could do whole-group discussion and notebooking. You could do the same format, but work with students in small groups while the rest of the class is working on other material. As students become more familiar with this process, you can give them more freedom and ask them to hold these discussions in their own small groups while you float between the groups. You could then bring the class back together to reach a final consensus during which each group shares the explanations they arrived at. Students could likewise share their explanations on posters, and students could participate in a gallery walk where they examine each group's ideas, offer feedback and observations on post-it notes, and then groups could revise their ideas after this non-verbal discussion.

While ultimately giving students more responsibility in developing their own understanding is ideal, in the beginning, you will likely need to keep a closer eye on the process. It will take time for students to develop a more scientific way of thinking, so your observations and questions can be key to students realizing dissonance between their explanations and their observations in activities and the real world.

Videos:

Videos can be an alternative to presentations or lectures. Short videos are best -- maybe 5 to 10 minutes -- and if you have the technology available, I recommend allowing students to watch the video independently or with partners. Why? Well, when students watch videos on their own, they can rewind, restart, and watch again and again as many times as they need to in order to take their notes, answer their questions, and understand the material. It also prevents vision or auditory issues from becoming a problem.

Texts:

Texts can be a good way to engage students in content literacy practices and present information during the Explain phase. Texts can be taken as excerpts from textbooks or trade books, or they can be articles printed from the web. Students could even visit websites to read the material there. I recommend providing students with a format to take notes and questions to answer based on the text to help them synthesize the information presented and connect it to what they are learning.

Web-Based Programs:

Lastly, there are some great web-based interactive programs and interactive texts out there that can present information to students in the Explain phase. To name a few, PBS, Annenberg Learner, and HHMI BioInteractive have some great interactive resources that students can obtain information from.

Practice is Important

Provide Practice

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How Will Your Students Solidify Their Understanding?

Elaborate

Provide students with opportunities to solidify and expand their understandings.

The **elaborate** phase is where students solidify their understanding by repeat exposure to the content, expand their understanding by diving deeper into the details, and apply their understanding to new but similar situations. While the **explore** and **explain** phases may require significant shifts in your instructional strategy, you will likely find that many of your existing activities work perfectly for the **elaborate** phase.

While you should still be engaging your students in the Science and Engineering Practices and incorporating the Crosscutting Concepts through your **elaborate** activities, the emphasis is on practice and not so much on discovery. For that reason, existing labs, simulations, texts, and challenges can be appropriately used here.

Like in your **explain** activity, tie your **elaborate** tasks to a Science and Engineering Practice – potentially the practice you identified in your objective statements but not necessarily. You may find engaging students in additional practices supports their expanding understanding of the content.

Identify activities you are already using that would fit well in this phase.

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TEACHER TIP:

Typically, you will need an **explore** and **explain** activity for each objective. That is not the case with **elaborate**, though. You may follow up a sequence of **explore-explain** activities with an **elaborate** activity that addresses several objectives in your bundle. This approach can be very effective in helping students synthesize everything they have learned.

Practice is important

Activities For The **Elaborate** Phase

Elaborate

The goal of the Elaborate phase is for students to solidify their understanding and apply the concepts to similar but new situations. The activities should be challenging but still within their reach. This is also the stage where students independently practice and apply what they have learned.

This stage is NOT intended as "extra fluff" or "side projects." It is the stage where students expand and cement their understanding through repeated practice and additional examples.

Key Points: students practice ***independently,***

Texts:

Texts, particularly current events or science news, make great Elaborate activities, because they aren't presenting the information like an encyclopedia or textbook. Rather, they are connecting these concepts to a real-world issue or idea. I love to use science news sites for my Elaborate activities. I will often take an article and chunk it out, inserting questions either in a column along the side or after various sections. The questions I use relate to the text, but they also might connect to what students have learned in the classroom. The goal is to marry what students have been learning with the new situation or information presented in the article.

Design Challenges:

Designs challenges can be great ways for students to apply their content knowledge. Before beginning any design, they should be planning their approach based on what they have learned. You will also want to incorporate more opportunities for them to provide a rationale for their decisions afterward, as this is where *you* will see their thinking in applying and demonstrating the content knowledge they have acquired.

Investigations:

The Elaborate phase here is where you could break out your old school "confirmation labs" that are basically designed to illustrate a concept. After students conduct the lab, they can explain it and connect it to their prior learning experiences. In that way, they are not just spitting back observations but still connecting this new experience to their past ones.

Projects:

Projects are a way to provide opportunities for independent practice, because they ask students to demonstrate their knowledge in a different format. If thus far they have discussed and written their explanation of a phenomenon, students could create visuals or models to illustrate the phenomenon instead. If they have expressed their knowledge in writing, perhaps students are asked to give a presentation or participate in a formal discussion or debate.

