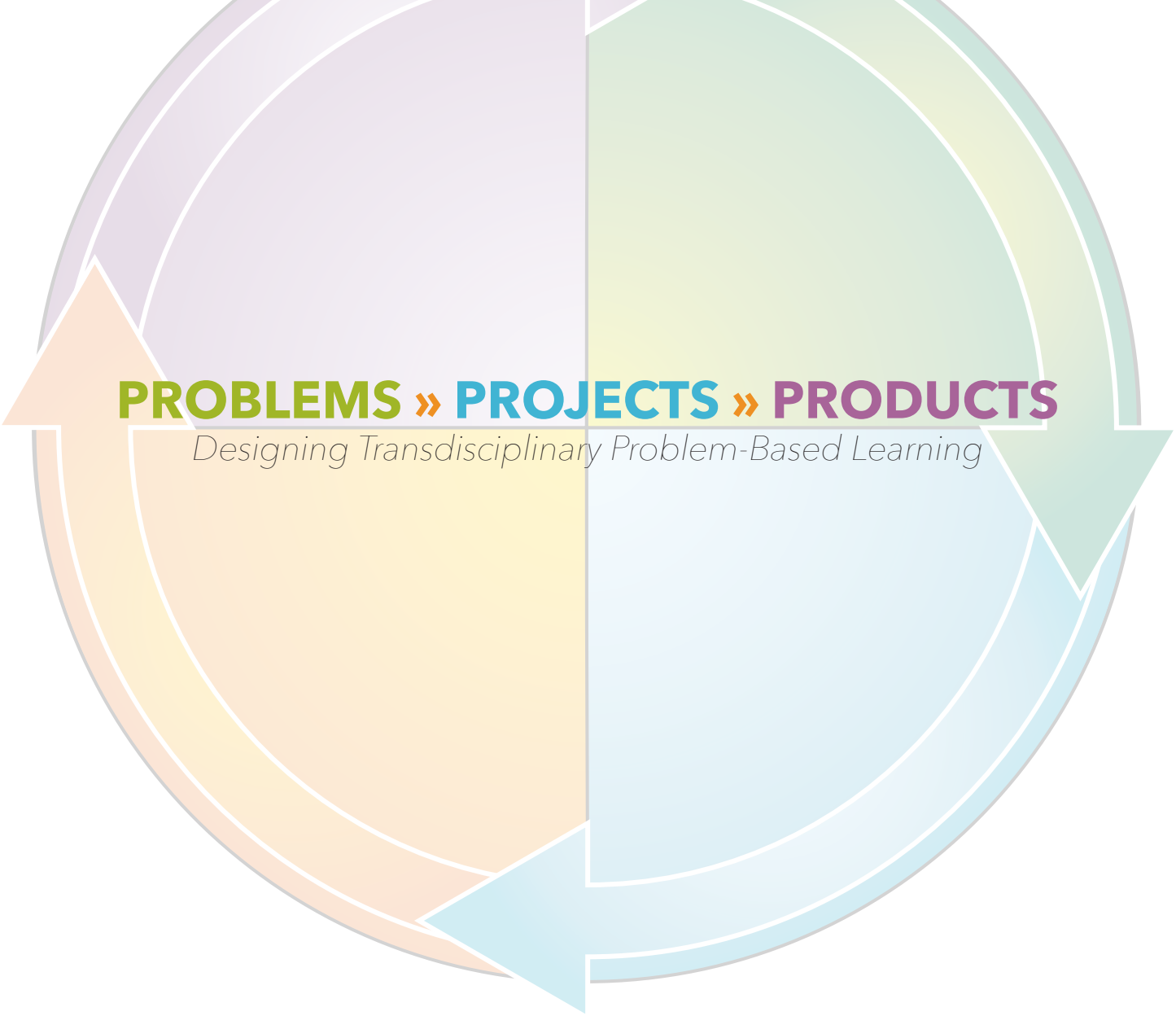


by Sheli O. Smith & Annalies Corbin

Design Team:
Ketal Patel | Kat Deaner | Elliot Mork | Brian Coffey | Lori Trent | Beth Witte | Steve Lewis
Mari Biehl | Jeff Schneider | Jim Bruner

THE PAST FOUNDATION

Problems > Projects > Products:
Designing Transdisciplinary Problem-Based Learning
Third Edition

ISBN: 978-1939531-09-4

LCCN: 2013947885

INTRODUCTION

BRAINSTORM

BUILD

EVALUATE | MODIFY

FORMS

Over the preceding decade, many generous people have read and used our workbook and toolbox. To all who have provided feedback, we thank you. We owe an enduring debt of gratitude to each and every teacher, specialist, and expert who has worked with us and tested our process. Working with students, educators, administrators, and policy makers across the U.S., we have the opportunity to constantly examine how we will make this process better and more accessible. Their input makes the workbook and toolbox a dynamic process that looks different from when we began in 2000, and different from when we published the first edition of the workbook in 2010.

Some of the ideas within this workbook have come directly from teachers, such as the Lewis Rubric. Many of the examples are based on actual problems & projects carried out by teacher/student teams. The success of the workbook and toolbox is in large part due to the interactive nature of our team and teachers working together to build tools that work for a variety of learning styles.

Encouragement, advice, and support from our partners, a key component of our work, have contributed to the workbook in ways we cannot begin to enumerate, but for which we are very grateful. Since partners are a critical component of the PAST model, we are constantly seeking out new alliances, and building on established partnerships. We recognize that together with all our partners, we have the greatest potential to drive the transformation of 21st century education.

Feedback from our Knowledge Capture team is instrumental in our own reflective process and real time course correction as we travel down the road of transformation. To Dr. Hunter and her team, Maria and Meghen, know we would not be able to do this without you and your insights.

Finally, it is important to acknowledge the tireless work and support of the fabulous PAST STEM Coordinator team and our support staff. Without their commitment to bettering education and seeing the transformation through to a complete paradigm shift for all students, this workbook would be but a pale shadow of its robust self.

The PAST Foundation stands for Partnering Anthropology with Science and Technology. Our motto, *Access through Innovation*SM, keeps us focused on exploring and continuously considering new ways to link learning to life.

Work on *Problems » Projects » Products* began over ten years ago, and has undergone a process of trial, experimentation, and on-going field-testing. It is a process-driven workbook, intended to provide hands-on templates for designing and implementing 21st century education. The step-by step process outlined in this book is designed to help instructors and community partners build robust and sustainable environments that engage and excite the learning team of students and teachers.

Over the years, we have been fortunate to have educators across the country work with us to help us better understand their needs and outlooks. Based on tenets of anthropology, our process is intended to be holistic, dynamic, and agile. We draw upon the success of many concepts and strategies put forth in education since the late nineteenth century, such as *design cycles*, *mastery*, various *learning strategies*, *standards*, and *modalities of learning*. We draw from an anthropological perspective, using global issues as a driving influence behind the creation of guiding statements, essential questions, relevant issues and projects. We promote a transdisciplinary approach to projects, in an effort to de-silo content areas, and bring education closer to reflecting real life. Finally, we contend that education begins at birth and does not end until we take our last breath. This extends to the way we present the process of learning—integrated into our lives.

A primary goal of our work is to create a process that takes any topic and reveals how interconnected subjects are. If we cannot read, we cannot understand science, nor can we ground math in real world problems. Life is interconnected, learning should be as well.

A second goal is to partner professionals with educators, drawing on compelling events that engage and excite students. We see students taking what they learn in formal education out through their adult lives, affecting how they approach decision-making, articulate problem-solving, and perceive the world around them. We believe that helping our youth better understand the interconnectivity of the world will prepare them to be better members of the community. The lasting impressions created by students, educators, and community partners when they build programs together encourages the PAST team to update and perfect the process, keeping it current and responsive to the needs of today's youth.

Some of the first questions teachers ask are: *how does this really differ from any two-year fad in education?*, and, *where will I find the time to do this*? Transdisciplinary problem-based learning (TPBL) is an instructional strategy. Thus, TPBL is not a fad nor an add-on. This instructional strategy focuses on process as well as product, aligning to the new Common Core and Next Generation Science Standards, as well as the needs of the 21st-century skills. We built a process that scaffolds teachers through planning a project in a holistic manner, and implementing projects—grounded in real world problems—with fidelity. This process combines a number of historically successful techniques that build on inquiry-based learning, mastery, transdisciplinary approaches, and progressive education.

However, any new process takes commitment and practice for it to grow from a reform movement into an integrated piece of global education. Willingness to change requires reassessment of how one teaches and what tools will be used to teach in a new way. This process is not an add-on, but rather a delivery system for education. When built collectively, with consideration of schedule, available tools and resources, the process takes no more time than current methods of planning and delivering instruction.

TPBL does, however, *look* different. This strategy requires more teacher planning on the front end, more student interaction with creating the project and assessment, less lecturing, and less singular teacher grading. TPBL supports more peer-to-peer learning, furthers differentiated instruction, and accomodates students' modalities of learning. In the end, TPBL produces results that far exceed current expectations, challenging the status quo.

Enjoy the process and let your creativity shine. Focus on the culture of your community. Incorporate real problems that are important to your community into the learning process. The enjoyment of learning alongside your students will ignite your passion for teaching. The PAST team challenges you to design, construct, and engage in experiences that link learning to life. The need for education to transcend current boundaries, through field experiences, digital access, and social networking, is key to 21st-century educational transformation.

You have the power to deliver a new way of learning to your students, schools, districts, and states. You have the opportunity to build on modern technologies and discoveries with your students and community partners. You have the responsibility to prepare the 21st-century student for the real world through the framework of transdisciplinary teaching and learning.

Sheli O. Smith & Annalies Corbin

What every school needs:

A quality education program that addresses real world issues and engages students and teachers in learning partnerships.

PAST focuses on a replicable process of building holistic education, so that teachers can easily facilitate learning across content areas, add rigor, and make real-time course correction in the midst of the learning process. We work with you and your community to transform your education system.

INSTRUCTIONAL STRATEGY

An overarching approach to teaching.

Transdisciplinary Problem-Based Learning

CULTURAL STRATEGY

The underlying worldview you take to deliver instruction.

Community-Based Issues

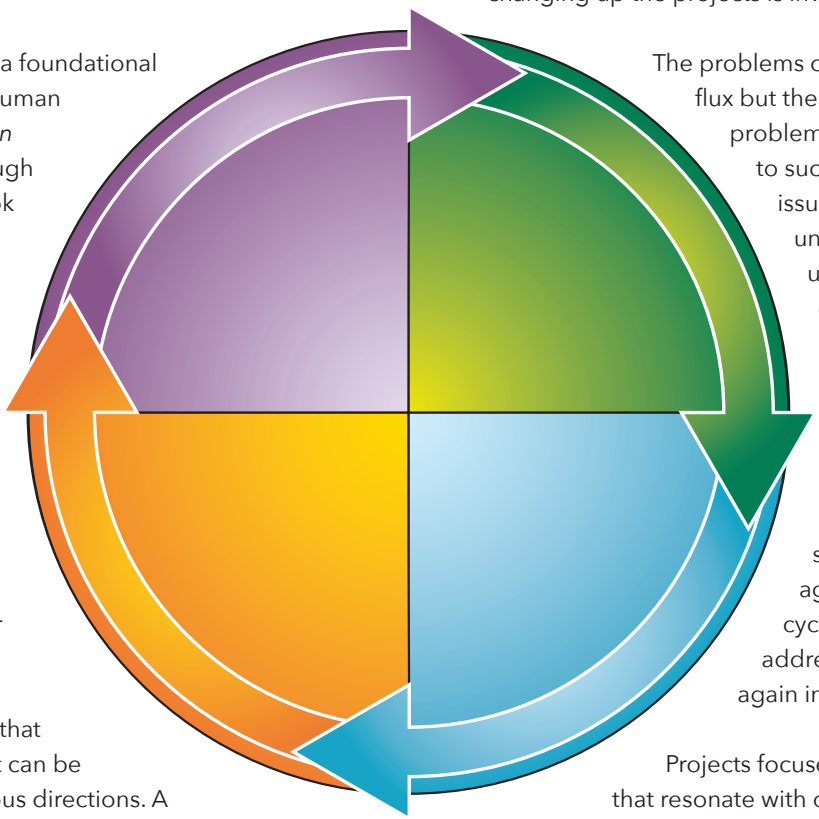
DELIVERY SYSTEMS

These should tie your instructional and cultural strategies together in a replicable process.

The PAST Foundation Process

The following sections scaffold through each stage of the design process. First, the Brainstorm section introduces initial discussions of foundational blocks that inform and aid the process. Second, the Build section includes a step-by-step approach for planning and building successful TPBL units. Third, the Evaluate, Modify, Share section, outlines products that help teachers and administrators benchmark planning, implementation, and outcomes. Each section is color-coded along the top edge of the page serving as a compass through the workbook. We have tried to be as inclusive as possible, thus it is important to note that after using the process several times, the Brainstorm section need not be revisited with teachers who have successfully integrated the process into their classrooms.

This TPBL workbook uses a foundational concept–universal to all human thinking–called the *Design Cycle*, and it threads through every part of the workbook process. Our design cycle is color coded green, blue, orange, and purple throughout the workbook to assist teachers and students in identifying and articulating where they are in the process, and recognize if they accidentally truncate the process, diminishing rigor and fidelity.



It is crucial to understand that the process is nonlinear. It can be approached from numerous directions. A classic question is which to create first: the problem or the product–and the answer is, either. It is up to you. In TPBL, the order does not matter, as long as you create a product that demonstrates mastery of associated standards, embedded in a project addressing real world problems or issues. However, since the workbook is published in a printed format, the process is laid out in a specific sequence–but this should not be regarded as the "correct" order. Regardless of the order you approach TPBL with, the workbook is intended to be hands-on, providing examples and blank templates to assist in planning and implementing. At the end of workbook is a link to an online toolbox, containing blanks of all the important forms for ease of copying.

Outcomes of TPBL are highly individualized, though the underlying process is the same. Consider a creative writing project about the effects of pressure on a Styrofoam cup on its journey to 7000 ft. underwater, or a creative writing project to compare "Clarity vs. Purity" challenging students in science class. Both achieve the same goals and can successfully instill the same learning concepts, but will look very different from one another. Keeping problems and projects fresh is a sure way to keep students, as well as faculty, engaged in all learning environments. Linking standards across content areas demonstrates that solving problems requires broad perspectives and numerous skills. Teaching the same lesson year after year is mind-numbing. Using the same approach but changing up the projects is invigorating.

The problems of the world are in constant flux but the critical thinking and problem-solving skills necessary to successfully address the issues remain the same. The universal process humans use to solve problems, the design cycle, is the "Kevlar thread", or fundamental component, of learning. As problems are "solved", the solutions often lead to consequences that create or reveal other problems, starting the process all over again. In short, the design cycle is the way humans address problems again and again in a perpetual quest.

Projects focused on problems or issues that resonate with our communities help identify community partners who can assist with and enrich projects and their resulting products. This is, by far, the most challenging aspect of TPBL, and is often referred to as "the fragile link." The process described in the workbook is intended to demystify partnering outside the school building. Roles and expectations are explained, ensuring that teachers and community partners utilize their respective expertise and strengths as a 'good practice' model for students to follow. The ability to build beneficial coalitions is a vital skill that students will use throughout their lives. Partnerships are proactive and reflect an important part of 21st-century learning, that education is a community effort, no longer isolated within a school building. A provided example and

form help identify project needs and potential community partners are addressed in the Build section.

School to school, district to district, community to community, the approach to the defining a relevant problem varies. Some choose overarching themes or "capstones" such as *Sustainability*, *Growth*, *Transportation*, or *Energy*—broad all-encompassing topics with diverse, associated problems or issues. Others choose to allow each grade to define overarching problems by academic year, semester, or quarter such as *Building a Better Cow* in one quarter and *Building a Better Pasture* in another. Ultimately, both approaches attempt to develop "wicked problems" relevant to the community and students. In each case, the process remains the same, the problem drives the projects. Several forms presented in the workbook—*Define Your Problems*, the *Design Process*, and the *TPBL Graphic Organizer*—each assist teachers in brainstorming and identifying problems that resonate with themselves and their community.

Projects in TPBL are not a result of lecturing. Instead, they take the lead in instruction to provoke questions that require students and teachers to search for answers and develop skills to complete a product. Products are the demonstration of learning, showcasing what students have learned and mastered through the implementation of a project, in a quest to solve a problem. A problem can have an infinite number of associated projects that address the issue from any core content area. A project can have numerous products that resonate with the students' modalities of learning. The *TPBL Graphic Organizer*, *Ways to Experience Learning*, *The Two-Week Planner*, and the *Backmap* assist teachers in planning and scheduling robust TPBL.

Another important step in the TPBL process appears in the *Evaluate, Modify, and Share* section. Successful implementation draws on a teacher's pedagogical expertise. Simply delivering a message does not ensure learning is taking place. All projects rely on feedback to gauge pace and success. Teachers elicit formative feedback from the students in order to design the best path for individualized learning. Teachers benchmark their own progress in delivery of content by summative assessment of the student's mastery of the concepts and skills. The *Lewis Rubric*, the *TPBL Snapshot*, and the *Fidelity Checklist* help teachers align projects to Common Core and Next Generation Science Standards, build consistent and clear criteria for projects and products, and assess implementation.

Used as a whole, the PAST Foundation TPBL workbook enables teachers to build and implement 21st-century instruction that has the power to take students on a journey of learning that will endure well beyond their time in the classroom.

STEM

In 1983 the landmark publication *A Nation At Risk: The Imperative for Educational Reform*, by President Reagan's Commission on Excellence in Education, first explored the deteriorating test scores in science and technology among high school students (Gardener et al, 1983). By the mid-1990s, industry, politicians, and educators noted that Scholastic Aptitude Test (SAT) scores continued to fall, and trends in the number of students graduating from college in the fields of Science, Technology, Engineering, and Math were discouraging. For the first time in the 20th century, American industries could not fill their quotas for job opportunities with U.S. graduates. Thus, the conversation gained wider attention as the public searched for ways to increase the presence of these disciplines in education. Numerous acronyms were suggested, but ultimately "STEM" (Science, Technology, Engineering, and Math) took hold. By 2005, the STEM movement evolved beyond the four letters to embrace the concept that STEM is an approach to education that relies on applied-learning instructional strategies (National Academies of Sciences, Engineering, and the Institute of Medicine 2005). Today, STEM simply is good practice teaching. A child with good STEM literacy has the ability and skills to make sense of the world around him or her. A teacher with good STEM teaching skills makes the world come alive in ways that engage students and inculcate critical concepts.

Instructional Strategies

Strategies for delivering instruction run the gamut from general concepts that form the foundation for content delivery, to specific classroom plans for managing students and time. Beginning in the early 1800s educators began developing instructional strategies to facilitate the delivery of knowledge concepts. One of the first instructional strategies used in the U.S. was summarized in the familiar rhyme "reading, riting, and rithmatic," representing the three core content areas deemed necessary to produce a successful and literate adult (Thimbs and Limbird 1825). These were based on the earlier work of Sir William Curtis, who identified three foundational characteristics of literacy: 1) Reading and Writing, 2) Reckoning and Figuring, and 3) Wroughting and Wrighting.

Over the years, numerous instructional strategies were deconstructed, defined, and developed. After World War II, when schools of education began expanding across the U.S., the term "–based learning" was used to label various types of instructional strategies, such as project-based learning, inquiry-based learning, and problem-based learning.

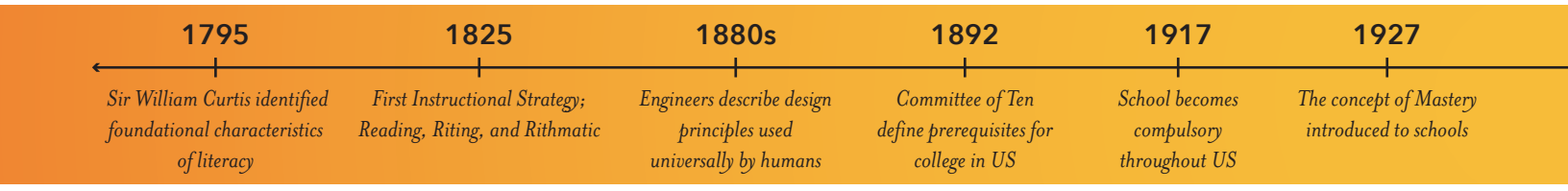
Problem-Based Learning

Problem-based learning (PBL) is an overarching instructional strategy that provides the framework for building content-rich projects, aligned to standards, that require students to use design principles to systematically solve a problem. Even DaVinci was a problem-based learner. But it was not until the 1950s, when Case Western University set about deconstructing instructional strategies that the term *problem-based learning* arose.

