"Education is not the learning of facts, but the training of the mind to think."

Albert Einstein
1879-1955

Phenomenon Based Learning

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Agenda

- What is PBL
- 3D learning approach
- How is different
- PBL framework
- PBL process in each of the framework
- Case study for grades K – 2, 3 - 5, 6 - 8 and 9 -12
- Conclusion

Phenomenon

A fact or situation that is observed to exist or happen, especially one whose cause or explanation is in question.

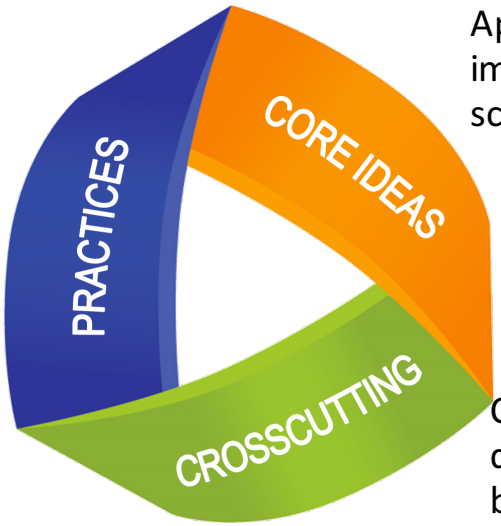
Planets Revolve around Stars

vs.

Mercury's orbit travels across the sun in 2012, 2016 and 2019

Shift in science standards calls for:

Investigate, evaluate and reason scientifically – science instruction should integrate the practices, or behaviors, of scientists and engineers as they investigate real –world phenomenon and design solutions to problems.



Apply content knowledge – broad importance within or across multiple science or engineering discipline.

Connect ideas across disciplines – to develop a coherent and scientifically based views of the world, they have to make connections across the domains of sciences. Cross cutting have all applications across all domains.

Dimension 1 – Science & Engineering Practices

1. Asking questions (science) & defining problems (engineering)
2. Developing and using models
3. Planning & carrying out investigations
4. Analyzing and Interpreting data
5. Using mathematics & computational thinking
6. Construction explanations (science) and designing solutions (engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Dimension 2 – Disciplinary core ideas

1. Physical Sciences – Matter, motion, waves
2. Life Sciences
3. Earth & Space Science
4. Environment Science
5. Engineering, Technology and Applications of science

Dimension 3 – Crosscutting concepts

1. Patterns
2. Cause and Effect
3. Scale, Proportions and quantity
4. System and system models
5. Energy and matter
6. Structure and Function
7. Stability and Change