Assess And Assess Again

Embed Assessments

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How Will You Assess Understanding Throughout The Lesson?

Evaluate

Embed assessment throughout your lesson sequence.

While typically listed last on visuals and descriptions of the 5E Model, the **evaluate** phase is actually a part of each and every phase. Formative assessments should be embedded throughout the learning sequence. These assessments can focus on content understanding (the Disciplinary Core Ideas), mastery of the skills (Science and Engineering Practices), or the ability of students to apply the Crosscutting Concepts to the content. Or they may incorporate *all* of these components. Design the assessment to suit your needs, and use the information to inform your instruction moving forward.

You may or may not use a summative assessment for the lesson sequence. A summative assessment may follow several instructional sequences, depending on the amount of content you incorporated into one sequence. You may include a summative assessment only at the very end of the unit, utilizing a three dimensional assessment to fully assess the NGSS Performance Expectation.

Use the table below to identify how you will incorporate formative assessments into each phase of your lesson sequence.

Phase & Activity	DCIs	SEPs	CCCs	Assessment Task

You can learn more about developing three dimensional assessments for the NGSS Performance Expectations at the iExploreScience blog or in the Science Teacher Tribe Course and Community.

assess And Assess Again

Activities For The **Evaluate** Phase (Formative)

evaluate

In the Evaluate phase, students are engaging in activities that are consistent with those presented in prior phases but with the goal of assessing their explanations. As with all assessment, teachers should have a clear understanding of evidence of student learning and what to "look for" in student work.

Key Points: formative and summative; both ***teachers AND students*** *assess student ideas; evidence and "look fors" are important*

Predict, Explain, Observe:

Predict-Explain-Observe asks students to make predictions based on their common-sense interpretations of phenomena. It elicits their prior ideas, gives voice to that understanding through the explanation, and then engages students in the science and engineering practice of designing and carrying out investigations to actually test those ideas.

Focused Listing:

Focused Listing is all about brainstorming. Students are asked to recall what they have learned about a topic from a previous grade or even just a previous unit. It is a great way to gauge students' familiarity with concepts that they are about to study, and it can provide insight into the types of investigative phenomena and examples the teacher might use throughout the unit to build upon prior understanding.

Annotated Student Drawings:

Annotated student drawings (ASD) is a strategy that can be used before instruction to assess student's initial ideas about a phenomenon or after instruction as a way to publicly share their thinking. Students can also use this strategy to reflect on their own learning, if they are given the opportunity to examine their first drawings and consider how their understanding has changed.

To implement this strategy, the teacher will present students with a scientific idea or concept and ask students to create a drawing to illustrate what is happening. They will use annotations (captions) to provide additional information about what is occurring in their picture - key ideas, important words, so on.

Chain Notes:

Chain Notes is a strategy that gives students the chance to examine, respond to, and build upon others' thinking. Because their addition must connect to the person before them, students must go beyond basic recall and actually synthesize and evaluate what others' have said.

To implement this strategy, the teacher will present an open-ended question focused on a single concept. The first student will respond to the question in one to two sentences, and then pass it on. They must read all prior responses before writing their own idea, and their idea MUST connect to the ideas listed before theirs. Students should have the paper for no more that 2 minutes - responses should be brief. When the paper has made its rounds through the room, the Chain Notes can be projected or read aloud, giving students the opportunity to offer additional feedback and ideas.

~~And Assess~~ assess Again

Activities For The **Evaluate** Phase (Formative) cont...

Concept Card Mapping:

Concept Card Mapping is another of my favorite activities. It can be used to activate prior knowledge, help them think about the connections between concepts, and make those connections visible. It is an amazing assessment tool to evaluate if student's understanding goes beyond the basic surface-level definitions, facts, etc. Also, it is an incredibly low-risk activity that provides opportunities for all students to be successful, because there is no single "right answer." In Concept Card Mapping, a handful of concepts are presented and students identify connections between the cards. They indicate these with lines and notations. For example, if students are mapping the carbon cycle, they might connect "oxygen" and "photosynthesis" with the phrase "is released during."

First Word – Last Word:

First Word-Last Word is a strategy that is used both before engaging in learning activities and after engaging in those activities. It is a way for students to reflect on their understanding, documenting its change. That said, it can also be used as just First Word or just Last Word.

The First Word part activates prior knowledge and asks students to consider what they know about a topic. This is a metacognitive skill that can encourage conceptual change. The Last Word part of this tasks is an opportunity for students to consider what they now know and compare it to their initial ideas.

