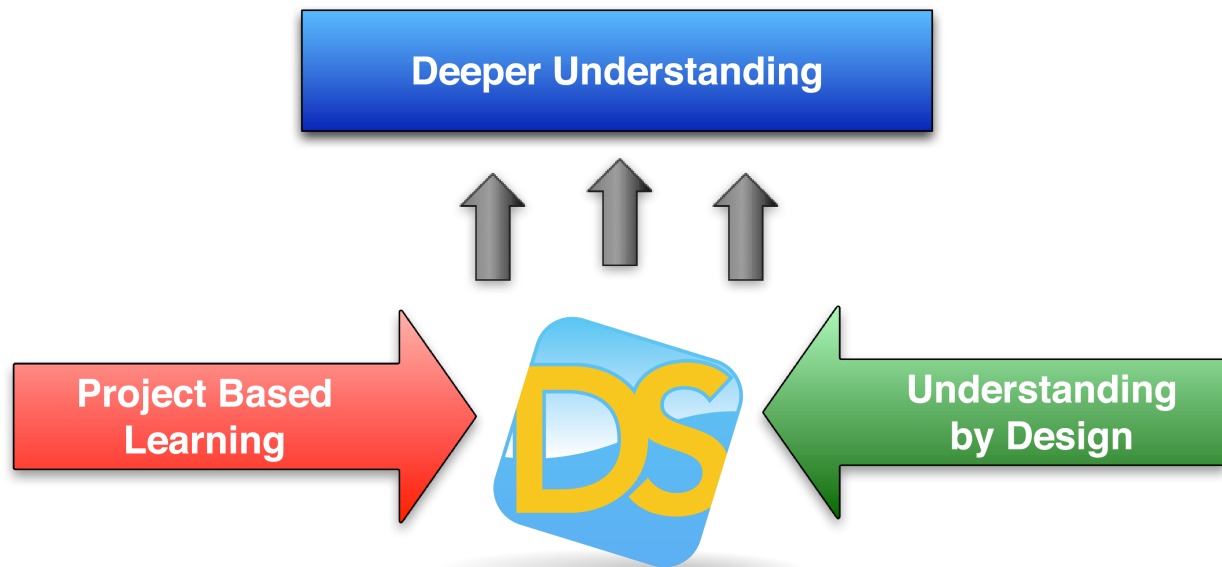


UNDERSTANDING BY DESIGN & DEFINED STEM



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UNDERSTANDING BY DESIGN & DEFINED STEM

Understanding by Design® (UbD™) offers a planning framework to guide curriculum, assessment and instruction with a focus on teaching and assessing for understanding and transfer. Defined STEM provides sets of modules in which students engage in “real world” applications of key concepts and skills. In this paper, we will describe the complementary connections between Understanding by Design and Defined STEM

KEY IDEAS

The two key ideas of Understanding by Design are contained in its title: 1) focus on teaching and assessing for understanding and transfer, and 2) design curriculum “backward” from those ends.

UbD is based on seven key tenets:

1. UbD is a way of thinking purposefully about curricular planning, not a rigid program or prescriptive recipe.
2. A primary goal of UbD is developing and deepening student understanding: the ability to make meaning of learning via “big ideas” and transfer learning.
3. Understanding is revealed when students autonomously make sense of and transfer their learning through authentic performance. Six facets of understanding – the capacity to explain, interpret, apply, shift perspective, empathize, and self assess – serve as indicators of understanding.
4. Effective curriculum is planned “backward” from long-term desired results through a three-stage design process (Desired Results, Evidence, Learning Plan). This process helps to avoid the twin problems of “textbook coverage” and “activity-oriented” teaching in which no clear priorities and purposes are apparent.
5. Teachers are coaches of understanding, not mere purveyors of content or activity. They focus on ensuring learning, not just teaching (and assuming that what was taught was learned); they always aim – and check - for successful meaning making and transfer by the learner.
6. Regular reviews of units and curriculum against design standards enhance curricular quality and effectiveness.
7. UbD reflects a continuous improvement approach to achievement. The results of our designs - student performance - inform needed adjustments in curriculum as well as instruction.