Problem-based learning is student-centered, and makes a fundamental shift from delivering content primarily through lecture and textbook readings, to a focus on gaining content knowledge through exploring solutions to a problem. Problem-based learning is a process that can be repeated to address any problem in any subject area (Purser, 2012).

The unique aspects of PBL are varied:

- PBL teaches mastery through brainstorming issues that require research and design, accomplishing tasks, evaluating and modifying the solutions, and sharing the solutions with real audiences.
- PBL requires that teachers and students become co-planners, co-learners, co-producers, and co-evaluators as they design, implement, evaluate, modify, and share the product. Students are stimulated to take responsibility for their own learning. Lectures are dramatically shortened and textbooks are used predominantly for reference.



- PBL is grounded in the use of design principles, which have been solidly researched and defined.
- PBL shifts the emphasis of success from rote memorization to applied learning. (Purser 2012)

Transdisciplinary PBL

Transdisciplinary literally means "across all disciplines." The concept that education should be more than simply inter-disciplinary, or even multi-disciplinary, is the basis of the CIRET Transdisciplinary School at the Sorbonne University in Paris (Nicolescu 1996). Often referred to as "holistic education," the goal of transdisciplinary problem-based learning is to link as many content areas as possible while finding solutions to real world issues, so that learning mirrors life.

Design Principles

Design principles are a universal attribute of human thinking. They help us organize and give structure to our attempts at solving problems. Every human uses the principles of design to come up with solutions to problems big and small. These principles form a process, enabling humans to organize the sequence of addressing a problem and synthesizing thoughts into a solution. In the late 1880s engineers began deconstructing the parts of problem-solving and eventually labeled the six parts of design, Brainstorm, Design, Build, Evaluate, Modify, and Share (Pólya 1945). A review of design principles in educational delivery systems reveals that textbooks often skip Build, Modify, and Share, three critical facets of applied learning.

Common Core Standards

Standards have been an issue since the late nineteenth century. In 1892 the Committee of Ten was organized by the National Educational Association (Lee 2013). They established English, Mathematics, History, Science, and Foreign Language as prerequisites for college admittance. Entrance exams to college, based on these five core subject areas, largely determined high school curriculum throughout the first half of the twentieth century and led to the creation of several standardized tests, including what is today the SAT Reasoning Test.

The decline in SAT scores, in part, prompted the National Commission on Excellence in Education to promote the need for national standards in their famous 1983 publication, *A Nation at Risk*. By 1989, the National Council of Teachers of Mathematics (NCTM) published curriculum standards for math. They were widely adopted. By 1995 there were National Science Standards and the following year National History Standards. Meanwhile, states were building their own standards, loosely modeled on the National Standards. In 2010 the Common Core State Standards were published by the National Governors Association. The Common Core cover Mathematics and English Language Arts. In 2013, the National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and Achieve completed the Next Generation Science Standards (Nerison-Low & Ashwill 1999; Phelan 2013).

Together, the Common Core and the NextGen Science Standards provide a clear and concise set of concepts that all students should recognize, understand, and be able to apply by the completion of high school.

Problems » Projects » Products

When employing PBL as an instructional strategy that addresses real problems there emerges a hierarchy in the process that creates successful outcomes for individuals or teams (Ostergaard and Summers 2009). This hierarchy begins with a problem. From the problem, one or more projects are selected to create solutions for all or part of the problem. Finally, a product is designed and either built or prototyped to demonstrate the intended solution. Collaborative design activities are common in many industries where teams take on specific projects, all addressing the large issue. In school this equates to a number of projects that address the same issue, and, depending on course content, create varying products, such as research papers, apparatus, pieces of art, models, or replicable experiments.

As an acronym, STEM is inherently limited. Many have attempted to broaden the scope by changing the acronym. Unfortunately, attention on the acronym, instead of the underlying process, promotes a continued focus on siloed content areas. No matter how many letters are insinuated into the acronym, the abbreviation alone will never be able to encompass all learning.

STEM

Science • Technology • Engineering • Math

STEM^2

Science • Technology • Engineering • Math • Medicine

STEM^3

Science • Technology • Engineering • Math • Medicine • Music

STEHM

Science • Technology • Engineering • Health • Math

STEAM

Science • Technology • Engineering • Art • Math

STREAM

Science • Technology • Reading • Engineering • Art • Math

SWEATER

Science • Writing • Engineering • Art • Technology • English • Reading

SWARMS

Science • Writing • Art • Reading • Math • Social Studies

SEQAL

Science • Engineering • Quantum Physics • Art • Language

How do we move beyond the limiting scope of these acronyms? Remember that STEM is far more than the sum of its letters; it refers to a holistic, transdisciplinary approach to content delivery.

STEM is simply good education.

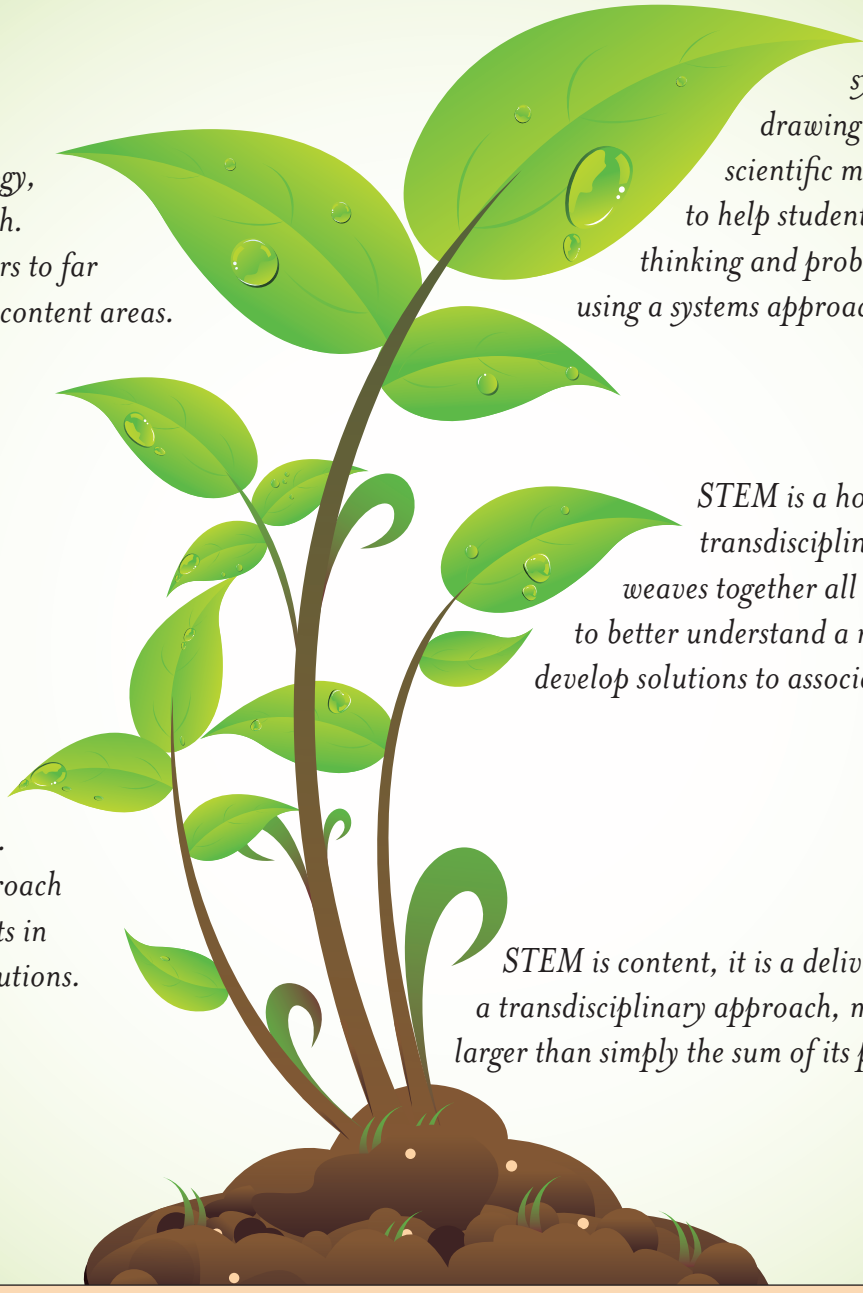
STEM is an acronym for Science, Technology, Engineering and Math. However, STEM refers to far more than these four content areas.

STEM is a delivery system for education, drawing on the strengths of scientific methods and technology to help students improve critical thinking and problem-solving skills using a systems approach.

STEM is a holistic or transdisciplinary approach that weaves together all school subjects in order to better understand a relevant issue and develop solutions to associated problems.

STEM is rooted in critical thinking and problem-solving. It is a systematic approach to learning that results in multiple, creative solutions.

STEM is content, it is a delivery system, and it is a transdisciplinary approach, making STEM much larger than simply the sum of its parts.



STEM (noun) \'*stem*\
The main ascending axis in education that supports knowledge, innovation, and student success.

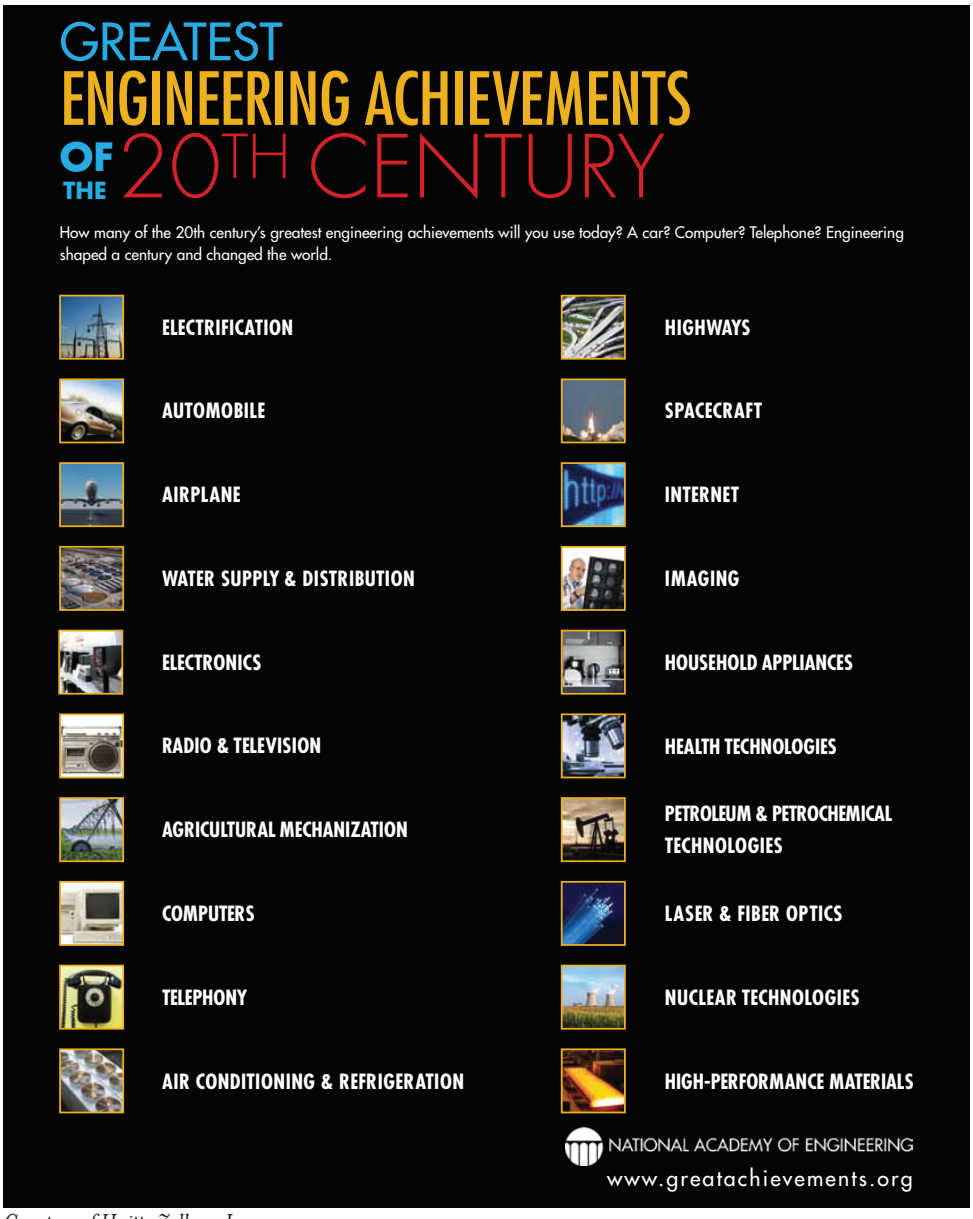
In the late 1960s, C West Churchman, Horst Rittel and Melvin Webber defined the concept of the 'Wicked Problem,' which relates to solutions that lead to new problems, or only solve part of a problem. As an example of a wicked problem, they cited moves in chess that solve an immediate dilemma but do not necessarily solve the entire game.

> *A wicked problem is a social or cultural problem that is difficult or impossible to solve for as many as four reasons: incomplete or contradictory knowledge, the number of people and opinions involved, the large economic burden, and the interconnected nature of these problems with other problems (Sanford Social Innovation Review).*

The problems of the world are in constant flux, but the critical-thinking and problem-solving skills that are needed to successfully solve these ever-changing problems remain the same.

Today, the concept of a wicked problem is widely used among software designers, city planners, and engineers. Relating the concept of the wicked problem to the design process applied to education, we can see that the design principles, integral to all problem-solving, is a perpetual process, suggesting solutions to one problem that often leads to the exploration of another collateral problem.

With the wicked problem in mind, choosing relevant issues for a school, a community partnership, technical apprenticeship, or continuing education reveals many paths that leads down numerous avenues of inquiry, all relating back to the issues at hand. For example, sustainability, world health, and local environment are large issues with many facets. These critical issues have the potential to generate years of projects completely relevant to modern societal needs.



Courtesy of Huitt-Zollars, Inc.

A decade after defining the concept of the Wicked Problem, Rittel and Webber identified ten components to every wicked problem. In 2011 the National Academy of Engineering published the Achievements of the 20th Century and the Challenges of the 21st Century (*see pg. 16*). Both of these references are republished here to assist in identifying and defining problems that resonate with teachers and students.

Addressing local and current problems relevant to a learning community allows students and teachers alike to attribute meaning to content learned. The invigorating aspect of this process is that once learning communities finish addressing one problem, other related or resulting problems become clear, and they can dive right back into the process with a new project.

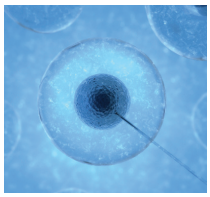
1. Wicked problems have no definitive formulation.
Formulating the problem and the solution is essentially the same task. Each attempt at creating a solution changes your understanding of the problem.

2. Wicked problems have no stopping rule.
Since you can't define the problem in any single way, it's difficult to tell when it's resolved. The problem-solving process ends when resources are depleted, stakeholders lose interest or political realities change.

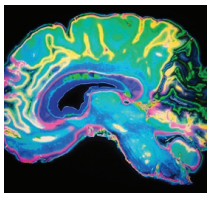
3. Solutions to wicked problems are not true-or-false, but good-or-bad.
Since there are no unambiguous criteria for deciding if the problem is resolved, getting all stakeholders to agree that a resolution is "good enough" can be a challenge, but getting to a "good enough" resolution may be the best we can do.

4. There is no immediate or ultimate test of a solution to a wicked problem.
Since there is no singular description of a wicked problem, and since the very act of intervention has at least the potential to change that which we deem to be "the problem," there is no one-way to test the success of the proposed resolution.

5. Every implemented solution to a wicked problem has consequences.
Solutions to such problems generate waves of consequences, and it's impossible to know, in advance and completely, how these waves will eventually play out. Various stakeholders have differing views of acceptable solutions. It's a matter of judgement as to when enough potential solutions have emerged and which should be pursued.



6. Wicked problems don't have a well-described set of potential solutions.
Formulating the problem and the solution is essentially the same task. Each attempt at creating a solution changes your understanding of the problem.



7. Each wicked problem is essentially unique.
There are no "classes" of solutions that can be applied, *a priori*, to a specific case. Part of the art of dealing with wicked problems is the art of *not knowing too early* what type of solution to apply.

8. Each wicked problem can be considered a symptom of another problem.
A wicked problem is a set of interlocking issues and constraints that change over time, embedded in a dynamic social context. But, more importantly, each proposed resolution of a particular description of "a problem" is expected to generate its own set of unique problems.

9. The causes of a wicked problem can be explained in numerous ways.
There are many stakeholders who will have various and changing ideas about what might be a problem, what might be causing it, and how to resolve it. There is no way to sort these different explanations into sets of "correct / incorrect."

10. The planner (designer) has no right to be wrong.
Scientists are expected to formulate hypotheses, which may or may not be supportable by evidence. Designers don't have such a luxury–they're expected to get things right. People get hurt when planners are "wrong." Yet, there will always be some condition under which planners will be wrong.

Based on: Rittel, H., & Webber, M. (1973). "Dilemmas in a General Theory of Planning," Policy Sciences, 4, 155-169.

Drawing upon some of the most challenging issues of our time, the National Academy of Engineering has compiled a list of 'wicked problems' that confront us globally.

We need to come up with viable solutions that have as few negative repercussions as possible. Use these challenges as an impetus for brainstorming your problems, projects, and potential solutions.

GREATEST ENGINEERING CHALLENGES OF THE 21ST CENTURY

The century ahead poses challenges as formidable as any from millennia past. These are the Grand Challenges for Engineering as determined by a committee of the National Academy of Engineering:


MAKE SOLAR ENERGY ECONOMICAL


ENGINEERING BETTER MEDICINES


PROVIDE ENERGY FROM FUSION


REVERSE-ENGINEER THE BRAIN


PREVENT NUCLEAR TERROR


DEVELOP CARBON SEQUESTRATION METHODS


MANAGE THE NITROGEN CYCLE


SECURE CYBERSPACE


PROVIDE ACCESS TO CLEAN WATER


ENHANCE VIRTUAL REALITY


RESTORE AND IMPROVE URBAN INFRASTRUCTURE


ADVANCE PERSONALIZED LEARNING

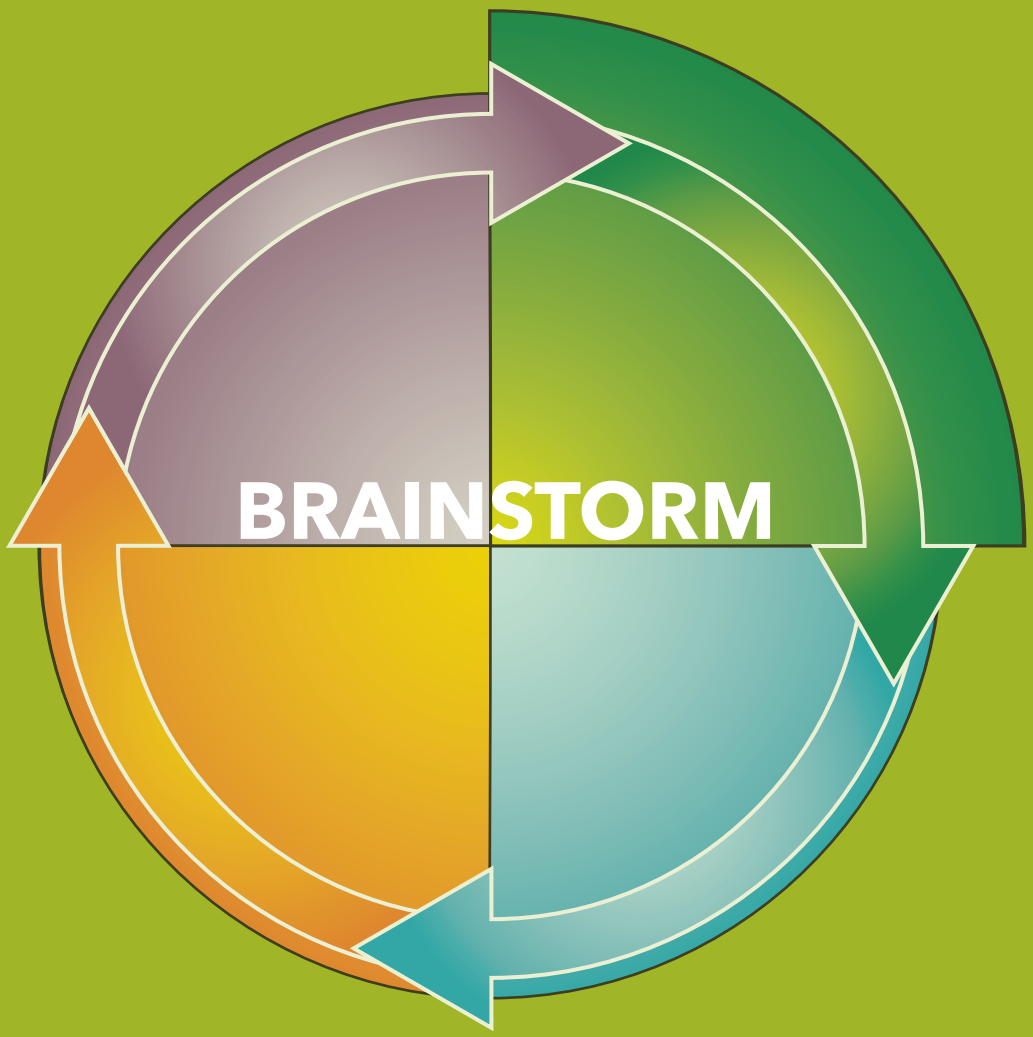

ADVANCE HEALTH INFORMATICS


ENGINEER THE TOOLS OF SCIENTIFIC DISCOVERY

WHAT CONTRIBUTION WILL YOU MAKE IN THE 21ST CENTURY?