Framework for K - 12

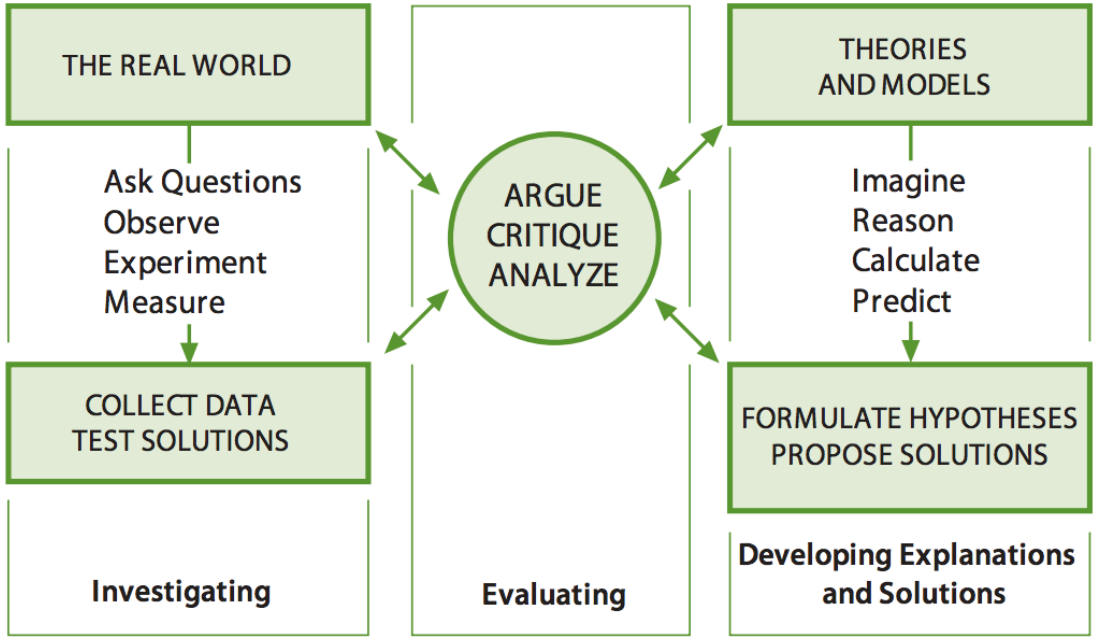
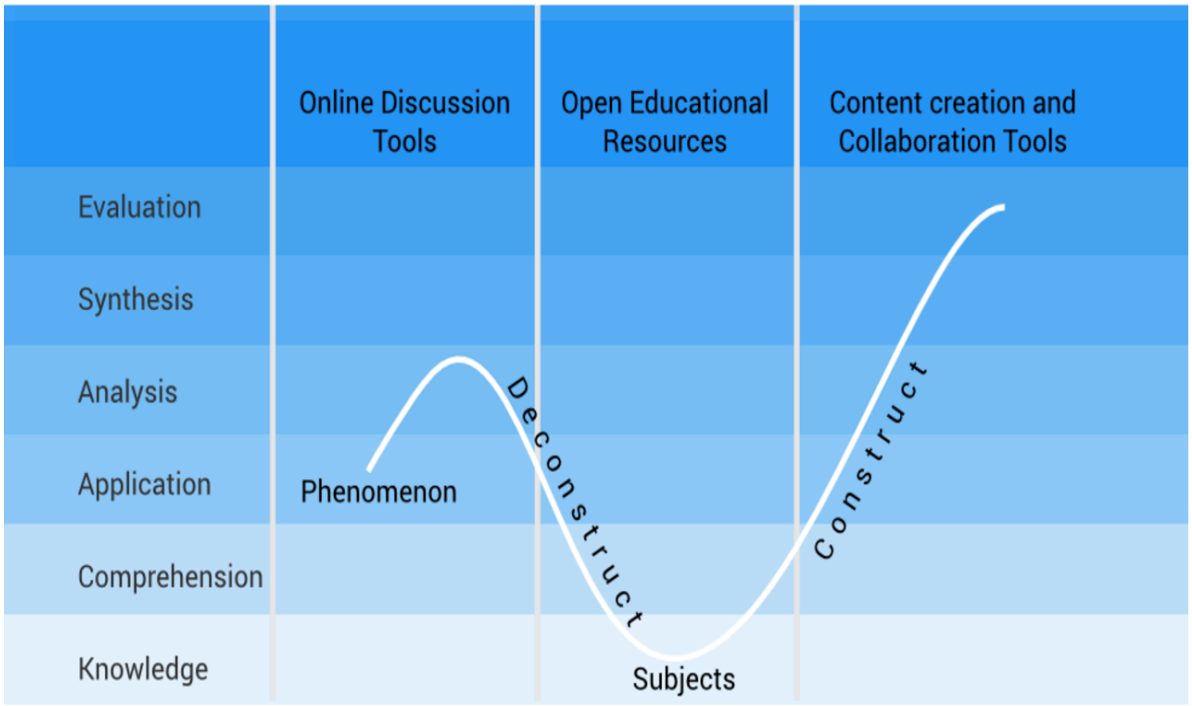


FIGURE 3-1 The three spheres of activity for scientists and engineers.
Source: National Academy of Sciences

