MOVE OVER STEM -
MAKE WAY FOR DREAMS EDUCATION

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One of the hottest movements in education right now is the focus on STEM (Science, Technology, Engineering, and Math) education. Linked together through a strong focus on technical and scientific studies, STEM education is driving the educational conversation around what to teach and how to teach our students.

The concept and acronym of STEM were developed by the National Science Foundation in an attempt to create greater attention on the need for more workers in the science fields. This coincided with a push at the federal and state level for increased spending and development of STEM supported education. There are many variants of STEM, with the most common being the addition of the arts to make STEAM education.

Shortcomings of STEM

There is much to laud about the STEM model but it does have its shortcomings. The biggest flaw in this model is that it is less of a model and more of a collection of connected content areas. Although STEM does create interest and focus around these content areas, it does little to show learners or teachers how to connect these content areas or even how to find entry points into these rich curricular areas. The second concern with STEM education is related to this issue. As STEAM illustrates, more and more content areas are being added to STEM. It no longer matters whether there is a connection point or not, advocates from other disciplines are trying to tie their focus areas to the STEM bandwagon. This creates an odd hodgepodge of different content areas with no definable connections to be found in the model. The final issue with STEM reflects the evolving role of technology in all learning systems. STEM calls out technology as a unique discipline requiring equal time with science, engineering, and mathematics. This may have been the case in the recent past, but technology is now infused throughout these disciplines. This is not to say that there are not unique careers to be found in technology. There are and these careers should be explored. But technology should no longer be classified as a stand-alone content area. All of these content areas require a deep understanding of how technology interfaces with the discipline. DREAMS addresses this issue by focusing first on process skills and then applying it toward specific content areas. Move over STEM and make way for DREAMS education.

DREAMS Definition

DREAMS or Design, Research, Engineering, Art, Math, and Science fills in some critical gaps in all current versions of STEM. DREAMS begins with a focus on two specific process areas. These are design thinking and research. The DREAMS model then applies these process skills to the content areas of Engineering, Art, Math, and Science. Although STEM implies process, it does not delineate process in the model design. In this way, STEM provides little direction beyond suggestions for content focus. Design and research seem implied in the STEM model (since they are used by engineers and scientists) but they are not clearly addressed and their

absence does not give the learner a starting point or a defined set of tools to explore the content.

Design thinking is a primary driver in DREAMS. Students start with a question to be solved, a problem to be fixed, or an interesting idea that takes them through the content areas. Research is also critical to the DREAMS model. Research gives the learner tools to gather and analyze information to support their work. In today's data rich learning environments, a learner must have a solid grounding in research skills to make sense of the world around them.

Content is also important to the DREAMS model. Engineering, Art, Math, and Science provide the focus of investigation in the DREAMS model. The design thinking and research connect these content areas. The STEM model does not have this process glue to hold the model together or link the content areas. The inclusion of art in the STEAM version of STEM is a good example of this. As noted above, art in the STEAM model feels like a clunky add-on to the original STEM concept. It has limited connections to the world of science or math and only becomes relevant if one assumes a design process. In DREAMS, art is a critical component and becomes a necessary playground for much of the design work.

Figure 1

PROCESS SKILLS -	Design (Thinking) Research – Scientific Process Informational Literacy
CONTENT AREAS -	Engineering Arts Math Science

DREAMS focus on Process Skills

That defines this newer version of STEM but what does the DREAMS model actually look like in design and practice? The first part of the model is really about process skills. These include design thinking and research. Design is really more about design thinking than designing, although participants in a DREAMS programs will end up designing products. Research is the other process skill that all DREAMS participants will need. Research not only includes sound grounding in the scientific process but also a thorough grasp of informational literacy. These process skills of design thinking and research can be used in any discipline although there is an emphasis on the delineated content areas.

Design Thinking (Process Skill)

Design thinking has a rich history. Design thinking differs from the technical field of design because it is a process of work rather than a specific design task. There are many different models for design thinking and a number of excellent articles and books on this process. David Kelley who founded IDEO has written extensively in the area and has developed the IDEO model of design thinking. Rolf Faste helped make Stanford University one of the leaders in this field as far back as the 1980s. This work has been continued at Stanford through the Design Thinking for Social Innovation School and the work of Tim Brown who has written extensively in the area. Design thinking models vary based upon their purpose and audience but there are many similar features to the different models. I have taken the liberty to synthesize the various models into one that supports K-12 instruction and the work of educational institutions. This hybrid model includes the following steps: 1) Inspiration; 2) Ideation; 3) Exploration; and 4) Creation.

Figure 2 – **Design Thinking Model**

Inspiration - Ideation - Exploration - Creation

Inspiration in this design thinking model can originate from many different places. It can start with a question, problem, or challenge. How do we cut down on paper usage? How could we increase the number of students who purchase lunch? What does a 21st Century classroom look like from a student perspective? Inspiration can also be more directed. It can start from a curricular topic, an assignment, or just an idea. The point here is that inspiration to start the process can come from the learner or from external sources and can be fully elaborated or simply a hint of an idea. Anything that starts the process forward is inspiration. In many design thinking models, inspiration often comes from looking at the needs of the customer or end user.

Ideation is the process of creating a number of ideas or brainstorms around the inspiration. At this point in the process, the more ideas, the better. Look for connections, use word play, and put forward crazy ideas because the purpose here is to stimulate further thought.