Defined STEM reinforces these tenets and supports the UbD framework for curriculum, instruction and assessment. Through the utilization of performance tasks and related resources, Defined STEM reflects the educational strategies of STEM education and project-based learning. Real-world videos set the stage for each learning experience by showing the practical application of educational concepts within an industry and/or organizational context. Performance tasks built around the demands of specific careers/industries ask the students to apply knowledge and skills in authentic situations. Literacy tasks encourage students to read, synthesize and write informative and/or position papers around the real-world issues. Tasks set in an international context give learners opportunities to explore challenges and opportunities with global implications.

THREE STAGES OF BACKWARD DESIGN

Understanding by Design proposes a 3-stage “backward design” process for curriculum planning. The deliberate use of backward design for planning curriculum units and courses results in more clearly defined goals, more appropriate assessments, more tightly aligned lessons, and more purposeful teaching. Backward planning asks educators to consider the following three stages:

STAGE 1 – IDENTIFY DESIRED RESULTS

What should students know, understand, and be able to do? What content is worthy of understanding? What “enduring” understandings are desired? What essential questions will be explored? What should students be able to do with their learning?

The first stage of backward design targets established Standards and related educational goals (e.g., 21st Century Skills). Since there is typically more “content” than can reasonably be addressed within the available time, teachers are obliged to make choices. This first stage in the design process calls for clarity about priorities.

The modules of Defined STEM are closely aligned to state and national academic standards, including Common Core and the Next Generation Science Standards to help educators focus on high-priority goals. More specifically, the tasks and associated resources of Defined STEM prioritize learning around application of knowledge and skills within and across subject areas, rather than simply “covering” lists of objectives. These rich tasks naturally connect academic content with 21st Century Skills (e.g., critical thinking, creative problem solving, collaboration, communication and use of technologies) that are increasingly recognized as vital for success in the 21st century.

Stage 1 of UbD asks teachers to identify the “big ideas” that students should come to understand, and then to identify or craft companion essential questions. Big ideas reflect transferable concepts, principles and processes that are key to understanding the topic or subject. These ideas are then embodied through open-ended, thought-provoking “essential questions” to guide student inquiry and problem solving.

More specific knowledge and skill objectives, linked to the targeted Content Standards and Understandings, are also identified in Stage 1. An important point in UbD is to recognize that factual knowledge and skills are not taught for their own sake but as a means to larger ends. Ultimately, teaching should equip learners to be able to use or transfer their learning; i.e., meaningful performance with content. This is the “end” we always want to keep in mind.

Defined STEM frames its modules around big ideas, essential questions and contextualized performance tasks to guide the learning experience. Specific knowledge and skills are learned in the context of authentic applications.

STAGE 2 – DETERMINE ACCEPTABLE EVIDENCE

How will we know if students have achieved the desired results? What will we accept as evidence of student understanding and proficiency? How will we evaluate student performance?

Backward design encourages teachers and curriculum planners to first “think like an assessor” before designing specific units and lessons. By considering the needed assessment evidence to document and validate targeted learning outcomes, teaching is invariably sharpened and focused.

Understanding by Design distinguishes between two broad types of assessment – Performance Tasks and Other Evidence. The performance tasks ask students to apply their learning to new and authentic situations as a means of assessing their understanding and ability to apply their learning. More traditional assessments (e.g., test, quiz, skill check) are used to assess more specific and discrete objectives.

Once a basic performance task idea has been identified, teachers are encouraged to frame the task by using the acronym G.R.A.S.P.S. to establish a more authentic context for application: (1) a real-world Goal; (2) a meaningful Role for the student; (3) authentic (or simulated) Audience(s); (4) a contextualized Situation that involves real-world

application; (5) student-generated culminating Products and Performances; and (6) the performance Standards (criteria) for judging success.