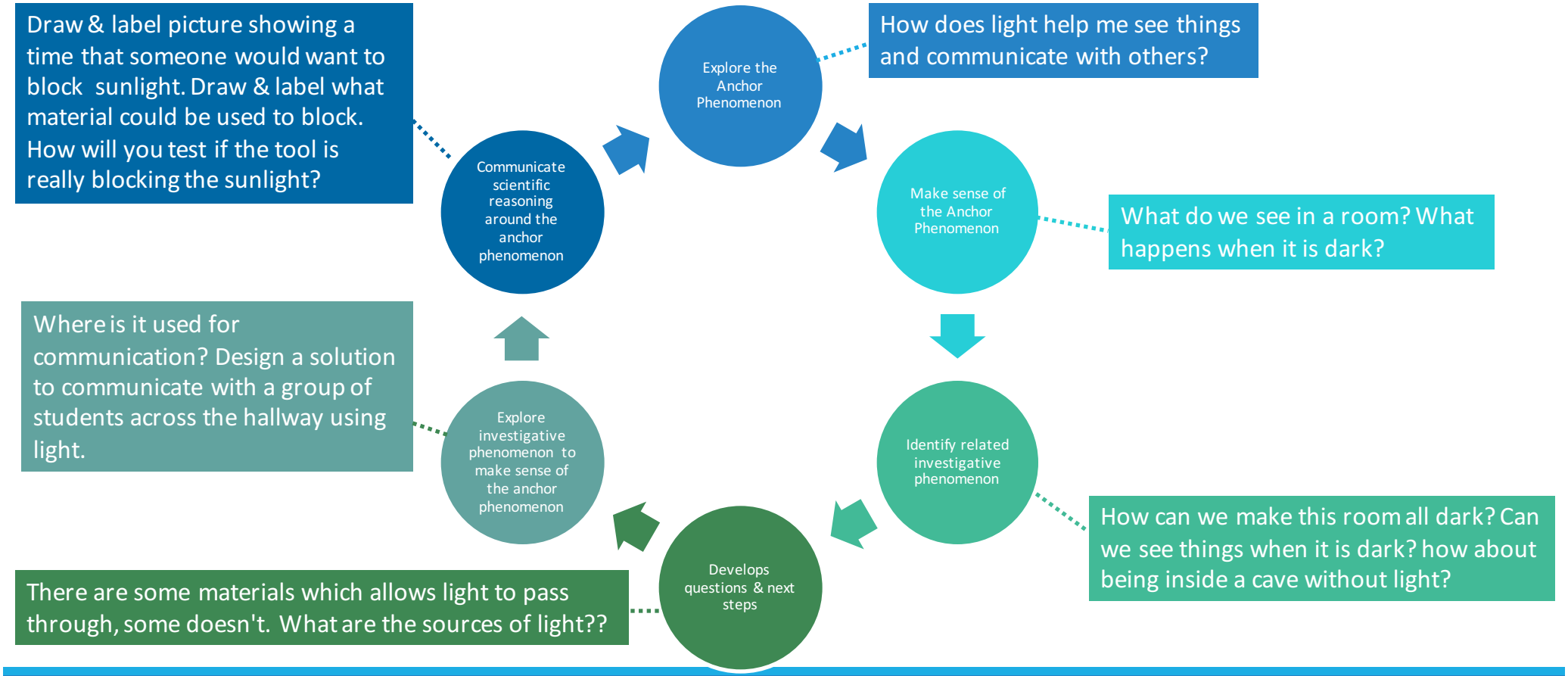
How is it different?



- In our regular learning framework, students gain knowledge and comprehend it, apply to real life scenarios, analyze and synthesize information that relates to different concepts/subjects they are learning.

- In PBL, the student starts with the real life scenario, identify, analyze different subject links, understands the gaps, seeks out the knowledge and try to comprehend the links and synthesize the whole information. It is a form of holistic teaching and way to show integration of subjects.

Process in PBL



What we've figured out so far	How this helps our design
We need a source of light in order to see.	We will need to use a light source in order to send our message. We should use one that is small enough and safe enough to bring inside of school - like a flashlight
Some light sources are natural and others are man made.	
Some light sources, like the flashlight, are small and safe enough to bring into a box.	
Some materials, like tissue paper or construction paper, block some of the light	Maybe we could figure out a way to block or not block light using different materials to communicate different messages.
Some materials, like cardboard or wood, block all the light.	
Some materials, like plastic wrap, don't block the light.	
Materials that block some or all of the light make shadows on different surfaces.	Maybe we could figure out a way to make different shadows with different materials to communicate different messages.
Different shaped materials make different shaped shadows when we shine light on them.	
Light sources that are certain colors, are certain shapes, are in certain locations, and that go on and off in certain patterns, communicate certain messages to us.	Maybe we could figure out a way to change the color, shape, location, or the on and off pattern of the light source, to communicate different messages.