NATIONAL ACADEMY OF ENGINEERING
www.engineeringchallenges.org

Courtesy of Huitt-Zollars, Inc.


BRAINSTORM

A set of school Habits or norms help create a culture of learning within a school, by providing a community-defined framework of desirable characteristics and behaviors. School habits are a set of constructive and positive traits that drive success for administrators, teachers, and students, both in school and in the world at large. These attributes encourage students to strive toward self-improvement while instilling local, cultural values. School Habits should resonate with the priority of cultural values held within each distinctive community. Although the full range of norms or Habits considered important does not vary greatly, the order of importance does vary by community, reflecting cultural and community relevance. Habits should be fully embedded throughout the school, in both the language used to define expectations, and the assessments used to define progress and mastery. Embedding habits requires student buy-in, and therefore student participation in creating the language of habits is encouraged.

Habits' order and wording change by community:

CRITICAL THINKER	The student uses critical thinking skills to analyze, synthesize, and evaluate information and observations (In-class assignments)
INQUIRING LEARNER	The student asks questions, which extend concepts and applications to create or discover ideas, products or decisions.
COLLABORATOR	The student demonstrates effective collaboration, honoring diversity, appropriate interaction, and successful completion of task.
COMMUNICATOR	The student presents his/her perspective in an effective manner that includes the consideration of the audience.
ENGAGED LEARNER	The student actively constructs meaning taking advantage of opportunities, actively speaking and listening, and demonstrating openness to learning.
ACTIVE AND RESPONSIVE DECISION-MAKER	Students take ownership for their decisions by reflecting on their work, making adjustments, and evaluating their overall performance.

Habits of Mind developed in 2006 at Metro Early College High School, Columbus, Ohio.

Early versions of schools' Habits tended to be complex

INNOVATION	Panthers explore and solve global issues using the STEM design process.
RESPONSIBILITY	Panthers are stewards of our community's legacy.
OWNERSHIP	Panthers take responsibility to embrace change.
CHARACTER	Panthers promote honesty and fairness towards others.
COMMUNICATION	Panthers convey creative ideas through a variety of media.
COMMITMENT	Panthers make decisions that display leadership.

Habits developed in 2010 at Linden McKinley STEM Academy, Columbus, Ohio. Students changed the sequence to spell IROC³.

Today, schools often build Habits around acronyms and succinct statements of meaning

1. Using sticky notes, brainstorm traits you personally think your students should model.

2. Consolidate your group's similar traits into a list of ten habits for success.

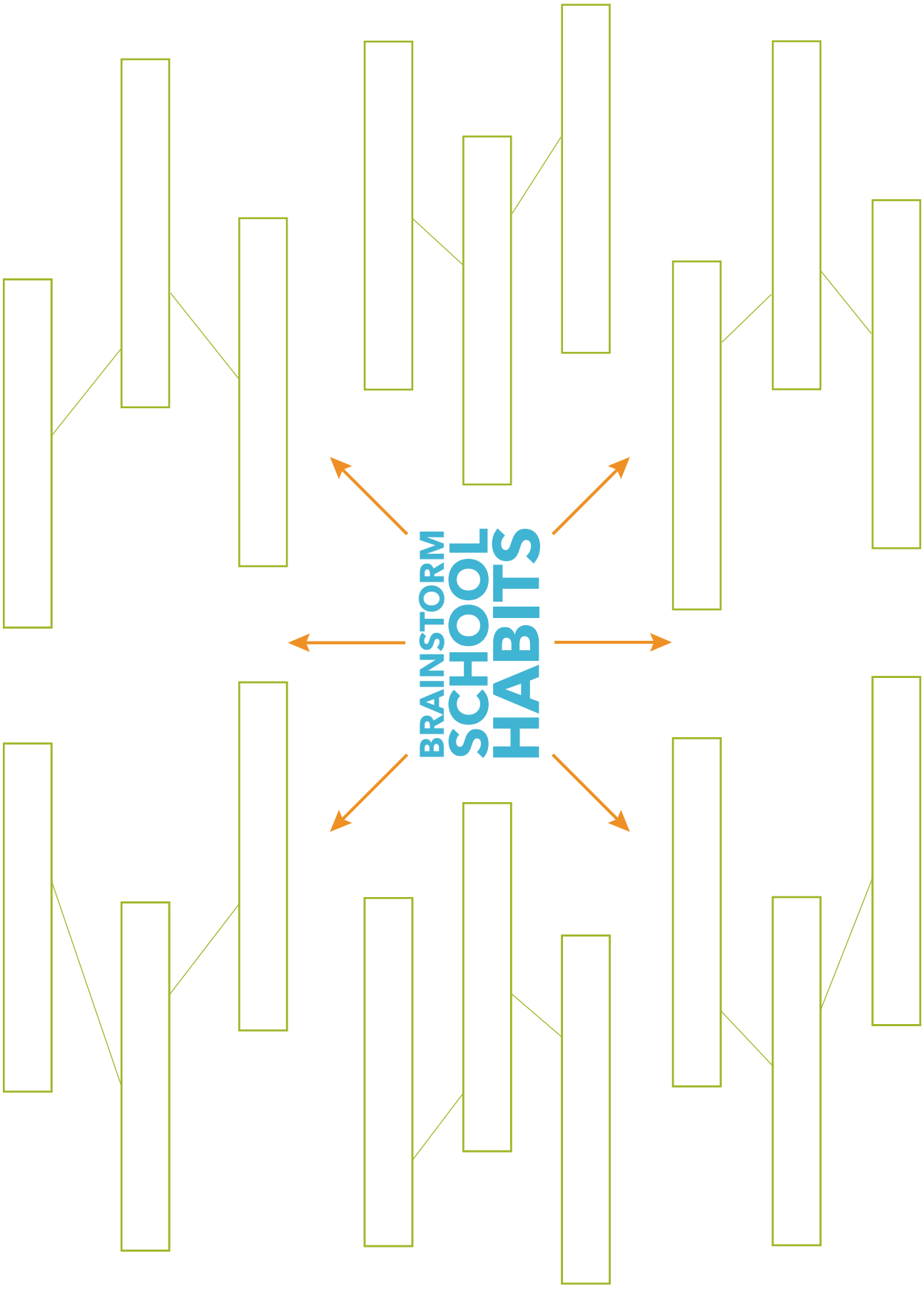
1.	6.
2.	7.
3.	8.
4.	9.
5.	10.

3. Agree on the top 5 habits. **4. Work together to define these habits.**

1.	
2.	
3.	
4.	
5.	

5. Put this activity down and return to it later.

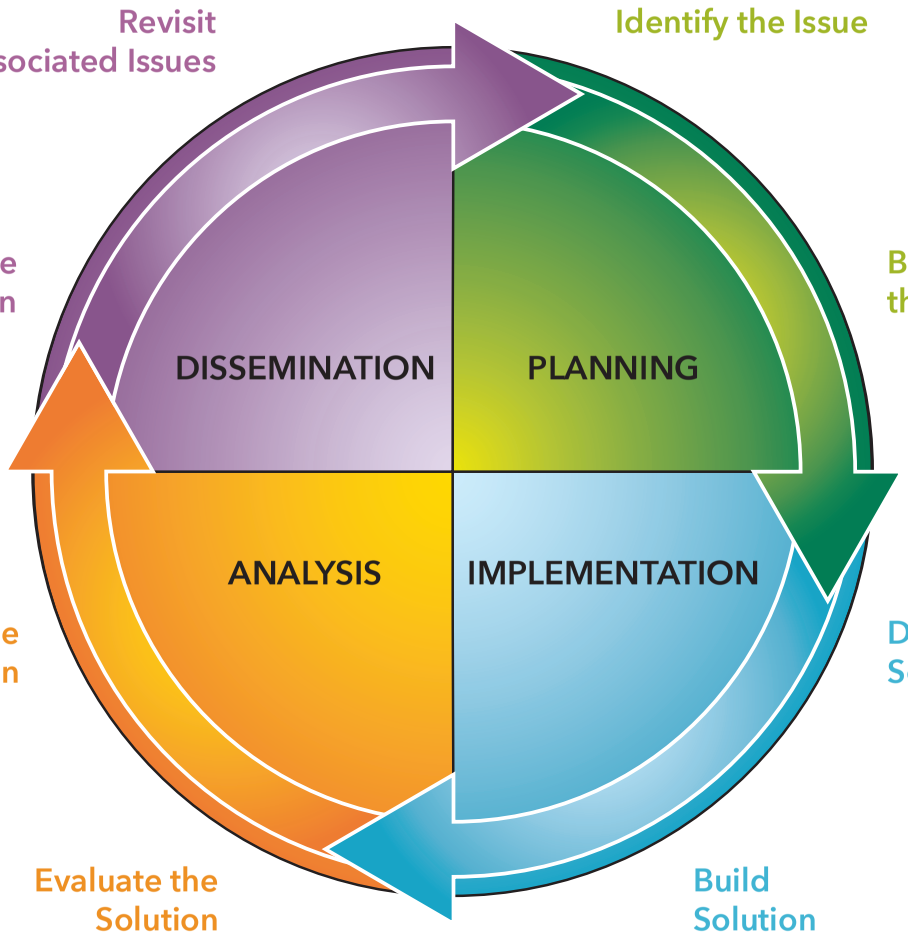
Refine the statements until they crystallize the meaning of the trait. Once your school administration and faculty have a set of School Habits, use a Visual Thesaurus with students to bring the habits in line with their age and understanding.


BRAINSTORM
SCHOOL
HABITS

DESIGN PRINCIPLES

Creating a TPBL unit is a stepped process that begins with a problem.

Dissemination shares and communicates the solutions, the successes, and the modifications to an authentic audience. This is an important skill in the design process and prepares students by building communication skills and confidence.

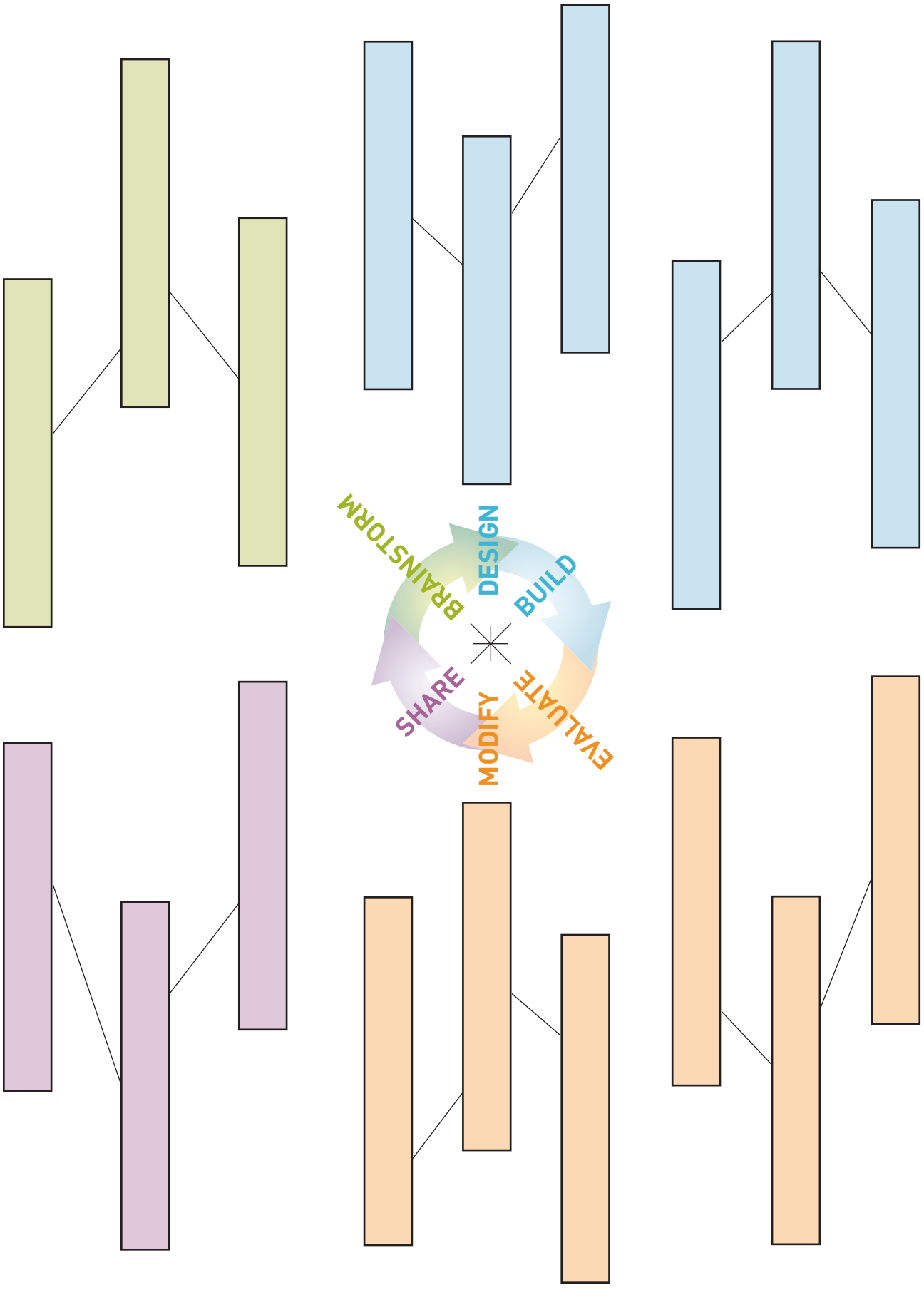


Planning identifies the issues or problems, brainstorms a project that can lead to a solution, and defines the product that represents a solution.

Analysis evaluates the solution against the criteria of the brainstorm, and reveals whether or not the solution requires modification.

Implementation designs and builds a solution to the problem or issue defined during the brainstorm.

The design cycle describes a universal process of human thinking, that helps us organize our attempts at solving problems. We all go through the process numerous times a day, but rarely articulate the steps. Use the Visual Thesaurus to create your own design cycle synonyms for the different steps within the process. What language resonates with you? What language would your students understand? Be sure to use this lexicon in your classroom as you communicate this process to your students.

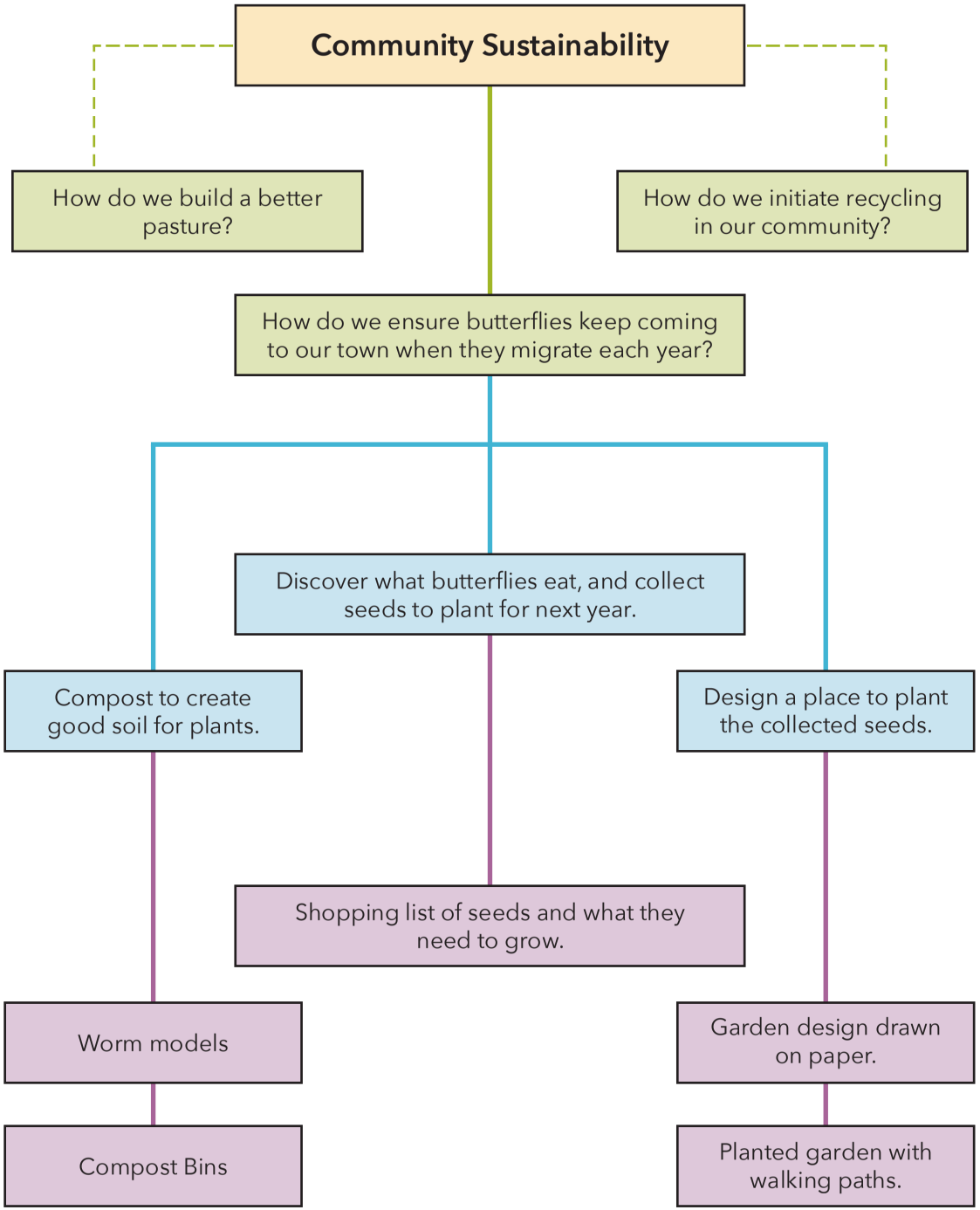

BRAINSTORM
DESIGN
BUILD
EVALUATE
MODIFY
SHARE

Theme refers to an overarching issue that contains many inter-related problems.