Every Defined STEM module is framed around an engaging, multi-faceted performance task involving application of learning. These performance tasks are authentic, reflecting “real-world” problems and issues that provide students the opportunity to demonstrate their understanding of key concepts and processes. The tasks are introduced through engaging and motivational videos that depict how people outside of schools are using academic knowledge and skills on the job.

Defined STEM utilizes the G.R.A.S.P.S structure to frame its performance tasks. The first four sections of each task use the G.R.A.S. elements to create an appropriate context/scenario in which students operate. The tasks call for students to use 21st Century skills – creativity, critical thinking, problem solving, collaboration and communication –in combination with academic knowledge and skills. Many of the tasks are set in a global context to prepare students for living in an increasingly interconnected, “flat” world.

Every task contains a minimum of four products (P) designed to address a variety of outcomes and enable teachers to differentiate to address students’ varied interests and talents. These products may be developed by individual students or created collaboratively in groups. Teachers can also modify and customize the provided tasks using G.R.A.S.P.S.

Each Defined STEM task includes one or more criterion-based rubrics that define the performance standards (S) to guide the evaluation of student work. The Defined STEM website allows educators to adapt the rubrics as needed.

STAGE 3 – PLAN LEARNING EXPERIENCES AND INSTRUCTION

How will we support learners in coming to understanding of important ideas and processes? How will we prepare them to autonomously transfer their learning? What enabling knowledge and skills will students need in order to perform effectively and achieve desired results?

In Stage 3 of backward design, teachers plan the most appropriate lessons and learning activities to address the three different types of goals identified in Stage 1: transfer, meaning making, and acquisition (T, M, and A). Too often, teaching focuses primarily on

presenting information or modeling basic skills for acquisition without extending the lessons to help students make meaning or transfer the learning.

Teaching for understanding and transfer means that learners are given opportunities to apply their learning to new and realistic situations, and receive timely feedback on their performance to help them improve. Thus, the teacher’s role expands from solely a “sage on the stage” to a facilitator of meaning making and a coach giving feedback and advice about how to use content effectively.

The Defined STEM modules are constructed around rich performance tasks to give learners opportunities to apply their learning to authentic situations – local, national and global in scope. Just as coaches of athletic teams plan their practices based on the demands of authentic performance (the “game”) and the needs of their players, teachers using Defined STEM “plan backward” from the tasks to determine the needed knowledge, skills and strategies that students will need to perform well. The associated Defined STEM resources provide practical and proven support for teachers and students alike.

COMMON CORE CONNECTIONS

Both Understanding by Design and Defined STEM clearly support outcomes identified by the Common Core Standards and the Next Generation Science Standards. Here are a few of the many connections:

MATHEMATICS

The UbD Unit Planning Template in Stage 1 calls for teachers to identify the important things students should know (e.g., multiplication tables) and be able to do (e.g., division). While acknowledging the importance of the basics, the UbD framework also emphasizes understanding of conceptually larger ideas (e.g., equivalence and modeling) and associated practices (e.g., problem solving and mathematical reasoning). This is a point repeatedly stressed in the new Common Core Mathematics Standards.

Effective educators know from research and experience that rote learning of mathematical facts and skills does not promote mathematical reasoning, problem solving, or the capacity to transfer learning. An essential goal of UbD involves teaching so students understand and can transfer their mathematics learning to new situations.

Each of the performance tasks within Defined STEM requires higher order thinking and transfer of learning. They call for mathematical reasoning, problem solving and perseverance as learners work on cost analyses, product development based on applied Geometry and Algebra, scale drawings and the creation of mathematical models.

LANGUAGE ARTS

The Common Core Standards for English Language Arts have placed a stronger emphasis on non-fiction reading along with expository (informational) and persuasive (argumentation) writing. Defined STEM literacy tasks incorporate a number of non-fiction resources including newspapers, magazines, journals, press releases, and technical papers. Each performance task includes an associated informational literacy task and argumentative task. These tasks help deepen student knowledge of the topic being investigated. The informational tasks require students to do a “close” reading to gain the necessary information to perform the task. The argumentative/persuasive tasks demand that students support their position with evidence while asking them to consider numerous sides of an issue or problem. Thus, the tasks provide a “two-for” – relevant applications of mathematics, science and/or engineering in conjunction with important reading, research, writing and communication skills.