Next, engage students in a Sharing Initial Ideas Discussion[A] to brainstorm ideas about how they could help solve the school-wide problem of there being too much noise in the hallway using

Additional Guidance

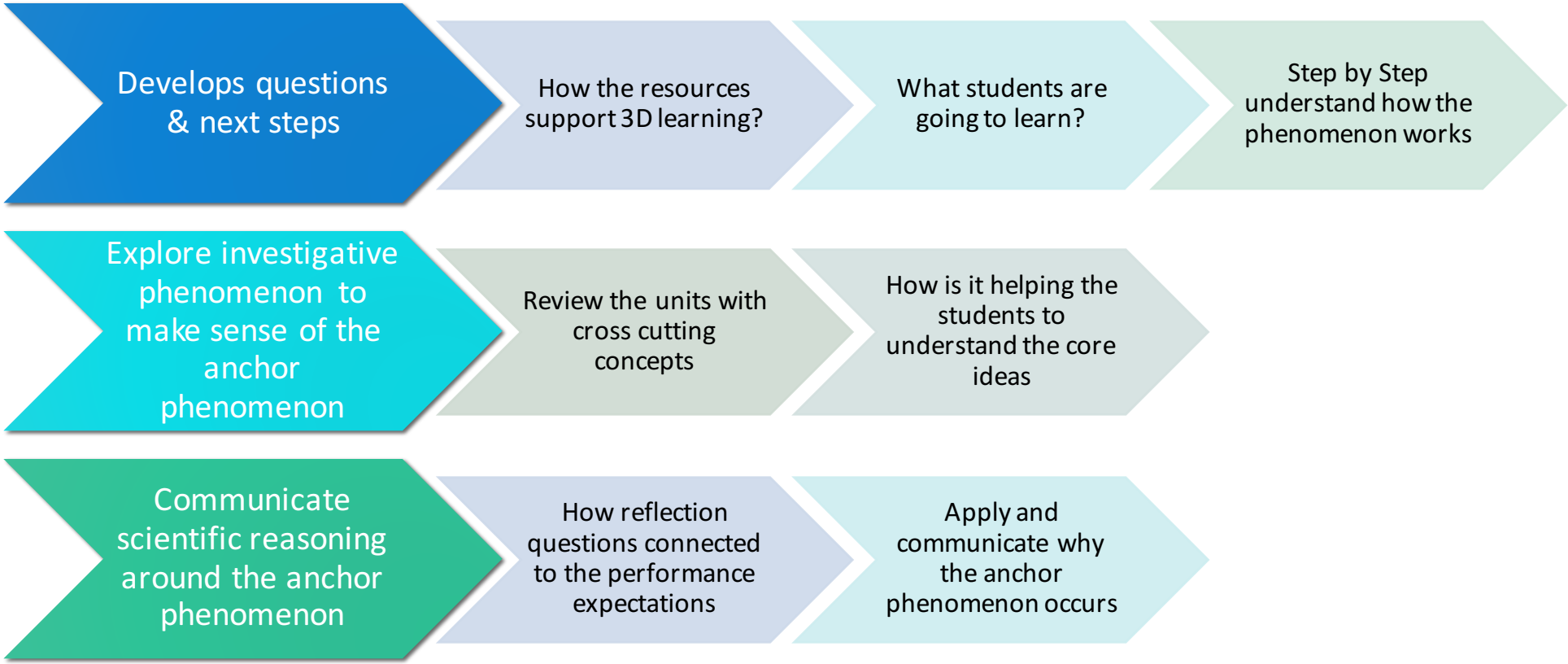
A It is assumed from this point on in the lesson that students will have elected to focus on the problem of noise in the hallways for the remainder of the unit. If your students select another area, such as the library, please note that you will need to slightly adjust the language in the following lesson plans to meet their needs.