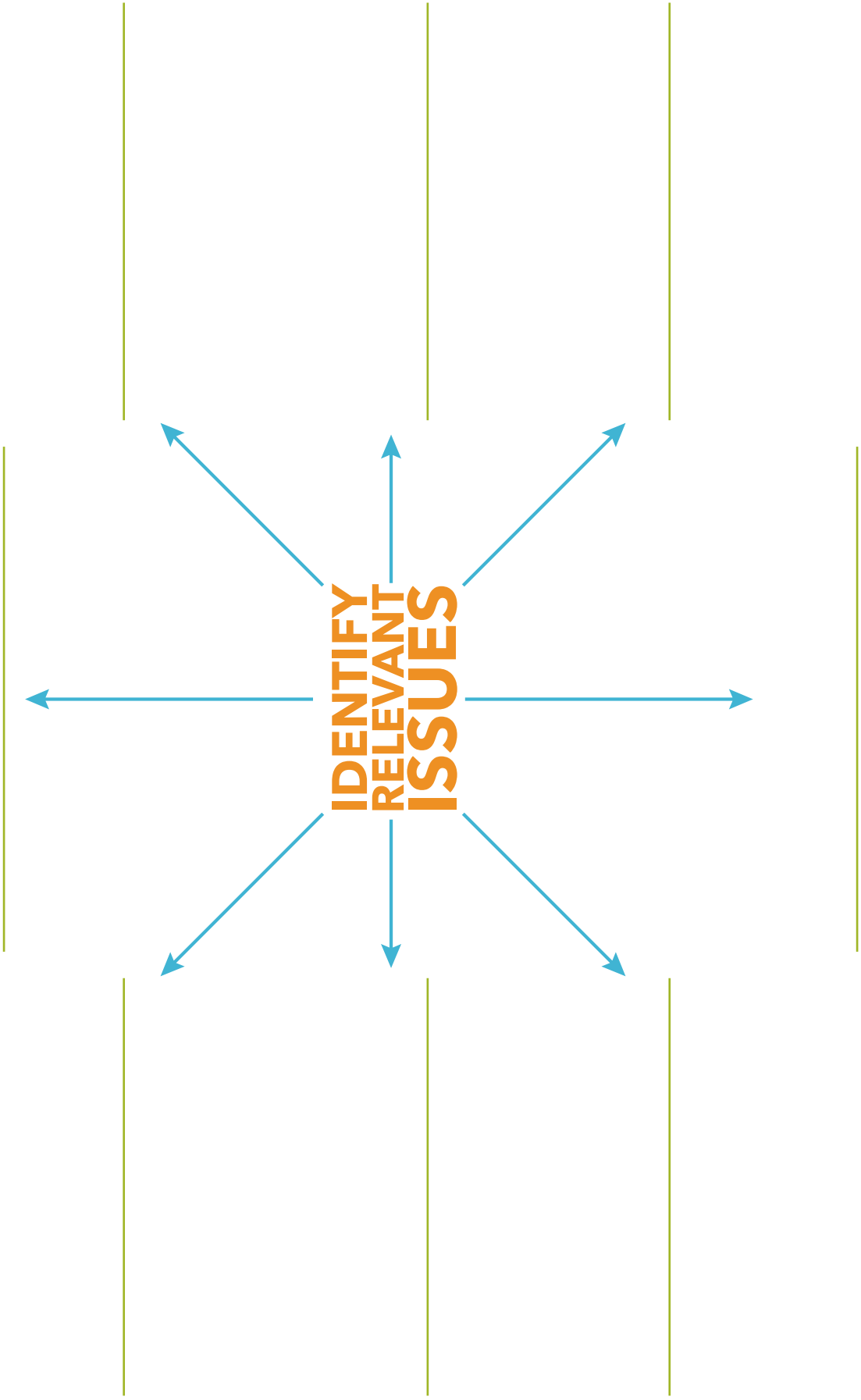
Problems (also called questions or issues) define the specific focus that relates to the theme and generates numerous projects within each content area. Stating the problem answers the question "why do this?", which brings relevance and rigor to projects.

Projects provide the hands-on learning in the classroom. Projects contain activities that provoke questions and lead to the information-gathering, designing, building, and evaluating needed to solve the problem and test the solution. Project planning allows teachers and students to manage time and assess progress. Projects define how students get to a solution, which is critical to problem solving and just as important as the answer.

Products provide the evidence of learning, detailing the learned concepts that each student has acquired and how they got to the solution. They are the tangible objects created within a project.



Theme and projects developed at Platte Elementary School, South Dakota.


IDENTIFY
RELEVANT
ISSUES

Question Development is not linear. There are many paths to planning all the parts of STEM TPBL.

This semester's theme is conservation

Theme

I have a lot of cardboard and boxes. The students can build a model

Usually for chemistry I do an absorption lab

Problem

We need to study slope, ramps would be a good way to do it

How can my students raise awareness about oil spills in residential neighborhoods?

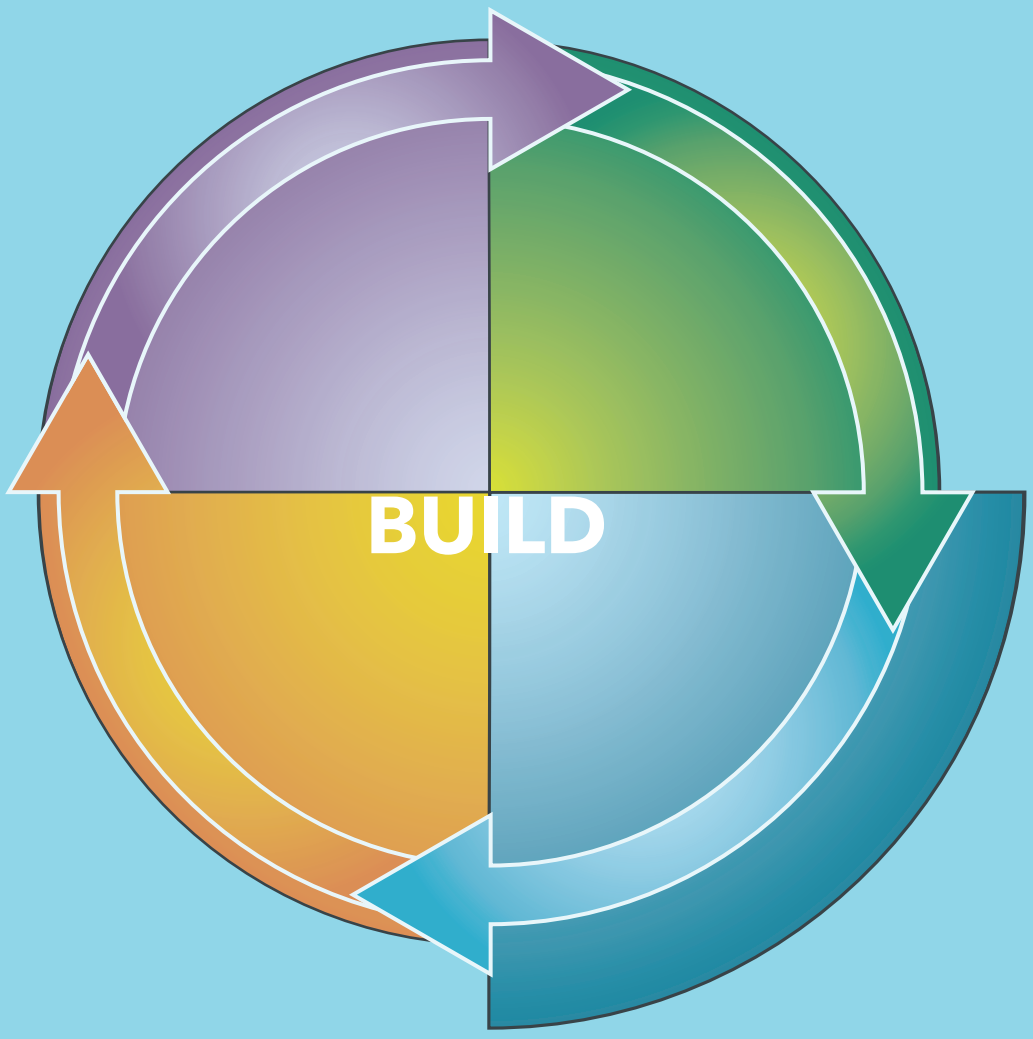
Project

I saw a news piece on the lack of ramps around town

The students can design and build a TV ad selling their absorption product

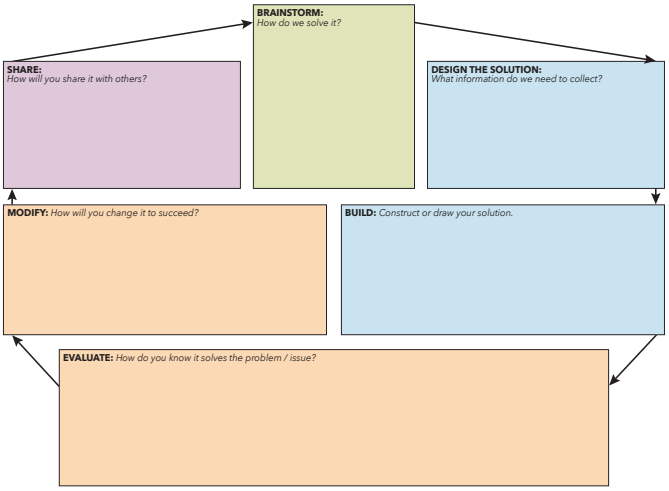
Product

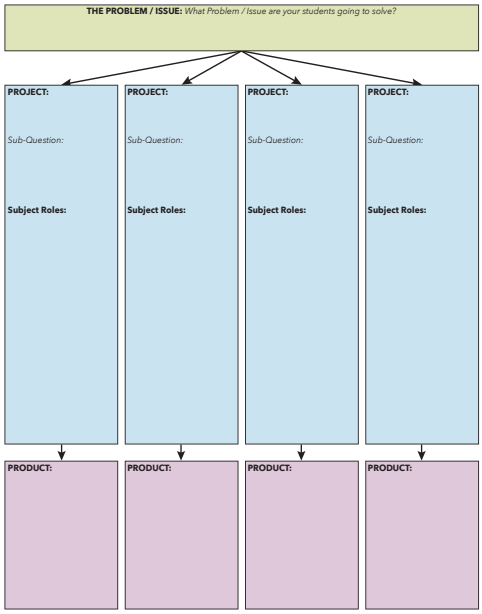
This fits into our community improvement theme for the quarter


BUILD

Using a replicable process, there are a series of templates that help administrators and teachers form foundational ideas for planning.

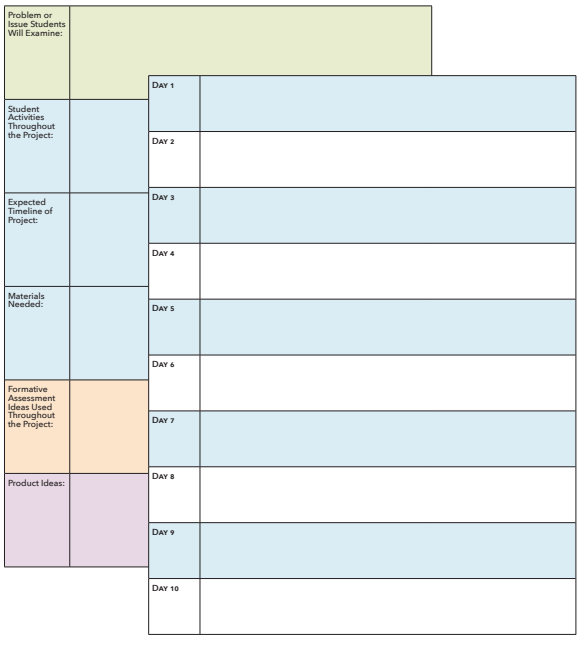
The **Design Process** articulates design principles that are universal to human thought. Articulating parts of design in each and every project helps students understand the parts of critical thinking and how those parts are integral to all problem solving. Giving students the tools to dissect a problem empowers them to take on all problems.



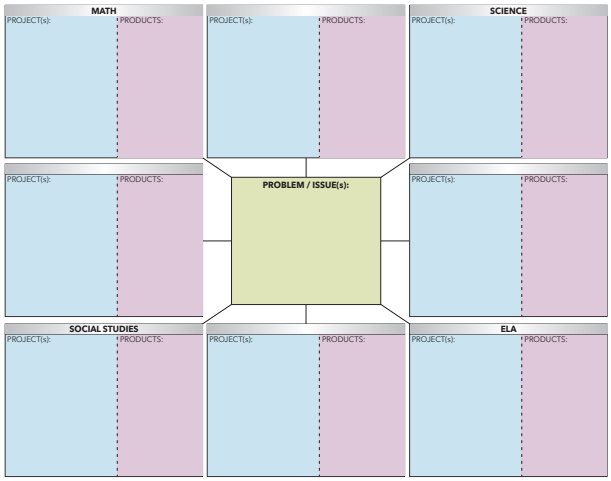


The **Graphic Organizer** helps in planning an entire quarter or a series of projects, in a single two-week period. The organizer helps define how a problem can be addressed through different projects and students can demonstrate their learning through a variety of products.

The **Two-Week Planner** is a management tool that helps track progress, define needed resources, and document product ideas. It is a great tool for administrators to use for managing resource acquisition, monitoring progress, and assessing rigor. Posting Two-Week Planners is a great mechanism for informing all stakeholders of the process, scope, and pace.

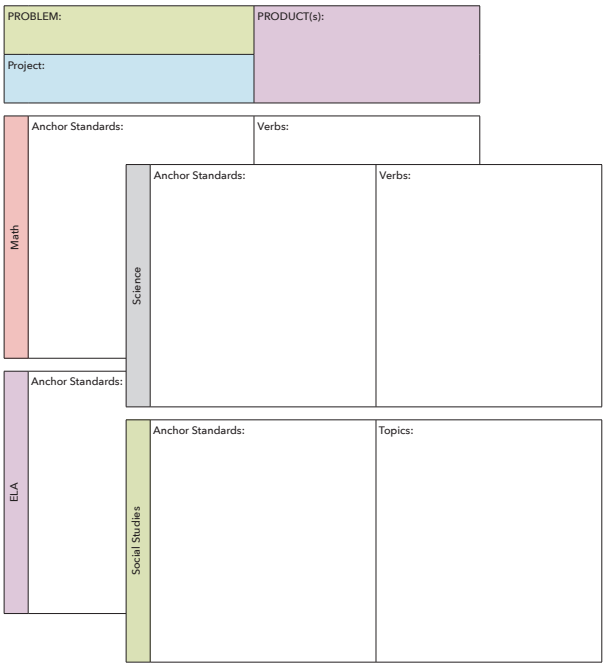


Among the forms for planning rigorous and relevant projects that address real world issues are a series of ways to benchmark work against established standards. Projects and products can be benchmarked by state standards, Common Core standards, and Next Generation Science standards. Which standards are used is up to district and state mandates. The forms exist to help teachers better understand the process of aligning lessons with existing benchmarks and understanding how to consistently define mastery of concepts.



The **Content Breakout Organizer** helps articulate how different content areas are going to integrate learning by addressing the same problem. It is a snapshot of numerous projects that are examining the same problem through different lenses.

The **Content Alignment Organizer** helps us understand what it looks like to master a specific standard by aligning the verbs of the standards and their specific component parts. The verb defines what mastery looks like. For example, the 6th grade anchor standard, Reading Literature, defines grade level mastery with X components expecting students to be able to X, Y, Z.



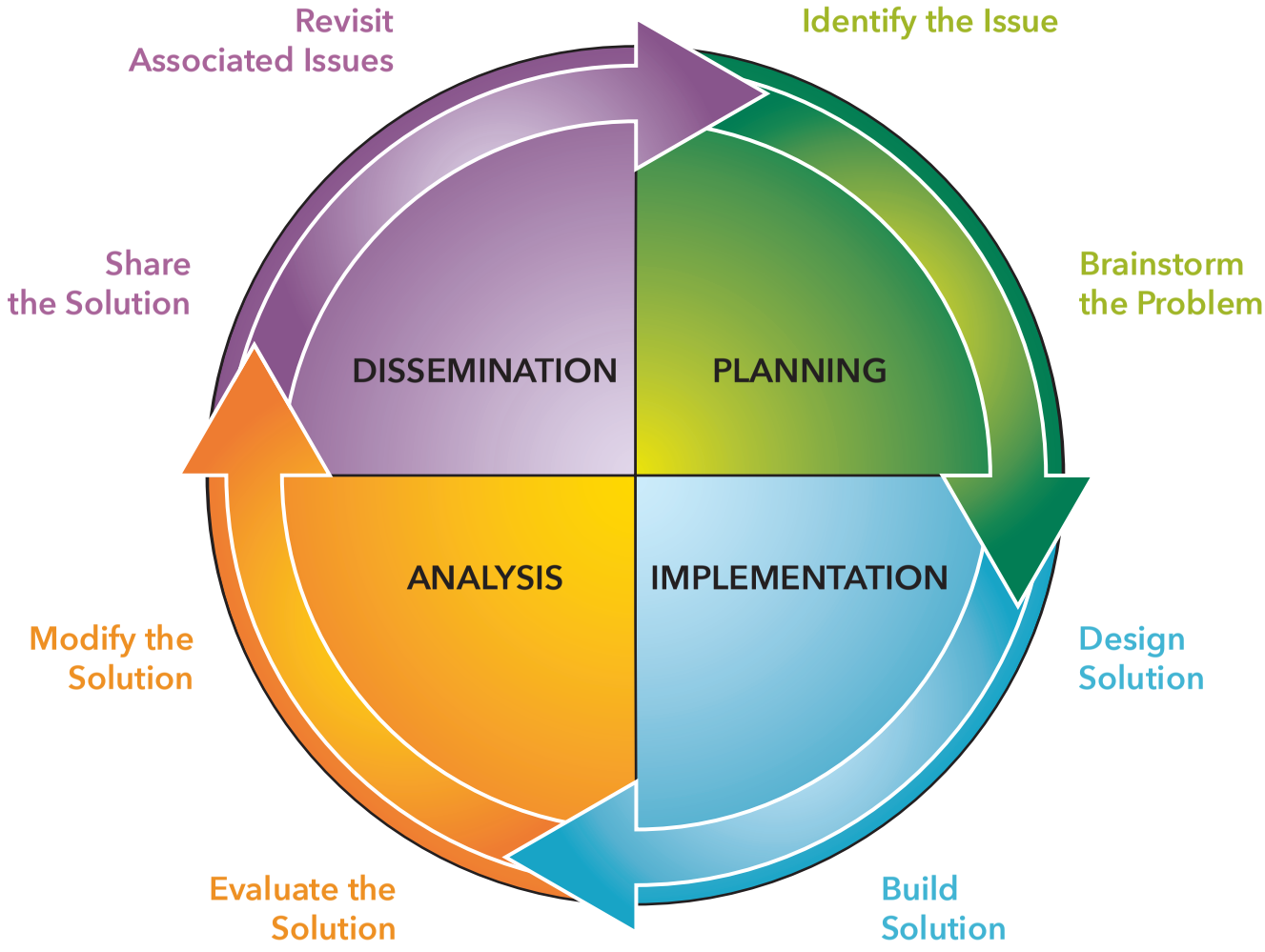
PRODUCT:

Length / Size
☐
☐
☐
☐
☐
Organization & Layout
☐
☐
☐
☐
☐
☐
☐
Materials / Resources
☐
☐
☐
☐
☐
☐
☐
☐
Engagement
☐
☐
☐
☐
☐
Other
☐
☐
☐
☐
☐

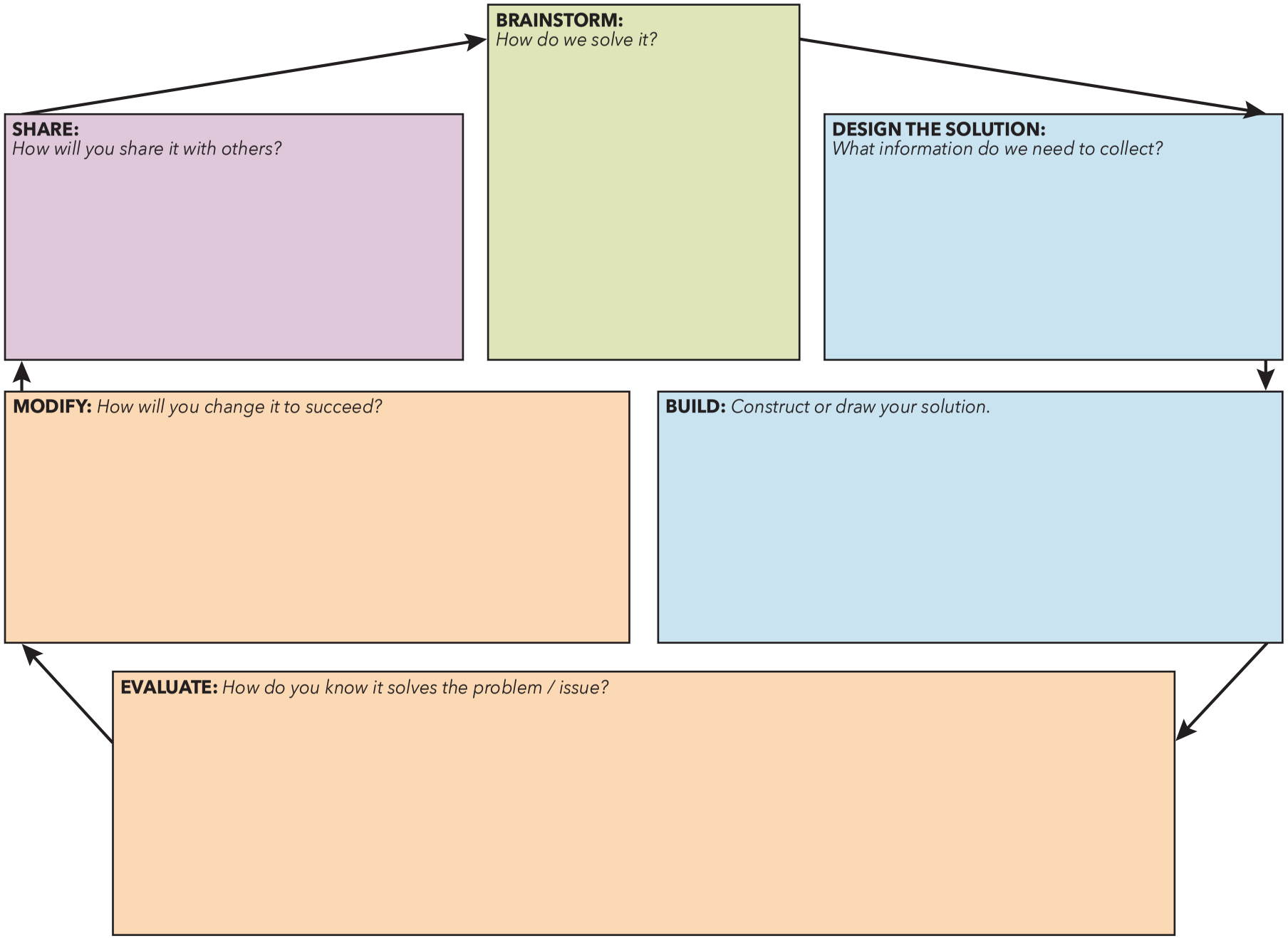
A **Product Criteria Rubric** defines what a good product looks like. Teachers and students can build the rubric together. The fact that students have a say in building the criteria sets the stage for student success. After all, if you are the one who defines what a good product looks like then you are capable of creating that product.