Odd One Out:

Odd One Out presents students with a list of similar items but asks students to identify which item does not belong. Students have to justify their reasoning for their selection. Odd One Out is a strategy that can elicit prior knowledge or assess student understanding after a learning experience.

Collaborative Clued Corrections:

Collaborative Clued Corrections (CCC) is a technique that allows teachers to address common mistakes on past assignments in a meaningful way. First, students complete an assignment, turn it in, and it is graded. But instead of simply marking these responses right or wrong and handing the papers back, the teacher chooses a few student samples that represent mistakes or challenges many students experienced. Marks on the paper do not identify right or wrong answers but only "clue" students into what may need corrected. In groups, students examine the sample to identify the problem areas and revise these before receiving their own papers back.

Model Analysis:

Model Analysis is an amazing way to tie in the Science and Engineering Practice of Developing and Using Models while simultaneously assess student understanding of Disciplinary Core Ideas. In Model Analysis, students are given a model or representation -- think a diagram of the water cycle, a to-scale three dimensional model of the size of the planets, or a picture of a plant cell -- and asked to evaluate whether it is an accurate representation of the object, situation, or concept it was created to convey. By identifying the strengths and weaknesses of the model -- its accuracies and its limitations -- students are demonstrating their own understanding as well as revealing whether they may still have misconceptions that are reinforced by these representations.

Designing A 5E lesson sequence

The NGSS is all about guiding students to scientific understanding through the application of Science and Engineering Practices that lead to student discovery. Students are doing science to learn science. The 5E Model is a great framework for structuring your lessons to develop conceptual understanding of the content – a constructivist approach to science instruction that leads to long-term understanding and skill and knowledge gains. The 5E Model requires a significant shift in the way we think about and carry out science instruction, It's a new mindset for the future of science education. This guide was designed to walk you through designing a 5E lesson sequence based on your NGSS unit storyline.

Step one

1. Identify your objectives.
2. Order and bundle your objectives.
3. Refine your objectives for use in the classroom. Focus on action verbs, taken from the Performance Expectations, Evidence Statements, and Science and Engineering Practices.

Step Two

1. Choose your phenomenon for your **engage** activity based on the questions it generates.
2. Determine how you will present your phenomenon. Avoid using resources that explain the phenomenon.
3. Engage your students with the phenomenon so that they are active learners from the beginning. Expect students to generate questions, make predictions, and access prior knowledge. Incorporate ways for them to express themselves through discussions, writing tasks, drawings, or actions.

Step Three

1. Identify an investigative phenomenon for your students to explore. This may or may not be the same phenomenon you used during the **engage** phase of your lesson sequence.
2. Choose the Science and Engineering Practices your students will use to discover the concepts. While this practice may align to the practice you incorporated into your objectives, you may find another practice better supports student discovery. For example, your objective may ask students to "construct an explanation based on evidence" while your **explore** activity may engage students in collecting that evidence through "analyzing and interpreting data" or "conducting an investigation."
3. Remove all explanatory information. Strip your activity to the bare bones to allow for student discovery.

Step Four

1. Engage your students in productive science talk to guide meaning-making from the **explore** activity.
2. Utilize student ideas when providing teacher-directed instruction. Focus this instruction on concisely expressing the scientific ideas students are giving voice to and to providing the appropriate scientific terminology for their ideas.
3. Determine how students will document their new understandings, such as through notebooking, developing models, responding to questions, synthesizing information through written responses, etc. Align this task to the objective(s) you originally identified.

Step Five

1. Provide students with the opportunity to solidify and expand their understanding of the content and mastery of the skills and practices.

Step Six

1. Embed assessment throughout the lesson sequence. Incorporate a formative assessment into each phase – from a simple science starter or exit ticket to a more elaborate formative assessment activity like "concept card mapping" or "odd one out."
2. When planning your formative assessment strategy, identify what content, skills, and crosscutting concepts you may be focusing on in each assessment.
3. Determine whether you will include a summative assessment for this lesson sequence. It is not always necessary to do this. You may summatively assess students after several lesson sequences or wait until the end of the entire unit to utilize a three dimensional assessment that addresses the complete standard (or standard bundle).

Developing Your 5E Lesson Sequence

Standard(s)

lesson objective(s)

-
-
-

Engage Phenomenon

How Will You Present it?

What Questions Will it Generate?

Explore Phenomenon

How Will Students Discover the Content?

SEP: ___________________________________

CCC: ___________________________________

Student task:

Formative Assessment Look-Fors

Questions to Guide Student Thinking

Observations to Support Student Understanding

Explain Discussion Questions & Outcomes

Explain Student Task

Formative Assessment Look-Fors

Elaborate: Opportunities for Practice

Formative Assessment Look-Fors

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