Students may struggle with coming up with ideas to design a device with the available materials, and this is normal the first time they engage in the engineering design process. If this is the case, you may want to suggest that they need to create two communication signals: one to communicate when students are making noise and another when they are not. Revisit the devices seen on the Light and Shadow Hunt, thinking about how each one communicated a message. This will help students see how a message was communicated with others.

Process in PBL

Explore the Anchor Phenomenon	Unit Level	With Instruction & guidance , they should be able to figure out how and why the phenomenon works	Has relevant data, images and text to students in the range of ideas	Multiple cross cutting concepts
Make sense of the Anchor Phenomenon	Students may ask questions/pose	Evaluate the question	What are the causes/How a few things influence	
Identify related investigative phenomenon	Lesson Level	How students are making sense	They have to apply the practice to understand	Has relevant data, images, text to engage students

Process in PBL



Group - Anchor Phenomenon

Grades K - 2

Why are some things hard and some things soft?

Grades 3 - 5

Why do you feel the burn when you touch a hot object?

Grades 6 - 8

Why is the Statue of Liberty Green?

Grades 9 - 12

Despite flu vaccination, you do see flu epidemics happen every few years. Why?

Framework

- Anchor Phenomenon
  - Synopsis
  - What students will figure out
- Identify related investigative phenomenon
- Develop questions and next steps
  - Lesson question
  - Lesson performance expectation
  - What students will figure out
  - Cross Cutting disciplines
    - Other Subjects
- Explore and make sense of anchor phenomenon
- Methods to Communicate the reasoning and findings

PBL helps in

- Moving towards three dimensional learning
- It works highly on the student's cognitive process as they can come with the set of questions when the anchor phenomena is being discussed.
- Addressing diverse needs in children by choosing the topic of their level.
- Helps in complimenting any type of classroom – be it flipped or maker space, anchor question can spark their curiosity.
- Students are able to identify an answer to "why do I need to learn this?" before they even know what the "this" is.
- Designing solutions to problems allow students to build general science ideas in the context of their application to understanding phenomena in the real world,.
- Collaborative work in teams

PBL helps

- It is the phenomenon plus the student-generated questions about the phenomenon that guides the learning. The practice of asking questions or identifying problems becomes a critical part of trying to figure something out.
- Students also might ask questions about a phenomenon that motivate a line of investigation that isn't grade appropriate, or might not be effective at using or building important disciplinary ideas. Teacher guidance may be needed to help students reformulate questions.
- Highlight how science ideas help us explain aspects of real world contexts or design solutions to science-related problems that matter to students, their communities, and society.
- Can use multiple forms to communicate their learning.

How can it be adopted

- Curriculum Adaptation - What new ideas occur to you? Lesson plans are your origination point.
- Refinement of existing strategies
- Not all phenomena need to be used for the same amount of instructional time. You could use an anchoring phenomenon or two as the overall focus for a unit, along with other investigative phenomena.
- You may also highlight everyday phenomena that relate investigative or anchoring phenomena to personally experienced situations. A single phenomenon doesn't have to cover an entire unit, and different phenomena will take different amounts of time to figure out
- Clubs after school could be for teachers as well – innovation in practices

How it can be adopted

Prior Thinking About Phenomena	Thinking About Phenomena Through the NGSS
If it's something fun, flashy, or involves hands-on activities, it must be engaging.	Authentic engagement does not have to be fun or flashy; instead, engagement is determined more by how the students generate compelling lines of inquiry that create real opportunities for learning.
Anything students are interested in would make a good "engaging phenomenon"	Students need to be able to engage deeply with the material in order to generate an explanation of the phenomenon using target DCIs, CCCs, and SEPs.
Explanations (e.g., "electromagnetic radiation can damage cells") are examples of phenomena	Phenomena (e.g., a sunburn, vision loss) are specific examples of something in the world that is happening—an event or a specific example of a general process. *Phenomena are NOT the explanations or scientific terminology behind what is happening. They are what can be experienced or documented.*
Phenomena are just for the initial hook	Phenomena can drive the lesson, learning, and reflection/monitoring throughout. Using phenomena in these ways leads to deeper learning.
Phenomena are good to bring in after students develop the science ideas so they can apply what they learned	Teaching science ideas in general (e.g., teaching about the process of photosynthesis) may work for some students, but often leads to decontextualized knowledge that students are unable to apply when relevant. Anchoring the development of general science ideas in investigations of phenomena helps students build more usable and generative knowledge.
Engaging phenomena need to be questions	Phenomena are observable occurrences. Students need to *use the occurrence to help generate the science questions or design problems* that drive learning.
Student engagement is a nice optional feature of instruction, but is not required	Engagement is a crucial access and equity issue. Students who do not have access to the material in a way that makes sense and is relevant to them are disadvantaged. Selecting phenomena that students find interesting, relevant, and consequential helps support their engagement. A good phenomenon builds on everyday or family experiences: who students are, what they do, where they came from.