WHAT DO THE COLORS MEAN?

Throughout the workbook, we use the colors of the Design Cycle as a guide, representing part of the process, each element addresses. Note that some arrangements show the colors 'out of order', or skip a color entirely. This is an intentional reminder that the process is non-linear.



State the Problem / Issue: _____ **Name:** _____



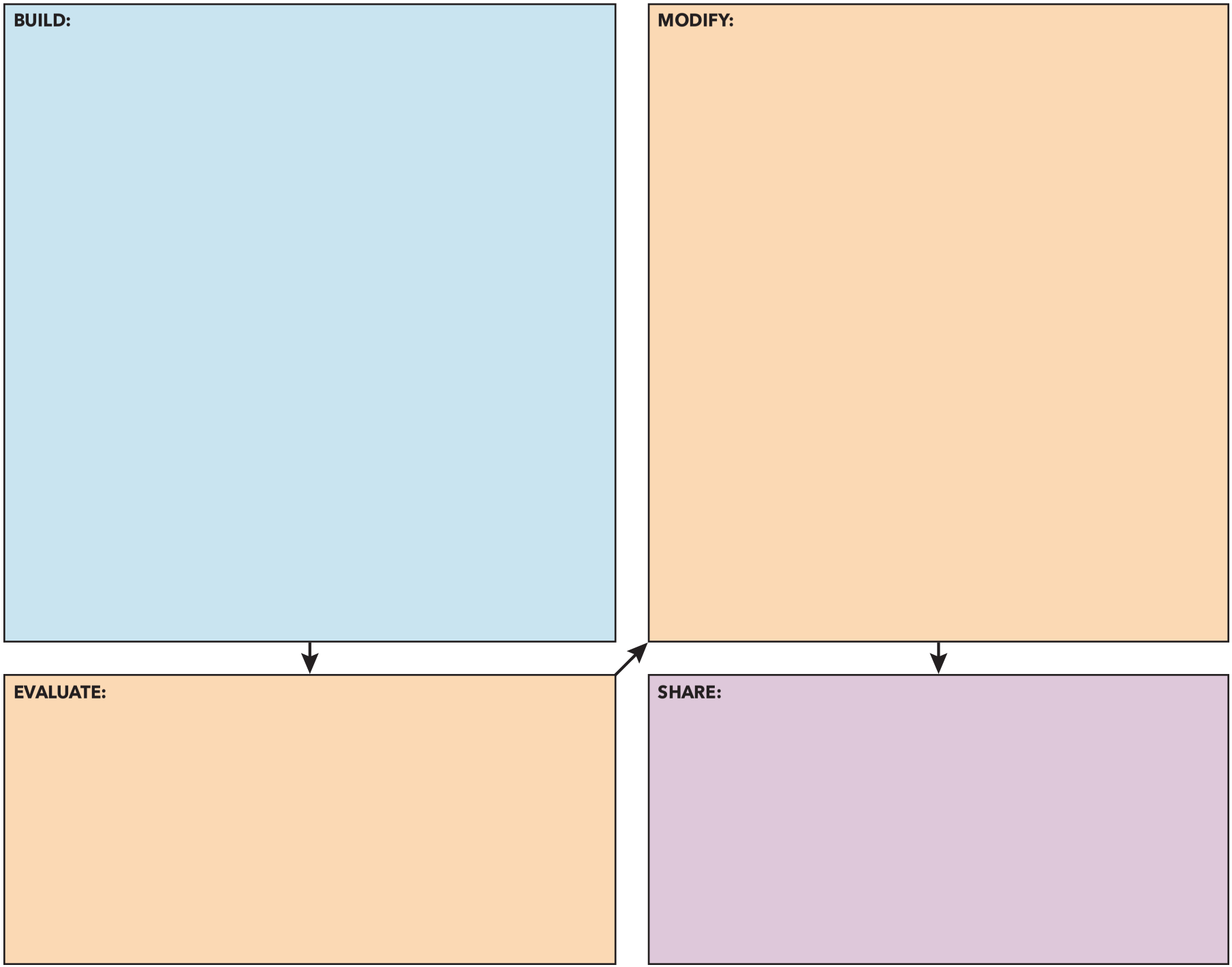
Name:
Date:
Period:

Materials:

DESIGN:

PROBLEM / ISSUE SCENARIO:

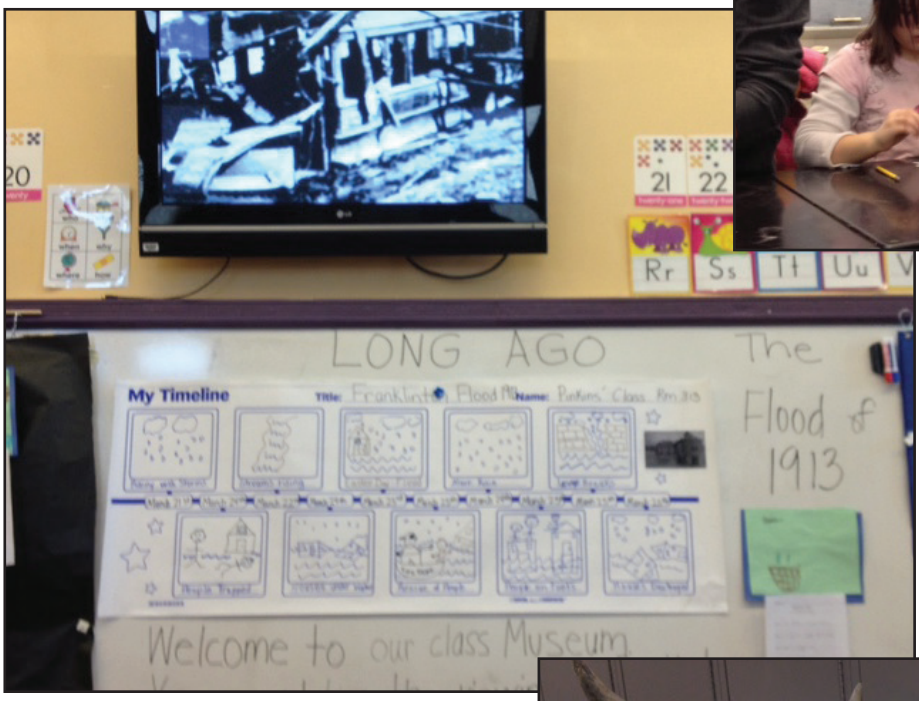
BRAINSTORM:


BUILD:
MODIFY:
EVALUATE:
SHARE:

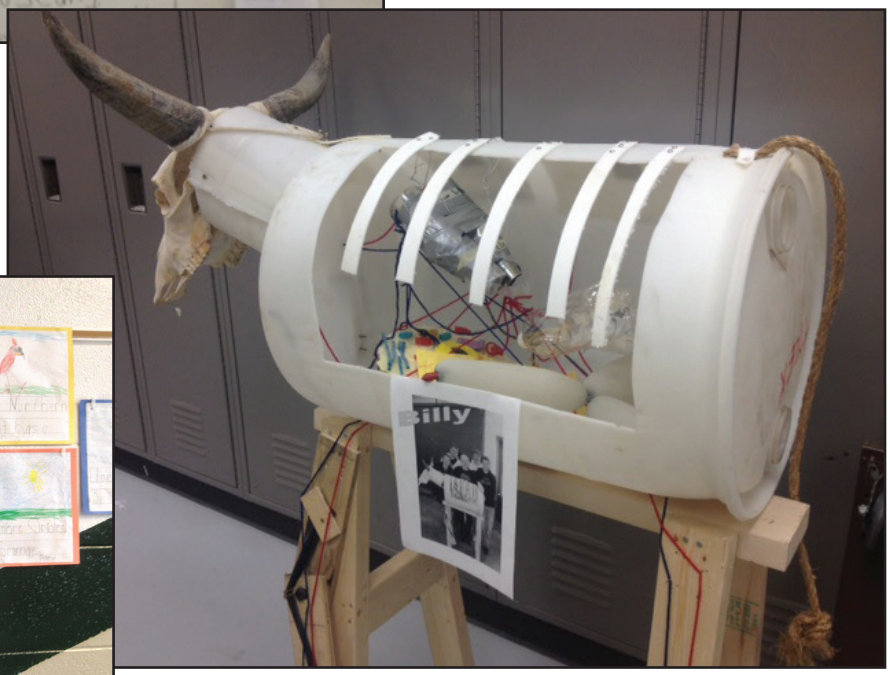
	Verbal	Visual	Logical	Audio/Musical
Types of Products	Advertisement Annotated bibliography Bulletin board Code Comic strip Debate Demonstration Diary Editorial Essay Fairy tale Family tree Fiction story Interview Jingle Joke book Journal Lesson Letter Letter to the editor Newspaper story Nonfiction Oral defense Oral report Pamphlet Petition Play Poem Press conference Radio program Riddle Science fiction story Skit Slogan Soliloquy Story telling TV program Write a new law	Animated movie Art gallery Bulletin board Bumper sticker Cartoon Chart Clay sculpture Collage Costumes Demonstration Diorama Display Etching Film Filmstrip Flipbook Game Graph Hidden picture Illustrated story Maze Mobile Model Mosaic Mural Painting Papier mache Photo essay Picture story for children Pictures Play Political cartoon Pop-up book Prototype Rebus story Slide show Story cube Transparencies Travel brochure TV program Web home page	Advertisement Annotated bibliography Chart Code Collage Collection Computer program Crossword puzzle Database Debate Demonstration Detailed illustration Edibles Experiment Fact tile Family tree Game Graph Hidden picture Labeled diagram Large-scale drawing Lesson Map with legend Mazes Mobile Model Petition Play Prototype Puzzle Recipe Riddle Survey Time line Transparencies Venn digram Working hypothesis Write a new law	Audio-video tape Choral reading Fairy tale Film Instrumental Jukebox Musical Poem Rap song Riddle Role playing Song Sound

Products can vary even within a single project. Although summative assessments are essential, they are not the only means of demonstrating mastery. Asking students to explore varied ways of presentation engages all students in learning. Displaying all student work is key to enable learning.

Starling Middle School students engaged



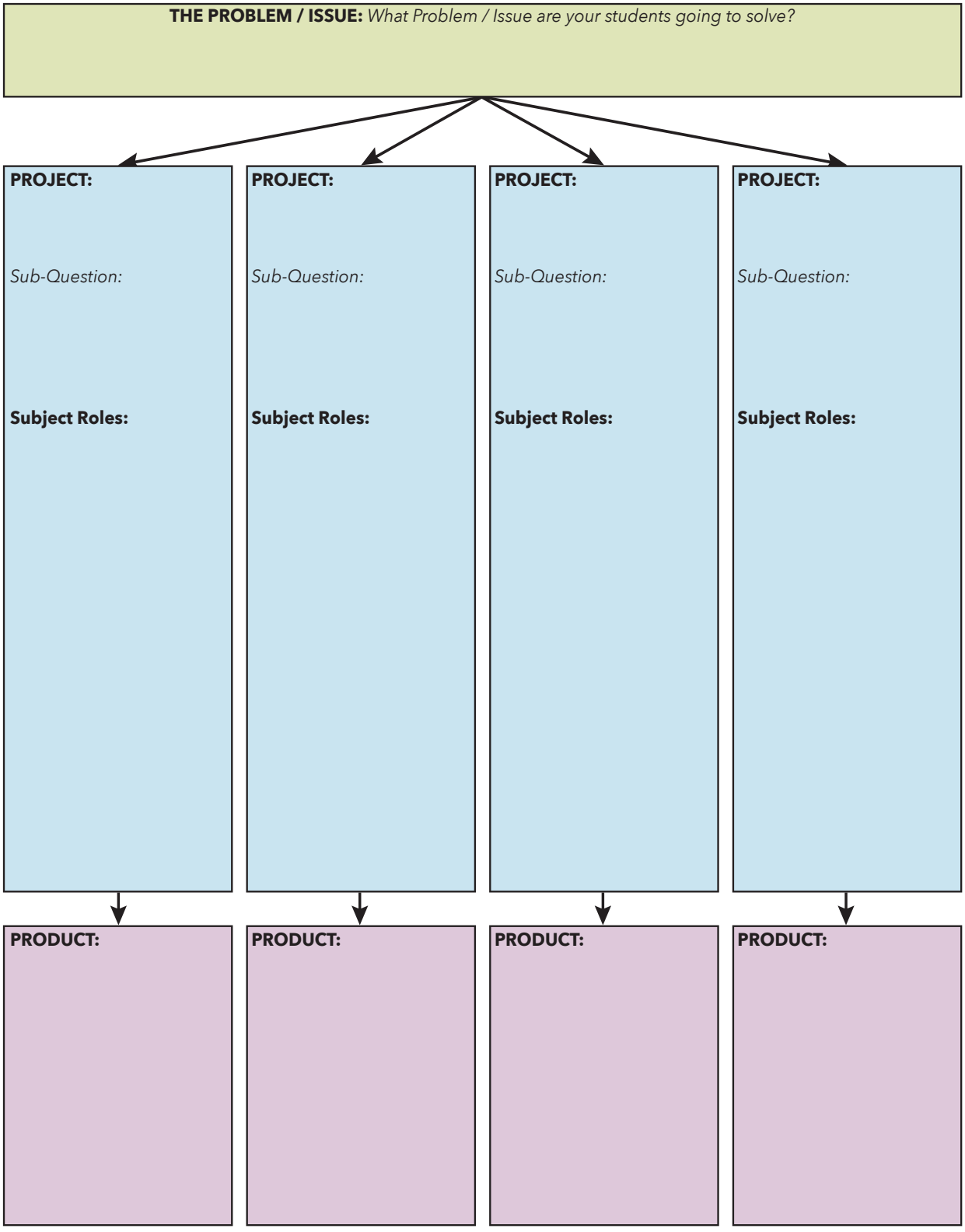
Avondale Elementary show of multimedia use

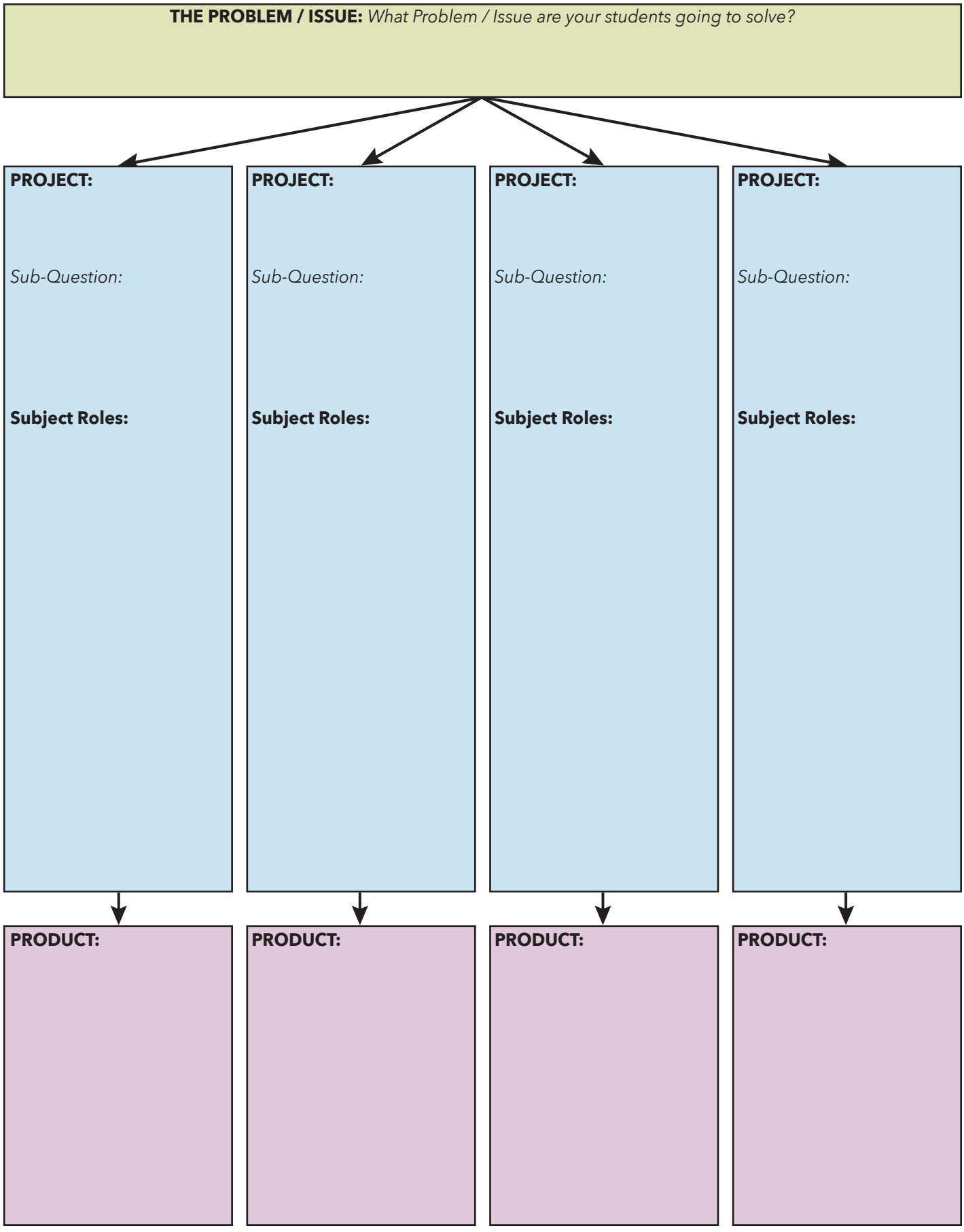


Platte-Geddes 7th grade "Better Cow" model

Armour Kindergarten show of birds

There are many ways to plan. The graphic organizer is a versatile form that enables teachers to plan, in a number of ways. The template that can be used to plan out projects for elementary grades (delineating the different content roles), or it can be used by a cohort of teachers demonstrating how the various content areas will work together in a project or series of projects.