Since most of the required reading in college and the workforce is informational in nature, engaging learners with the Defined STEM modules offers a motivating route to achieving the espoused goals of the Common Core Standards – college and career readiness.

NEXT GENERATION SCIENCE STANDARDS CONNECTIONS

The Next Generation Science Standards (NGSS) call for educators to focus on developing understanding of “big ideas” while engaging learners in “doing” science, not just learning facts about science. Here is a summary of the intent:

The framework focuses on a limited number of core ideas in science and engineering both within and across the disciplines... Reduction of the sheer sum of details to be mastered is intended to give time for students to engage in

scientific investigations and argumentation and to achieve depth of understanding of the core ideas presented.¹

Defined Stem offers a collection of practical and proven resources aligned to the Next Generation Science Standards. The modules and performance tasks provide contextualized learning experiences in the four domains – physical sciences, life sciences, earth and space sciences, and engineering and technology. Students have multiple opportunities to apply the NGSS Crosscutting Concepts such as *structure and function* and *energy and matter* within “real world” scenarios. Essential questions and core ideas are provided in each module to reinforce these concepts. Many of the modules feature interdisciplinary tasks to enable learners to see the natural connections among science, engineering and mathematics. Teachers who engage students with the Defined STEM modules are fulfilling the promise of the NGSS.

¹ National Research Council. (2011). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

APPENDIX

RESEARCH UNDERPINNINGS

Understanding by Design and Defined STEM reflect contemporary research on learning. A brief summary of some key findings is provided below.

FINDINGS FROM IN COGNITIVE PSYCHOLOGY

The book, *How People Learn: Brain, Mind, Experience, and School Experience*², provides a comprehensive and readable synthesis of research findings regarding learning and cognition. It offers new conceptions of the learning process and explains how skill and understanding in subject areas are most effectively acquired. Key findings relevant to UbD include the following:

1. Views on effective learning have shifted from a focus on the benefits of diligent drill and practice to a focus on students' understanding and application of knowledge.
2. Learning must be guided by generalized principles in order to be widely applicable. Knowledge learned at the level of rote memory rarely transfers; transfer most likely occurs when the learner knows and understands underlying concepts and principles that can be applied to problems in new contexts. Learning with understanding is more likely to promote transfer than simply memorizing information from a text or a lecture.
3. Experts first seek to develop an understanding of problems, and this often involves thinking in terms of core concepts or big ideas. Novices' knowledge is much less likely to be organized around big ideas; novices are more likely to approach problems by searching for correct formulas and pat answers that fit their everyday intuitions.
4. Research on expertise suggests that superficial coverage of many topics in the domain may be a poor way to help students develop the competencies that will prepare them for future learning and work. Curricula that emphasize breadth of knowledge may prevent effective organization of knowledge because there is not enough time to learn anything in depth. Curricula that are "a mile wide and an inch deep" run the risk of developing disconnected rather than connected knowledge.
5. Feedback is fundamental to learning, but feedback opportunities are limited in many classrooms. Students may receive grades on tests and essays, but these are summative assessments that occur at the end of learning segments. Grades, by themselves, do not provide the specific

² National Research Council (2000). *How people learn: Brain, mind, experience, and school: Expanded Edition*. Washington, DC: National Academy Press.

and timely information needed for improvement. What is needed are formative assessments, which provide students with opportunities to revise and improve the quality of their thinking and understanding.

6. Many assessments measure only propositional (factual) knowledge and never ask whether students know when, where, and why to use that knowledge. Given the goal of learning with understanding, assessments and feedback must focus on understanding, and not simply on memory for procedures or facts.

These findings provide a conceptual base for the Understanding by Design framework. Defined STEM offers a practical embodiment of UbD to provide relevant learning experiences for students to understand the when, where, why and how content and skills learned in the classroom may be applied in a real-world, global context.