Source : nextgenscience.org

Appendix

Phenomenon Based Learning Rubric

The phenomenon-based learning gives a holistic view of real-world phenomena - in a real context, breaking the curricular boundaries.

Dimensions	Limited evidence	Emerging	Developing	Accelerating	Advanced
1. Holisticity *-360 ° perspective* *- From the traditional curricular integration towards to the phenomena in the real world*	Although studying and processing phenomena, analysis or study is done more or less from the perspectives of traditional school subjects. An example may be a common theme, which is processed in various subjects. Another example may be an event or a theme day. The phenomenon-based learning is just spicy - not a systematic practice.	A Phenomenon combines different subjects, contents and objectives, but they are not merged together seamlessly. The phenomenon can be worked (studied) on different subjects in class, or to integrate different subjects e.g. in a project work. Traditional subjects aspects can still be seen in the background when studying a phenomenon. (Traditional curricular integration, the	The objectives and contents of different subjects are merged together seamlessly in a phenomenon. The phenomenon is not studied on the aspect of different school subjects (e.g. In designated subjects in class); the phenomenon is rather studied as a project (work) and long term process. The phenomenon-based learning is understood to be a teaching and learning method. Phenomena rise from the objectives of the curriculum; in addition they are	The objectives of learning arise from phenomena and they are multidisciplinary. The starting point of learning is not the integration of traditional school subjects; the focus is rather on current and actual events in the real world. The phenomena shall be identified and defined together with the whole learning community. Learning and working are not, as a rule structured by lessons or subjects. *Team Teaching is a key way of working.*	The objectives of learning arise from phenomenon and they are multidisciplinary. In the phenomenon-based learning the starting point is not the integration of traditional school subjects; the focus is rather on current and actual events in the real world. Learning and working are not, as a rule structured by lessons or subjects. The phenomenon-based learning is systematic and it is seen as a comprehensive

		integration of traditional school subjects)	connected to the currently relevant, actual issues and phenomena. *Collaborative Teaching or co-teaching one way of working.*		method of learning and teaching. *Team Teaching as a major way of working*.
2. Authenticity *-In the learning situation used methods, tools, and materials, correspond the real world, where the knowledge is used*	The phenomenon is a "textbook-like" or study materials focused - a small and pretty clearly defined entity.	The topic of learning is an authentic phenomenon from the real word.	The topic of learning is genuine, phenomenon from the real world. The phenomenon is timely and on behalf of content relevant to the learners in their world now and in the future. Learners examine and study the phenomenon by using real, authentic sources and materials and media.	The object of the learning is holistically authentic phenomenon from the real world .The examined phenomenon is current, actual and it has real world relevance to the learners now and in the future. In additions, the learner's output has relevance outside of school and it will be published to a wider public. Learners examine and study the	The learners' cognitions are authentic, i.e. the learner's thinking in learning situations corresponds as closely as possible thinking that is needed in the real world situation, where the knowledge is applied / used. Learners use authentic sources, materials and tools, and methods as the real experts and professionals use. Learning takes place