THE PROBLEM / ISSUE: What Problem / Issue are your students going to solve?
PROJECT:
Sub-Question:
Subject Roles:
PROJECT:
Sub-Question:
Subject Roles:
PROJECT:
Sub-Question:
Subject Roles:
PROJECT:
Sub-Question:
Subject Roles:
PRODUCT:
PRODUCT:
PRODUCT:
PRODUCT:

When solving real problems we can approach them through different content lenses. Real-world problem-solving isn't divided into subject areas and neither is our toolbox. Sometimes in defining a problem, we are inspired by a content area, or a product we want to build, or a project that excites us. No matter what brings you to your defined problem, other content areas can contribute to the solution, or inspire a separate but connected project that solves the problem in a slightly different way. Creativity and thinking outside the usual pace and structure of your class is important in this step of the planning process.

MATH	
PROJECT(s):	PRODUCTS:
Develop & implement an opinion poll. Analyze data, breaking down population and voting percentages.	• Survey • Graphs

SCIENCE	
PROJECT(s):	PRODUCTS:
Research energy & environmental impact of policies What constitutes life? What definitions exist? Understand extent of drilling's effect on the water cycle.	• Fact cards for debate • Bibliography sources • Posters of science facts

PROBLEM / ISSUE(s):

What candidate should I vote for?

What are their positions on topics we care about?

SOCIAL STUDIES	
PROJECT(s):	PRODUCTS:
Research election laws & procedures. Explore debate tactics (historic & current). Study effects of government policy on local communities.	• Debate

ELA	
PROJECT(s):	PRODUCTS:
Learn research methods. Write an opinion paper based on facts. Create political commercial.	• Note cards • Formal report • Text for posters • Political podcast • Video advertisement

Content adapted from problems and projects to address voting issues at West High School, Columbus Ohio.

SCIENCE

PRODUCTS:

PROJECT(s):

PRODUCTS:

PROJECT(s):

ELA

PRODUCTS:

PROJECT(s):

PRODUCTS:

PROJECT(s):

PROBLEM / ISSUE(s):

PRODUCTS:

PROJECT(s):

MATH

PRODUCTS:

PROJECT(s):

PRODUCTS:

PROJECT(s):

SOCIAL STUDIES

PRODUCTS:

PROJECT(s):

Problem or Issue Students Will Examine:	
Student Activities Throughout the Project:	
Expected Timeline of Project:	
Materials Needed:	
Formative Assessment Ideas Used Throughout the Project:	
Product Ideas:	

What wicked problem will students attempt to solve?

What activities and mini projects will lead students to their final demonstration of learning?

How do we assess that students have mastered the standards aligned to projects & products?

What is the end goal for students to show mastery of content? How does this connect to the original problem?

Day 1	Brainstorm / Build rubric
Day 2	
Day 3	
Day 4	
Day 5	
Day 6	
Day 7	
Day 8	Evaluation
Day 9	Modify
Day 10	Presentation to Authentic Audience

When will you create opportunities for formative feedback throughout the project to check for student understanding?

Creative incremental checkpoints throughout the life of a project are crucial in real time course correction, and informs the next steps in teaching and learning.

How do we design a project that builds on itself?

STEP 1: TWO-WEEK PROJECT PLANNER

NAME(s): SUBJECT(s):

Problem or Issue Students Will Examine:	
Student Activities Throughout the Project:	
Expected Timeline of Project:	
Materials Needed:	
Formative Assessment Ideas Used Throughout the Project:	
Product Ideas:	

NAME(s): SUBJECT(s):

DAY 1	
DAY 2	
DAY 3	
DAY 4	
DAY 5	
DAY 6	
DAY 7	
DAY 8	
DAY 9	
DAY 10	

Standards are the benchmarks by which we measure the rigor of projects. Including standards from multiple content areas helps students view problems through numerous lenses to make projects more robust.

At this point in your project development, you may add or alter activities slightly to align better with certain standards or to include additional standards. Remember, TPBL is an agile process that can expand or contract.

Traditional textbook-paced delivery often begins with standards, and then builds projects. This is limiting in two ways. First, most projects conceived this way are limited in what they can achieve, not allowing students to stretch beyond the minimum expectations. Second, they are often implemented without a clear problem driving the project.

However, if you begin with the project, attaching problem and product before aligning standards, the project has the potential to reach beyond the minimum expectation of students. By planning this way, teachers often find they hit standards within and above their grade level, as well as standards from across the Common Core and Next Generation Science Standards.

As you identify the standards you plan to address through the project, decide whether you will address each standard at the vocabulary, compare/contrast, or synthesis level of understanding. Use short cycle assessments to ask standards-based questions across all three levels of understanding. It is important to use standards-based questions that speak to the concept but not necessarily the project. This will help you ascertain mastery across an array of standards.

High School Next Generation Life Sciences				
Grades 9-12				
ANCHOR STD				
From Molecules to Organisms: Structures and Processes	•**Construct** an explanation based on evidence for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells.	•**Develop and use** a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms	•**Plan and conduct** an investigation to provide evidence that feedback mechanisms maintain homeostasis.	•**Use a model to illustrate** the role of cellular division (mitosis) and differentiation in producing and maintaining complex organisms.
Ecosystems: Interactions, Energy, and Dynamics	•**Develop a model to illustrate** the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere.	•**Evaluate** the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organism in stable conditions, but changing conditions may result in a new ecosystem.	•**Design, evaluate, and refine** a solution for reducing the impacts of human activities on the environment and biodiversity.	•**Evaluate** the evidence for the role of group behavior on individual and species' chances to survive and reproduce.
Biological Evolution: Unity and Diversity	•**Communicate** scientific information that common ancestry and biological evolution are supported by multiple lines of empirical evidence.	•**Construct** an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment.	•**Evaluate** the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species.	•**Create or revise** a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

National Common Core Language Arts Standards

Grades 10

Common Core Requirements	Theme	10
Speaking and Listening	Comprehension and Collaboration	•**Initiate** and participate effectively in a range of group discussions with diverse partners on grades 9-10 topics, texts, and issues, building on others' ideas and expressing their own clearly and persuasively
		•**Integrate** multiple sources of information presented in diverse media or formats evaluating the credibility and accuracy of each source
		•**Evaluate** a speaker's point of view, reasoning, and use of evidence and rhetoric, identifying any fallacious reasoning or exaggerated or distorted evidence
	Presentation of Knowledge and Ideas	•**Present** information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task
		•**Make** strategic use of digital media in presentations to enhance understanding of findings, reasoning, and evidence and to add interest
		•**Adapt** speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate
	tions of l English	•**Demonstrate** command of English grammar and usage

National Common Core Math Standards

Algebra I and II

Common Core Math Standards	Algebra II
Interpreting Categorical & Quantitative Data	**Summarize, represent, and interpret** data on a single count or measurement variable
Arithmetic with Polynomials & Rational Expressions	**Understand** the relationship between zeros and factors of polynomials
Quantities	
Seeing Structure in Expressions	Interpret the structure of expressions.
Creating Equations	Create equations that describe numbers or relationships
Reasoning with Equations & Inequalities	Understand solving equations as a process of reasoning and explain the reasoning
The Real Number System	
Complex Numbers	**Use** complex numbers in polynomial identities and equations
Trigonometric Functions	**Extend** the domain of trigonometric functions using the unit circle
Making Inferences, Justifying Conclusions	**Make inferences and justify conclusions** from sample surveys, experiments, and observational studies
Vector and Matrix Quantities	

National Common Core Standards- Math

National Common Core Math Standards

Geometry

Common Core Math Standards	Geometry
Measurement and Data	**Use** probability to evaluate outcomes of decisions
Congruence	**Experiment** with transformations to the plane
Similarity, Right Triangles, Trigonometry	**Prove** theorems involving similarity
Modeling with Geometry	**Apply** geometric concepts in modeling situations
Geometric Measurement & Dimension	**Visualize** relationships between two-dimensional and three-dimensional objects
Expressing Geometric Properties with Equations	**Use** coordinates to prove simple geometric theorems algebraically
Circles	**Understand and apply** theorems about circles
Conditional Probability & Rules of Probability	**Understand** independence and conditional probability and use them to interpret data

National Common Core Standards- Math

Ohio Social Studies Academic Standards

High School

	Topic		
American Government	Civic Involvement	•Opportunities for civic engagement with the structures of government are made possible through political and public policy processes.	•Political parties, interest groups and the media provide opportunities for civic involvement through various means.
	Civic Participation and Skills	•Issues can be analyzed through the critical use of information from public records, surveys, research data and policy positions of advocacy groups.	•The processes of persuasion, compromise, consensus building and negotiation contribute to the resolution of conflicts and differences.
	Basic Principles of the U.S. Constitution	•As the supreme [illegible] of the land, the U.S. Constitution incorporates basic principles which help define the government of the United States as a federal republic including its structure, powers and relationship with the [illegible]	•Constitutional government in the United States has changed over time as a result of amendments to the U.S. Constitution, Supreme Court decisions, legislation and informal practices.
	Structure and Functions of the Federal Government	• Law and public policy are created and implemented by three branches of government; each functions with its own set of powers and responsibilities.	• The political process creates a dynamic interaction among the three branches of government in addressing current issues.
	Role of the People	•In the United States, people have rights which protect them from undue governmental interference. Rights carry responsibilities which help define how people use their rights and which require respect for the rights of others.	•Historically, the United States has struggled with majority rule and the extension of minority rights. As a result of this struggle, the government has increasingly extended civil rights to marginalized groups and broadened [illegible] for participation.
	Ohio's State and Local Governments	• As a framework for the state, the Ohio Constitution complements the federal structure of government in the United States.	•Individuals in Ohio have a responsibility to assist state and local governments as they address relevant and often controversial problems that directly affect their communities.
	Public Policy	•A variety of entities within the three branches of government, at all levels, address public policy issues [illegible]	• Individuals and organizations play a role within federal, state and local governments in helping to determine

Example Alignment: Standards shown here are aligned with the West High School "Who should I vote for?" problem outlined in the examples on pages 30, 39 & 47.

STANDARDS VERBS LIST

Grades K-5 Common Core & Next Gen Standards Verbs				Grades 6-12 Common Core & Next Gen Standards Verbs		
ELA	Math	Science		ELA	Math	Science
Understanding	Represent	Make Observations		Analyze	Solve	Use
Read	Understand	Construct		Determine	Understand	Develop
Write	Solve	Describe		Develop	Interpret	Construct
Demonstrate	Recognize	Plan & Conduct		Research	Relationships	Describe
Clarify	Interpret	Analyze		Clarify	Find	Evaluate
Develop	Find	Determine		Write	Graph	Illustrate
Produce	Explain	Design		Relationships	Represent	Support
Relationships	Compare	Ask		Demonstrate	Apply	Apply
Describe	Describe	Develop		Understanding	Describe	Conduct
Compare/Contrast	Write	Represent		Create	Explain	Design
Explain	Identify	Use Evidence		Read	Prove	Analyze & Interpret
Answer	Understanding	Interpret		Evaluate	Write	Plan
Introduce	Divide	Compare		Reflection	Compare/Contrast	Analyze
Sequence	Determine	Use Tools/ Materials		Read/Comprehend	Recognize	Determine
Produce	Graph	Define		Introduce	Evaluate	Provide Evidence
Determine	Apply	Identify		Produce	Determine	Revise
Accurately	Sequence	Use Model		Organize	Identify	Refine
Read/Comprehend	Read	Support		Point of View	Compute	Communicate
Point of View	Answer	Develop Model		Apply	Develop	Ask
Apply	Create	Obtain Information		Compare/Contrast	Produce	Create
Research/Projects	Justify	Obtain & Combine		Explain	Inference	Test
Create	Analyze	Generate & Compare		Inference for text	Analyze	Present
Decode	Develop	Predict		Sequence	Sequence	Compare
Reflection	Compute	Apply		Identify	Divide	Develop Model
Retell	Relationships	Measure		Solve	Calculate	Predict
Recall	Define	Read		Projects	Decide	Provide Explanation
Sequences	Evaluate	Use & Share		Answer	Define	Interpret
Inferences	Produce	Communicate		Sequences	Answer	Gather Information
Identify	Calculate	Use Observations		Accurately	Create	Integrate
Collaborate	Sequence	Claim		Interpret	Verify	Modify
Organize	Organize	Illustrate		Coolaborate	Sequences	Define
Ask/Answer		Solve		Reflection	Justify	Generate
Short Research		Plan & Conduct		Describe	Read	Calculate
Interpret					Understanding	Clarify
Know & Use					Reflection	Defend
Analyze						Model
Solve						

Verbs listed are ordered by frequency of occurrence in Common Core and Next Generation Science Standards.

PROBLEM: What candidate should I vote for?	**PRODUCT(S):**
PROJECT(S): • Quantify a communities' beliefs • Convince people to vote a certain way • Research environmental impact • Explore debate tactics	• Graphs of facts • Note sheets / TV Ad / Paper • Debate • Note cards • Bibliography • Discussions

MATH	Anchor Standards: Measurement and data Interpreting categorical and quantitative data Conditional probability & rules of probability Making inferences, justifying conclusions	Verbs: Evaluate Summarize, Represent & Interpret Understand & Interpret Make inferences & Justify
ELA	Anchor Standards: Comprehension & collaboration Presentation of knowledge & ideas.	Verbs: Initiate Integrate Evaluate Present Make Adapt
SCIENCE	Anchor Standards: Earth's place in universe Earth's systems Earth & human activity Ecosystems: interactions, energy, & dynamics Biological evolution: unity & diversity	Verbs: Evaluate Apply Develop Construct Analyze Describe with a model Create Represent Refine Revise Defend
SOCIAL STUDIES	Anchor Standards: American government Civic involvement Civic participation & skills Principles of the US Constitution Structure of the federal government Role of the people Public policy Government & Economy	Topics: Citizenship Process of involvement Historical perspective Effect of government policies Negotiation & compromise

PROBLEM:	**PRODUCT(S):**
PROJECT:	

MATH	Anchor Standards:	Verbs:

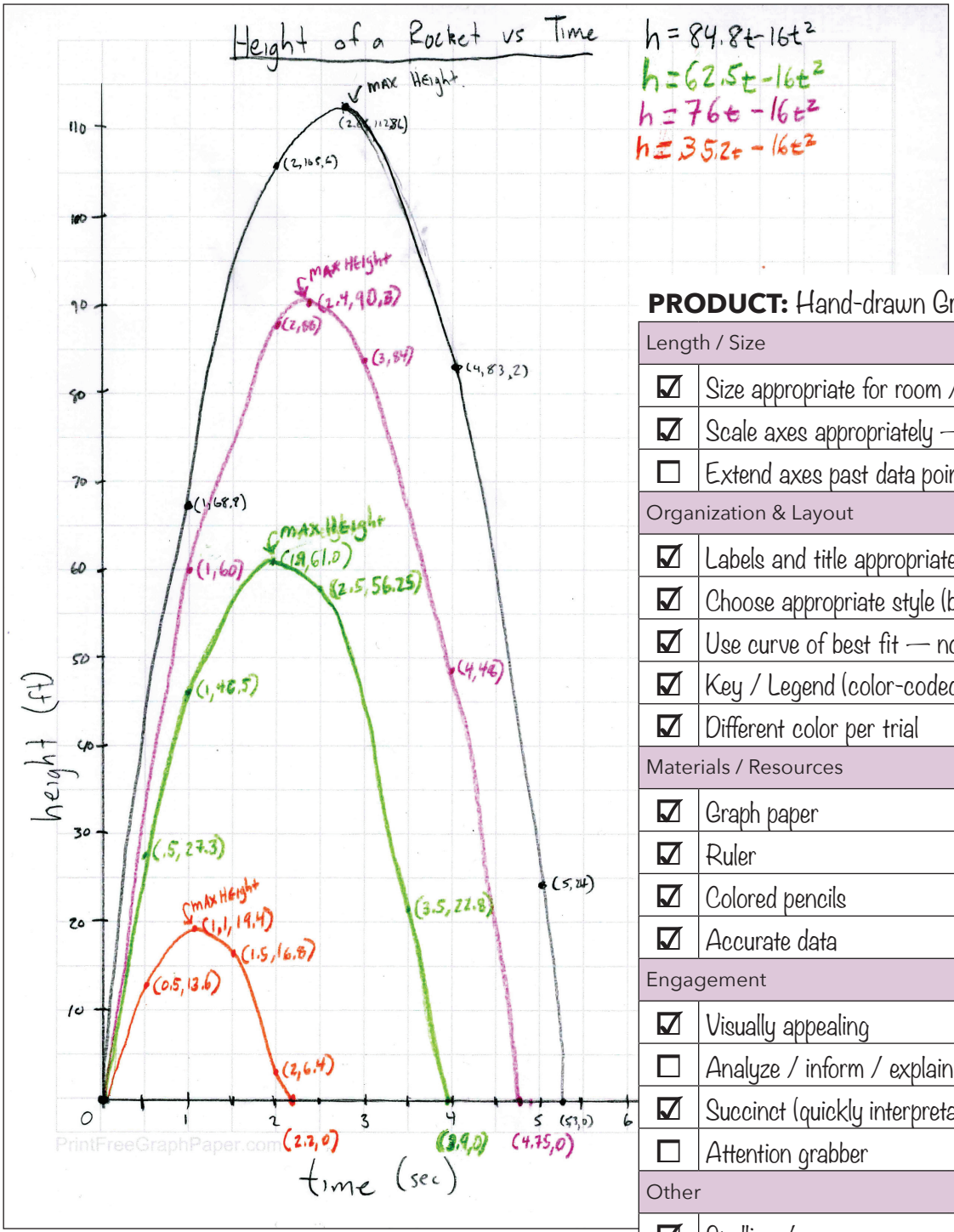
ELA	Anchor Standards:	Verbs:

PROBLEM:	**PRODUCT(S):**
PROJECT:	

SCIENCE	Anchor Standards:	Verbs:

SOCIAL STUDIES	Anchor Standards:	Topics:

Criteria for products create clear sets of specific expectations. Well-defined criteria articulate requirements, but do not force conformity in arriving at the product. Even though criteria can naturally be used to develop a rubric, they differ significantly. Criteria does not give a grading scale for various levels of completion and quality, it simply identifies what is expected for mastery.



Criteria applied to 9th-grade student rocket graph at Linden McKinley STEM Academy, Columbus Ohio.

PRODUCT: Hand-drawn Graph

Length / Size	
☑	Size appropriate for room / audience
☑	Scale axes appropriately — divisions, white space
☐	Extend axes past data points / white space
Organization & Layout	
☑	Labels and title appropriate (include units)
☑	Choose appropriate style (bar / line / pie) to fit into
☑	Use curve of best fit — not connect the dots!
☑	Key / Legend (color-coded)
☑	Different color per trial
Materials / Resources	
☑	Graph paper
☑	Ruler
☑	Colored pencils
☑	Accurate data
Engagement	
☑	Visually appealing
☐	Analyze / inform / explain data
☑	Succinct (quickly interpretable)
☐	Attention grabber
Other	
☑	Spelling / grammar
☑	Avoid breaks in graph (leads to inaccurate analysis)
☐	Extrapolation

PRODUCT:

Length / Size	
☐	
☐	
☐	
☐	
☐	
Organization & Layout	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
Materials / Resources	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
☐	
Engagement	
☐	
☐	
☐	
☐	
☐	
Other	
☐	
☐	
☐	
☐	
☐	

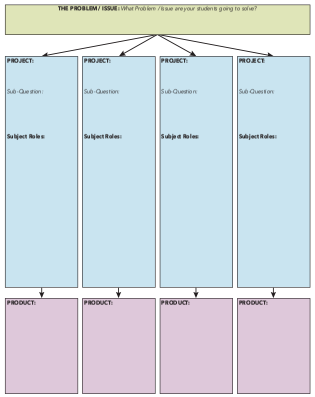
Backmapping charts projects over the course of a quarter (9-10 weeks). A backmap provides a quick glance at multiple projects, representing either one teacher or many coordinated teachers. At a glance teachers, students, and administrators know what projects link together and what products and/or presentations are expected.

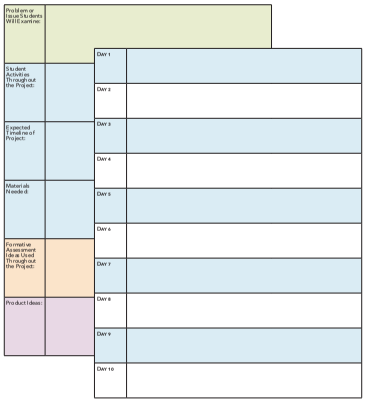
For administrators, the comprehensive collection of backmaps for the entire school facilitates planning, showcases accomplishments, and provides easily mapped benchmarks for progress.

QUARTER: TEACHER(s): SUBJECT(s):

PROBLEM / ISSUE:			
PROJECT:	PROJECT:	PROJECT:	PROJECT:
DATE/WEEK	*DATE/WEEK*	*DATE/WEEK*	*DATE/WEEK*
DATE/WEEK	*DATE/WEEK*	*DATE/WEEK*	*DATE/WEEK*

1 Graphic Organizer = **4 Two-Week Planners**





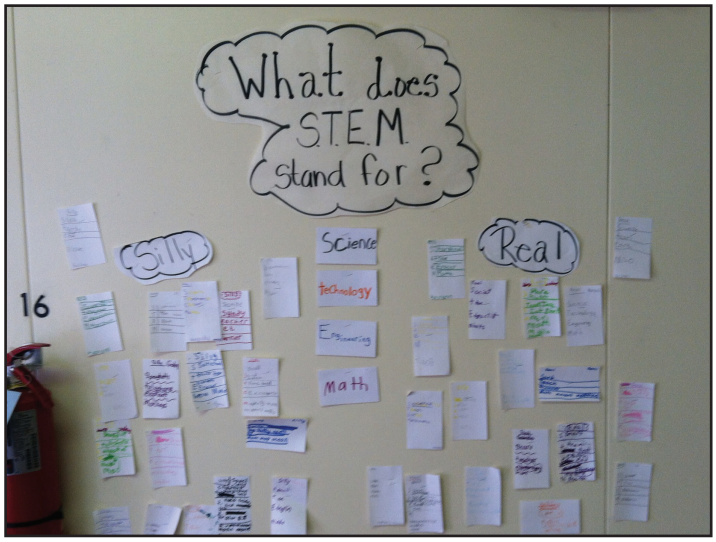
QUARTER: TEACHER(s): SUBJECT(s):

PROBLEM / ISSUE:			
PROJECT:	PROJECT:	PROJECT:	PROJECT:
DATE/WEEK	*DATE/WEEK*	*DATE/WEEK*	*DATE/WEEK*
DATE/WEEK	*DATE/WEEK*	*DATE/WEEK*	*DATE/WEEK*

Formative feedback is essential to the success of any project and the design of effective TPBL. It is a non-graded, honest assessment of where your students think they are, and where *you* think they are, in the process of learning. Formative feedback is used to inform.

Embedding time throughout your project plan to check for student understanding allows for opportunity to change course, modify the rigor of a project, and go back over content as necessary. Ask students to regularly monitor their own progress to help keep projects on task and schedule.

STEM Rocks the Box auditions partnered with Shadowbox Live



Westgate Elementary School

Westgate Elementary School

Starling K–8 School students at the OSU Howlett Greenhouse

The Project Snapshot is a quick summary of the parts of a project that lead to assessment. The Snapshot provides administrators a quick summary of projects activities and products as aligned to standards and standards-based questions. Results from the short-cycle assessments can be compared to what was planned, and provide teacher and administrator with clear gap assessment. The Snapshot can also be used by teachers to communicate with outside individuals about the academic rigor of projects happening in the classroom.

INSTRUCTOR: Ben Stein
GRADE LEVEL: 10th
SUBJECT: Math
OTHER TEACHERS/SUBJECTS: Social Studies, ELA, Science
START DATE:
PRESENTATION:

Theme: Energy & Community Impact
Overarching Question: What does our community believe?
Problem/Issue: Who should I vote for?

PROJECT OVERVIEW → ALIGNED STANDARDS

PROJECT *Activities:*
- Develop and implement an opinion poll.
- Analyze data from the opinion poll.

PRODUCTS *Evidence of Learning:*
- Survey
- Graphs to display data

PROBLEMS *Smart Goals:*

Standard & Objective
- Measurement & data
- Interpreting categorical & quantitative data
- Conditional probability & rules of probability
- Making inferences, justifying conclusions

FORMATIVE ASSESSMENT TOOLS → CHOOSE SHORT CYCLE ASSESSMENT → SHORT CYCLE ASSESSMENT

- ☐ Exit tickets
- ☐ Think, Pair, and Share
- ☑ Concept or Web Maps
- ☐ One Sentence Summary
- ☐ Observation
- ☑ Turn to Your Partner
- ☐ Journal Entry
- ☑ Hand Signals

BASIC — **VOCABULARY** Tests basic understanding of a concept.

PROFICIENT — **COMPARE & CONTRAST** Assess real-world application of knowledge

MASTERY — **EXTENDED ANSWER** Requires synthesis of knowledge in multiple applications.

Fold Here

Types & How Many	Pre-Scores	Post Scores
	75%	98%
[10] Vocabulary		
[ ] Compare & Contrast		
[ ] Extended Answer		
	53%	85%
[ ] Vocabulary		
[5] Compare & Contrast		
[ ] Extended Answer		
	31%	74%
[ ] Vocabulary		
[ ] Compare & Contrast		
[2] Extended Answer		

Growth

23%	32%	43%
Vocabulary •	Compare & Contrast •	Extended Answers

Questions
- The table shows the number of real estate transactions by type for the town. Based on the information in the table, which statement is true? [4 choices] (test bank #60)
- Based on the Bar Graph [speed of 4 runners in 100 yard dash], which of the following conclusions is true? [4 choices] (test bank #45)
- Based on the table of Coin Flip outcomes, which of the following statements is true? [4 choices] (test bank #36)
- The graph shows the value of Grandee Ltd. Stock at the end of every other year from 2006 to 2010. Which of the answers is the most probable value of Grandee Ltd. Stock at the end of 2004? [4 choices] (test bank #67)

INSTRUCTOR: GRADE LEVEL: OTHER TEACHERS/SUBJECTS: START DATE:

SUBJECT: PRESENTATION:

Theme: **Overarching Question:**	**Problem/Issue:**

PROJECT OVERVIEW → ALIGNED STANDARDS →

PROJECT *Activities:*

PRODUCTS *Evidence of Learning:*

PROBLEMS *Smart Goals:*

Standard & Objective

FORMATIVE ASSESSMENT TOOLS → CHOOSE SHORT CYCLE ASSESSMENT → SHORT CYCLE ASSESSMENT

- ☐ Exit tickets
- ☐ Think, Pair, and Share
- ☐ Concept or Web Maps
- ☐ One Sentence Summary
- ☐ Observation
- ☐ Turn to Your Partner
- ☐ Journal Entry
- ☐ Hand Signals

BASIC
VOCABULARY
Tests basic understanding of a concept.

PROFICIENT
COMPARE & CONTRAST
Assess real-world application of knowledge

MASTERY
EXTENDED ANSWER
Requires synthesis of knowledge in multiple applications.

Fold Here

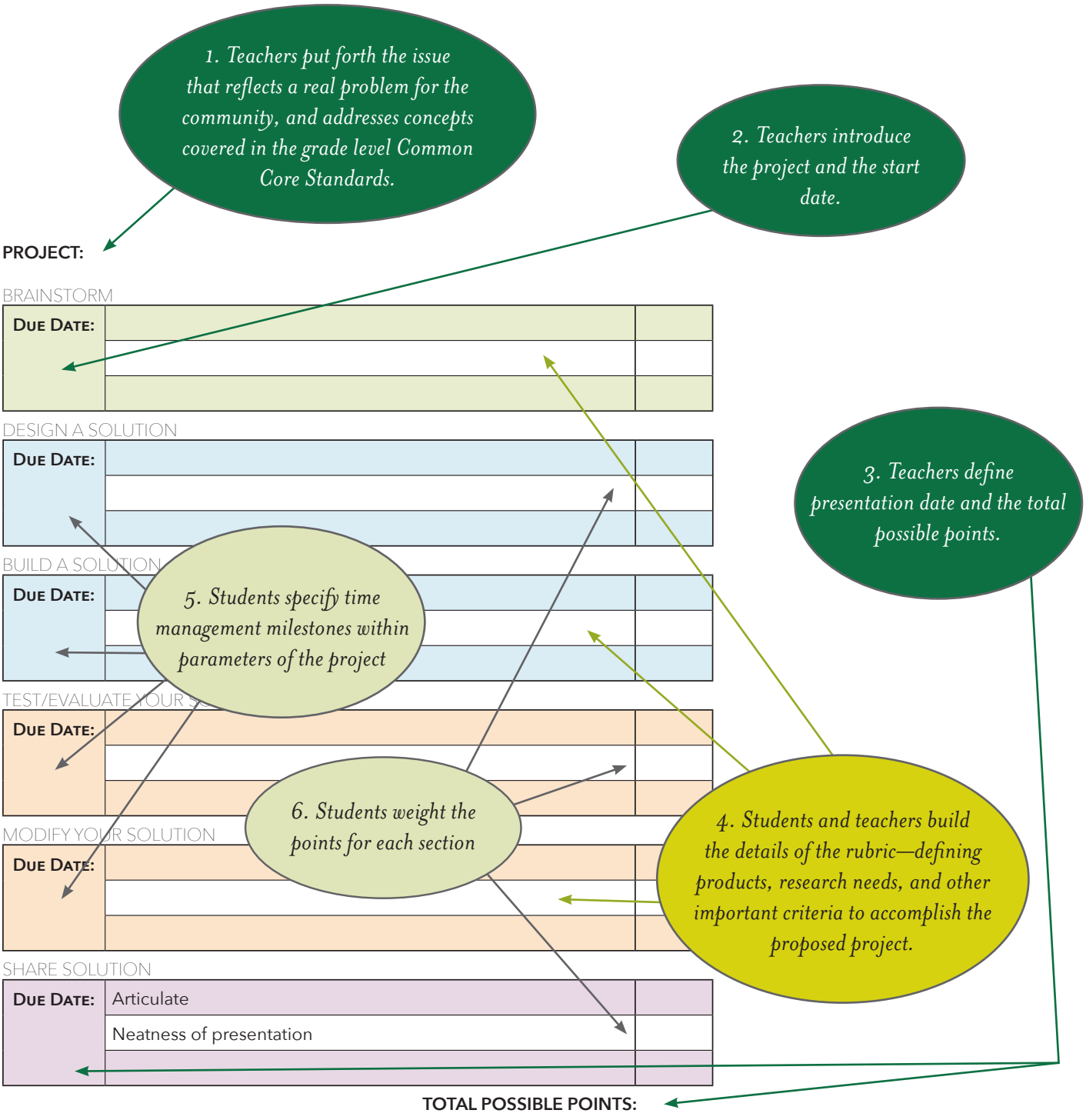
Types & How Many	Pre-Scores	Post Scores
☐ Vocabulary	☐	☐
☐ Compare & Contrast		
☐ Extended Answer		
☐ Vocabulary	☐	☐
☐ Compare & Contrast		
☐ Extended Answer		
☐ Vocabulary	☐	☐
☐ Compare & Contrast		
☐ Extended Answer		

Growth

Vocabulary	Compare & Contrast	Extended Answers
☐	☐	☐

Questions

Think of the Lewis Rubric as a checklist, or spot check, intended to help students manage time and resources. The rubric is adaptable. Some teachers use it solely to model what needs to occur in the process, while others use it as both a guide and a grading tool, leaving little mystery as to what each activity is worth. Still others use the rubric to manage time, set up the steps, provide formative feedback to both teacher and student, and ultimately drive grading. Whichever way you choose to use the Lewis Rubric, be sure to involve your students in its construction, and do it at the start of each project.



PROJECT:

BRAINSTORM

Due Date:		

DESIGN A SOLUTION

Due Date:		

BUILD A SOLUTION

Due Date:		

TEST/EVALUATE YOUR SOLUTION/DATA

Due Date:		

MODIFY YOUR SOLUTION

Due Date:		

SHARE SOLUTION

Due Date:	Articulate	
	Neatness of presentation	

Rubric format created by Steve Lewis, 2011.

TOTAL POSSIBLE POINTS:

Community partnerships are integral to creating authentic learning opportunities. Finding and forging community partnerships is simpler when the defined problems are relevant to the students *and* the community. Partnerships are intended to model for students the 'hows' and 'whys' of building coalitions that can solve problems. Partnerships draw upon the combined expertise of the teacher, and the deep content knowledge of the community partner, to deliver a more compelling project and a more engaging learning environment. Being able to succinctly describe a project is crucial to winning needed support.

	Benefits	Role	Expectations
Teacher	Through community partners, teachers gain rich content in the subjects pertaining to their project or the presentation of learning about the project. Community partners may also serve as an authentic audience for presentations.	The teacher's role is to interpret partner resources and information in appropriate language and delivery mechanisms for students.	Teachers should: • Ask for help • Talk out ideas even if not completely articulate • Tell partners specific needs • Allow others to help brainstorm • Be professional, prompt, courteous, and committed to follow through
Community Partner	Through teacher relationships, community partners gain impactful access to their community, and a role in shaping the future.	The community partner's role is to provide teachers with rich content, based on personal experiences, and provide students with specific examples of real-world application.	Community partners should: • Respond to calls or emails from teacher partners • Listen to ideas and provide advice and expertise • Think about creative ways to provide for specific needs. Leverage connections within the community.

Farmer's Market managers in Growing America, partnered with OSU Horticulture & Crop Science Department, from Metro Early College High School, Columbus Ohio.

Through a partnership with Metro Early College High School and The Battelle Memorial Institute, The PAST Foundation launched an ambitious program called *Growing America*. The goal was to introduce students to the full spectrum of getting fresh produce from seed to table. Over three years the program involved more than 25 partners from the community and higher education, expanded a student farm project, established an outdoor farmer's market, oversaw an ethnographic study of fresh foods that resonate with immigrant populations, and produced an activities workbook that is used across the nation. *Growing America* is an excellent example of a mutually beneficial partnership between a school and its community.

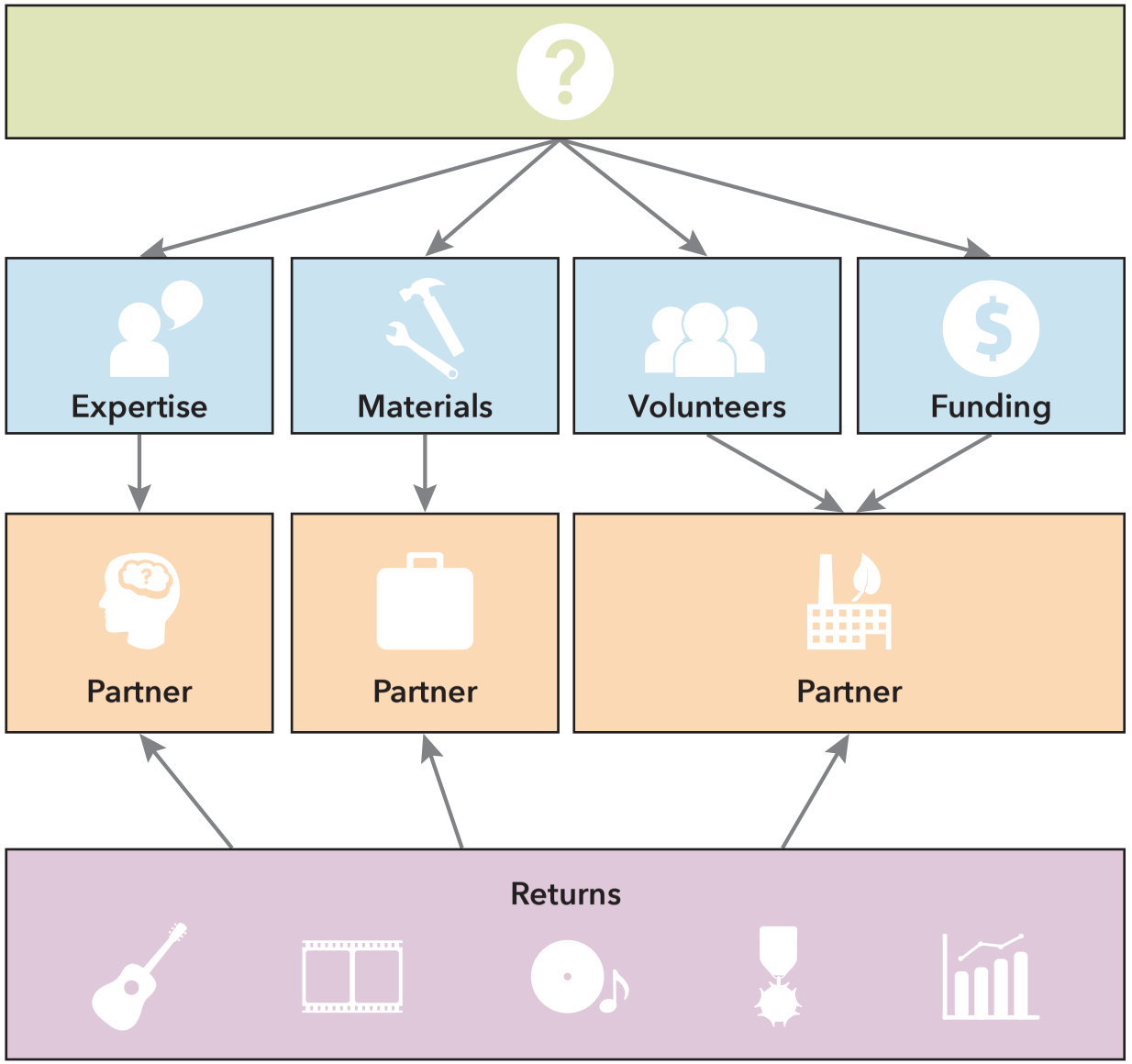
Creating a **Partners Matrix** helps define the help and expertise needed to ensure project success as well as helps manage who is partnering and do you still need more partners.

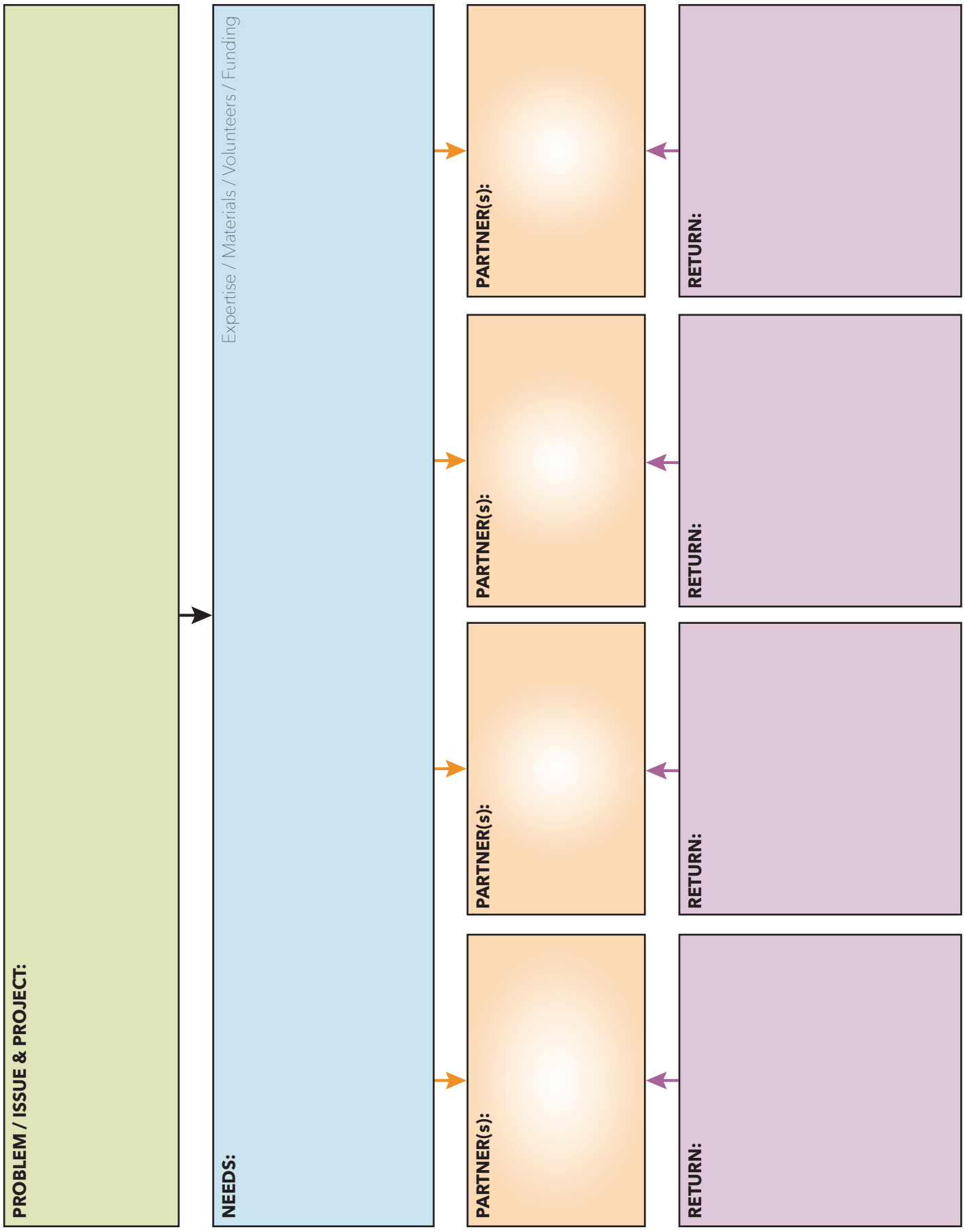
What **Relevant Problem** are you addressing with your students?