				phenomenon by using real, authentic sources and materials and media. Learners use methods and tools that are typical to the culture expertise – e.g. tools and devices that are used in the real working life.	in a real environment rather than in a traditional classroom. Learning community utilizes experts and professionals from various fields. Learners' outcomes / content produced by learners are relevant to real life, and they solve some problems that are significant in the surrounding society. Learners' outputs / content produced by learners will be published to a wider audience.
3. Contextuality (/context) *- Learners learn things in their natural context. Contextualization vs. De-*	While studying a phenomenon one looks at individual cases - one thing and perspective at a time. Learning the phenomenon is structured in the traditional way	The phenomenon is studied in structured entities. Things are learned in their natural context; context and meanings are understood by observing a wider	Learners are working on sets of entities instead of individual task or exercises (cf. Project-based working). The phenomenon is examined as a holistic entity, where	Learners work on vague and ambiguous, not the pre-defined phenomena (cf. Project work where the problem and topic are set by students). Learners	Learners work on the vague and ambiguous, not pre-defined phenomenon (cf. Project work where the problem and topic are set by students). Learners

contextualization.	with small tasks or exercises given by a teacher. (Tasks typically based on the closed task of objections, tasks with relatively strictly limited "right" answer.)	context. Learning process is structured and guided by learning tasks.	things are in a natural context; context and meanings are understood by observing wider context.	structure and analyze the phenomenon from different perspectives. (Learning process can be methodologically guided and facilitated by scaffolds* or by learning tasks that are open.)	structure themselves the phenomenon from different perspectives. Things are learned in a natural context and setting and meanings are understood by observing wider context where various aspects and topics come together. The phenomenon is understood and processed as a systemic entity.
4. Problem based inquiry learning *-Learning and collaborative knowledge construction is based on the learner's own questions. In the phenomenal*	The phenomenon is not studied problem based; teacher or students are not creating own questions s or problem settings as a basis for knowledge	The problem setting (wondering of the problem / research of the problem) works as a base for learning and studying a phenomenon. Problem setting comes from the	The phenomenon is studied based on the problem settings that have been collaboratively made together by learners. Learners set research / wondering problems as a basis for the review and	The phenomenon is studied based on the problem settings that have been collaboratively made and reflected together by learners. Problem settings are relevant to the learners and to their	The phenomenon is studied based on the problem settings that have been collaboratively made and reflected together by learners. Problem settings are relevant to the learners and

learning learners learn by wondering together.	construction process. (Questions, exercises and learning tasks are by all means used.)	teacher or is made by the teacher-centered way. Problem setting makes learning meaningful and significantly; it anchors things to be learned to the real world.	study of the phenomenon. Knowledge construction is a process of answering to the questions/problems.	real world. The setting of problems is a continuous process that guides individual and collaborative knowledge construction during the whole learning process.	to their real world. The setting of problems is a continuous process that guides individual and collaborative knowledge construction during the whole learning process. The learning process is an intentional process of developing hypothesis and working theories (working models, (mental) prototypes).
5. Learning process *-Learning is seen as a process, which is guided and facilitated by learning tasks* *-The learning tasks guide the learner's perception and*	The learning process is not guided by learning tasks, even the students are given separate individual tasks.	The learning process is guided by learning tasks which are mainly focusing learner on the content / focusing on the repetition of the information.	The learning process is guided by learning tasks that methodologically guide the learner's learning and facilitate the learner's learning process.	The learning process is guided by open learning tasks that methodologically guide the learner's learning. Learners also create their own learning tasks for themselves. Learners are aware of learning	The learners create their own learning tasks and learning tools (scaffolds *) for themselves. Learners are aware of the learning methods as well as their own and common learning

information process – the aim is to facilitate students to learning something new (methodological guidance).				methods and their own and common learning process.	process. Learners plan their own individual learning processes, as well as their collaborative learning processes.

Resources

- https://www.nextgenscience.org/search-standards?keys=matter&tid_4%5B%5D=All&tid_1%5B%5D=All&tid_2%5B%5D=All&tid%5B%5D=106
- https://www.nextgenscience.org/sites/default/files/AllTopic.pdf
- https://www.nap.edu/read/13165/chapter/2
- http://www.nextgenstorylines.org/how-does-light-help-me-see-and-communicate/
- https://www.noodle.com/articles/phenomenon-based-learning-what-is-pbl
- http://www.hhmi.org/biointeractive/virus-explorer
- https://globalgtchatpoweredbytagt.wordpress.com/2017/03/13/phenomenon-based-learning/
- https://www.nextgenscience.org/sites/default/files/Using%20Phenomena%20in%20NGSS.pdf

Thank You