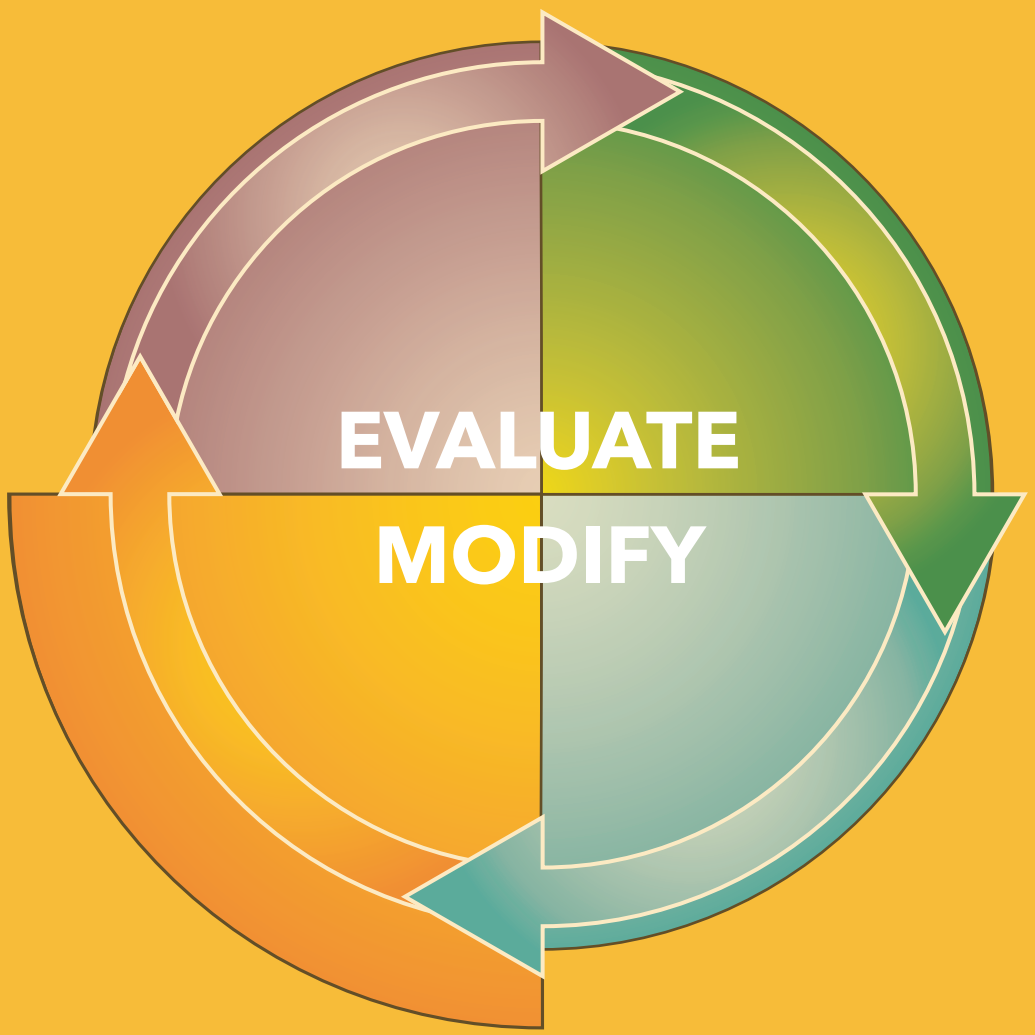
What **Project Needs** do you have that will help project success?

Which **Community Partners** can help secure or solve your need?

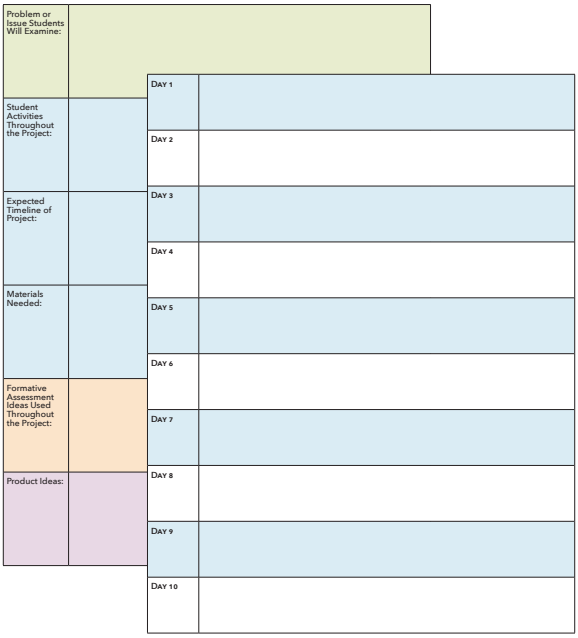
How will you and your students **Show Appreciation** for their help?




PROBLEM / ISSUE & PROJECT:
NEEDS:
Expertise / Materials / Volunteers / Funding
PARTNER(s):
RETURN:
PARTNER(s):
RETURN:
PARTNER(s):
RETURN:
PARTNER(s):
RETURN:

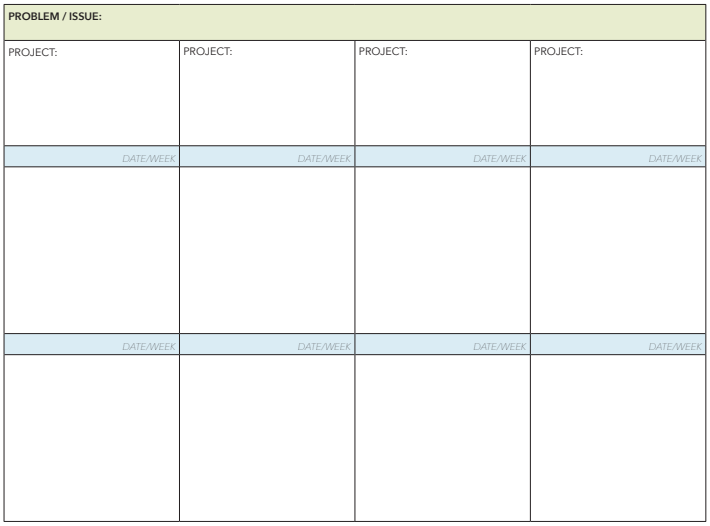

EVALUATE
MODIFY

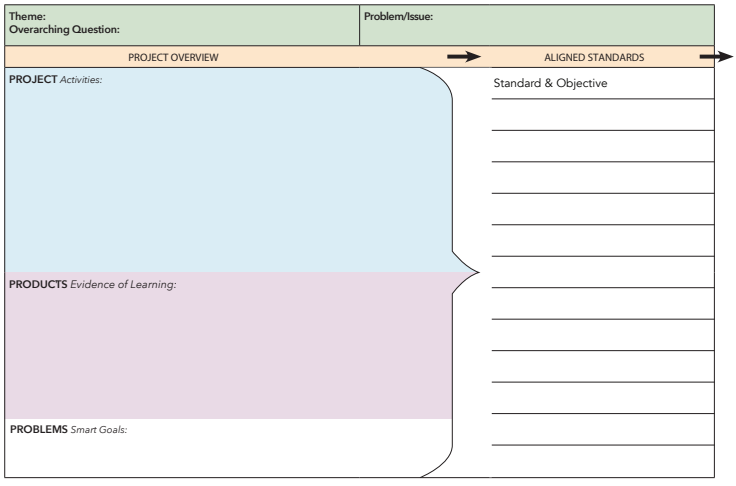
Throughout the workbook the provided forms encourage teachers to brainstorm, design, and build projects with products that they can implement in their classrooms. A number of the forms can serve both as planners and benchmarks for implementation. The forms shown here represent the expectations the teacher(s) set for themselves and the students. Posting these forms to a central location, such as a server or an online management tool enables all audiences to better understand what is happening in the moment, and what is expected for the future.



The **Two-Week Planner** is a management tool that helps track progress, define needed resources, and document product ideas. It is a great tool for administrators to use for managing resource acquisition, monitoring progress, and assessing rigor. Posting Two-Week Planners is a great mechanism for informing all stakeholders of the process, scope, and pace.

The **Backmap** gives a great view of the interplay between projects across an entire quarter. Numerous teachers post the large-format backmaps in their classrooms to help students envision how all the projects are interconnected and what to expect in the future. For the upper-grade levels, backmaps are a quick visual that allow administrators to track multiple projects occurring simultaneously throughout their school.





The **Snapshot** is a holistic overview for teachers and administrators to identify tools and processes used to gauge student mastery of aligned standards.

VISUALIZING YOUR PROJECT: EVIDENCE OF EFFECTIVE TEACHING

INSTRUCTOR(S): GRADE LEVEL(S): SUBJECT AREA(S):

PROBLEM/ISSUE: PROJECT:

Planning: Show visual evidence of brainstorm and rubrics building you and your students did for this project.
(Charlotte Danielson: 1a: Demonstrating knowledge of content; 1b: Demonstrating knowledge of students; and 3a: Communicating with students)

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

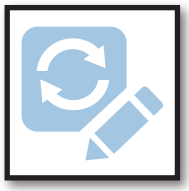
Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Design/Research: Show visual evidence of student research and/or design in formulating their projects.
(Charlotte Danielson: 1d: Demonstrating knowledge of resources; 3b: Using questioning and discussing techniques; 4b: Maintaining accurate records; and 4d: Participating in a professional community)

The Build: Show visual evidence of constructing the solution (Product).
(Charlotte Danielson: 1d: Demonstrating knowledge of resources; 2b: Establishing a culture of learning; 3b: Using questioning and discussing techniques; 4b: Maintaining accurate records; and 4d: Participating in a professional community)

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.



Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

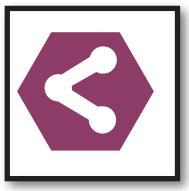
Modification: Show visual evidence of modifications students made to their projects.
(Charlotte Danielson: 1e: Designing coherent instruction; 1f: Designing student assessments; 3b: Using assessment in instruction; and 4b: Maintaining accurate records)

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

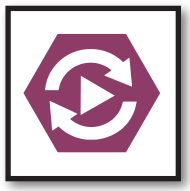
Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Share: Show visual evidence of your students sharing their products. Don't forget to capture their audience.
(Charlotte Danielson: 2b: Establishing a culture of learning; 3d: Using assessment in instruction; 4c: Communicating with families; and 4b: Maintaining accurate records)



Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.



Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

Right click to **change picture** above.
Then highlight text in this box and **write a short caption**.

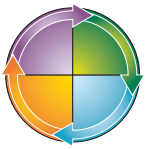
TPBL MODULE DELIVERABLES CHECKLIST

	Evidence	Number	Task
	Backmap		***Covers all projects across 1 Quarter***
☐			Activities across the duration of the projects that cover 1 Quarter
☐			Date range for your project
☐			Tie projects together if multiple teachers involved
	2wk Planner		***Provides rich Details for each project***
☐			Fill out each section so that anyone could take your module and run it.
☐			Activity and Benchmark (mini product) described for each day [Some administrators may ask for you to also indicate how an activity ties to a concept (standard).
☐			Identify audience and location
	Snapshot		***Provides Student Learning Objectives and Gap Assessment***
			Front side
☐			Give a synopsis of all **activities** you will undertake in project
☐			Give a list of all **products** you and your students will complete
☐			List concepts (**standards**) you plan to target with project; List them by citing anchor standard first then component (eg. Reading Lit: **Identify** key ideas and characters or Math: **Explain** patterns in the number of zeros)
			Reverse side
☐			Check off types of **formative assessment** you plan to use
☐			Fold page and enter **Questions** that relate to concepts (standards) listed on front side [You can ask 3 types of questions – Vocabulary questions gauge BASIC knowledge, Compare & Contrast questions gauge PROFICIENT knowledge, Extended answer questions that require explaining concept using vocabulary gauge MASTERY.

The Fidelity Checklist is a simple tracking tool that enables teachers and administrators to benchmark the success of delivering TPBL. The checklist tracks the fidelity of a project's implementation to the criteria provided below. Fidelity to this criteria is essential to effective TPBL implementation, and to student success.

INSTRUCTOR: CLASS: PROJECT:		Fidelity Check Date
BRAINSTORM		
☐	Teacher and students define steps to accomplish project	
☐	Teacher and students build a project rubric, with timeline and weighted points	
☐	Teacher and students define product requirements	
☐		
DESIGN		
☐	Students engage in research / data collection / blueprints / outlines / drawings	
☐		
BUILD		
☐	Students engage in building product	
☐		
EVALUATE PRODUCT		
☐	Students self-evaluate product using rubric	
☐	Students evaluate other student products using rubric	
☐		
MODIFY PRODUCT		
☐	Show evidence of product modification	
☐		
PRESENT LEARNING		
☐	Share with an authentic audience	
☐	Meet a definitive deadline	
☐		
ASSESSMENT *(attach all results to this sheet)*		
☐	FORMATIVE: Data quantified	
☐	SUMMATIVE: Short cycle assessment using standards-based questions aligned to project	
☐		

1. **Do the faculty know the first names of their cohort?**
    - Do teachers know the whole faculty?
    - Do teachers reach out to the entire Feeder System?

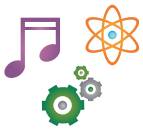


2. **Do teachers differentiate the hierarchy of Problem » Project » Product?**
    - Can teachers identify the problem?
    - Can teachers identify the product?

3. **Has the discussion in cohort planning evolved from student behavior to project planning?**
    - Is the school creating cohort time?

4. **Do the teachers know the standards instead of relying on the textbook to define standards?**
    - Do teachers know the difference between GLI's and Standards?
    - Do teachers recognize and plan for vertical alignment?

5. **Are teachers able to translate formative observations to quantitative data?**
    - Are teachers embedding the design cycle into TPBL units?
    - Are teachers embedding school habits into TPBL units?



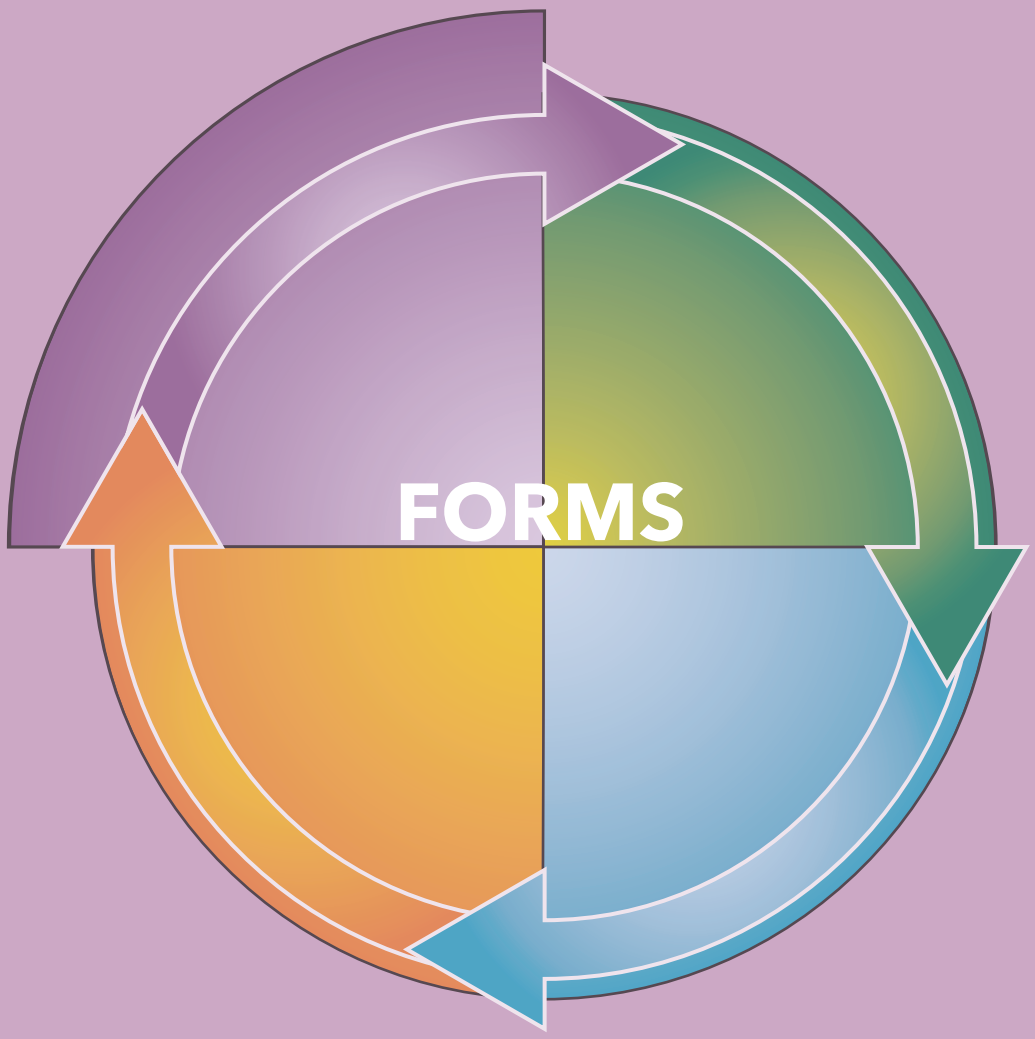
6. **Does TPBL empower teachers to be creative?**
    - Are teachers implementing their plans?

7. **Do teachers see TPBL as a delivery system instead of simply an add-on to text-based delivery?**

8. **Are teachers actively seeking community partners?**

9. **Do teachers actively demonstrate the learning of their students?**
    - Do teachers seek out authentic audiences for the demonstrations of learning?
    - Do teachers display ALL students' work regularly?

10. **Do teachers consciously understand the mechanics of time management?**
    - Do teachers hold firm on deadlines?



Download digital versions of the entire Toolbox at
www.pastfoundation.org/toolbox/

Gardener, David, et al. *A Nation At Risk: The Imperative for Educational Reform*. The National Commission on Excellence in Education, 1983.

National Academies of Sciences, Engineering and the Institute of Medicine. *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, 2005.

National Academy of Engineering. *Achievements of the 20th Century Poster*. Huitt-Zollars, Inc., 2011.

National Academy of Engineering. *Challenges of the 21st Century Poster*. Huitt-Zollars, Inc., 2011.

Nicolescu, Basarab. *The Transdisciplinary Evolution of Learning*. Centre International de Recherches et d'Etudes Transdiscipliaires (CIRET), 1996.

Ostergaard, Karen and Joshua D. Summers. "Development of a systematic classification and taxonomy of collaborative design activities," *Journal of Engineering Design* Vol. 20, No. 1, pp.57-81, 2009.

Pólya, George. *How to Solve It*. Princeton University Press, reprint 1945, 2004.

Purser, Ron. "What is Problem-Based Learning (PBL)?" San Francisco State University, 2012.

Rittel, Horst and Melvin Webber. "Dilemmas in a General Theory of Planning," *Policy Sciences*, 4:155-169, 1973.

Stevens, Brian. "The Sorry of the three R's," *Education Issue* 307:6, 2008.

Thimbs, John and J. Limbird. "Biographical Notices, January 29, 1825," *The Mirror of Literature Amusement and Instruction*, 5:75, 1825.

Lee, Miha. "History of American Educational Standards," manuscript, California State University, Northridge, 2013.

Nerison-Low, Roberta and Mark Ashwill. "The Development and Implementation of Education Standards in the United States," *The Educational System in the United States: Case Study Findings* Chapter 2, www2.ed.gov [5.2013], 1999.

Phalen, Rick. "Overview of the Standards Movement," *Assessment, Curriculum and Instruction, Sonoma State University*, www.sonoma.edu [5.2013], 2013.