Exploration is where ideas start to come to life. The work in this stage is concrete. Start to build something. Write it down. Make prototypes. Exploration builds from the ideation and turns the ideas into real things. Part of this process also involves testing and refining ideas, which in turn may lead to better models of the original idea or an entirely new model or idea.

Creation is the step where final production occurs. As noted above, it may not answer the original question or challenge but at the end of this process, a final product is created and usually shared.

As you can see, there are some unique attributes to this process. Design thinking by its very nature is experimental and not necessarily linear. Work in the exploration stage may lead one back to ideation or even begin a new inspiration. The purpose of design thinking is to spur

creativity and that means that the process may lead in unexpected directions and solutions. Failure is an expected part of the process and early prototypes exist to discover flaws and lead to improvements. Design thinking is not meant to be a strict recipe but more of an approach.

One can see that design thinking shares many attributes of other learning models. Using the Acquire, Analyze, Apply Model (Baird, 2014) as a comparison, it is easy to see how the stages of design thinking fit nicely into this broader cognitive construct. Both models start by trying to understand the task, problem, or information. They work toward looking at the issue in new ways and ultimately lead to application or product. Design thinking differs somewhat with a greater emphasis on the ideation and exploration stages and with a less linear approach to the final outcome.

Project based learning is another learning model that coexists smoothly with design thinking. Project based (or problem based) learning almost always starts with a challenging question or problem to be solved and often is a long term learning experience. Design thinking can easily be used in the project-based arena although once again, it is not as structured as project based learning in its goal toward solving a specific problem.

The scientific process is closely aligned with design thinking. Both can start from a hypothesis and rely upon exploration (experimentation in the scientific process) to lead one to a right answer. The scientific process is not always designed to lead one to a final product and it is much more systematic in its approach through the process than design thinking.

Perhaps the most analogous model that teachers can relate to design thinking is the writing process. In the writing process, inspiration also comes from multiple sources. Prewriting or ideation takes place and through the process of writing multiple drafts, exploration and eventually creation occurs. The differences between the two processes are somewhat minor. Design thinking usually works best with a team unlike the writing process. The options for final product are much more diverse in design thinking than writing but the similarities outweigh the differences between the two processes.

The focus in design thinking is found within the ideation and exploration stages. It is not constrained to one solution or even one area of problem solving. A good example of this would be to look at a design team tackling the issue of heart disease. If the design team only approaches heart disease from the mindset of a pharmaceutical company, all of their solutions will be new medications. If that same design challenge were approached from the perspective of a personal fitness gym, the solutions will only improve physical fitness techniques. A dietary supplement company will focus on nutrition factors. This is not true design thinking since limitations of solutions were built into the ideation and exploration stations. True design thinking must be open to all new ideas. This is what makes it different from other learning process models. This type of thinking can support an organization in pushing boundaries to find new creative ventures.

Research (Process Skill)

The scientific process and informational literacy are the research components of DREAMS. They require specific background knowledge but they both, like design thinking, are really more about a learning process. The scientific process is well known to all and has already been discussed as a companion tool to design thinking. When dealing with the sciences, students must always be prepared to develop a hypothesis and then test it by controlling for various variables. Information literacy is not so clearly defined.

Today's learner must know where to go to seek out information. They must be able to work in a variety of media. They must be able to sift through mountains of potentially valuable resources to find the most pertinent information related to their work. They must be able to discern reliable information from false information. This requires a specific set of skills known as informational literacy. Information literacy along with a deep understanding of the scientific process will allow DREAMS learners to be effective researchers.

DREAMS Focus on Content Areas

The fields of engineering, art, math, and science are rich with learning opportunities. These areas also overlap in many ways so that students may use their knowledge of math and science to tackle an engineering project. Through their use of art and design, they can then move forward with the development of a unique product that meets a specific need. Steve Jobs and the team at Apple used this approach when they invented the Macintosh computer. Having new technology was not enough. How the technology looked, felt, and interfaced with the user was just as important. Knowledge of the content areas and the attempt to answer questions found within the content areas give DREAMS education a reason and place to focus.

DREAMS Example

EUSD SCRAP CART in Action

How does the DREAMS model work in the real world? One example comes from the Encinitas Union School District. Members of the District Green Team started with a challenging problem. How could the District increase recycling efforts at all nine schools while reducing overall landfill amounts, and save the District money.

The team began with a design thinking approach. Inspiration came from the challenge to increase recycling. Before moving on to Ideation, Exploration, and Creation, the team first focused on Research. How much trash was being created? What part of the day created the most trash? How much did the District pay for trash collection? Recycling was already occurring on most campuses. What was working? What wasn't working? The team interviewed students, teachers, and custodians to find out. Science and math were incorporated, as lunch waste audits were held at different campuses. Trash items were counted, weighed, and analyzed. These audits showed the total amount of trash, what was in the trash, and how much each student was adding to the overall landfill amount. With this research in hand, they moved on to ideation and exploration. Although recycling was in place on most campuses, it wasn't being done well and much of the waste that could be composted was going into the trash. Models of recycling carts that gathered all compostable waste in bins, separated recyclable materials in others were designed. How long would students take to go through the line with the new carts? What materials would be more durable to the weather? How high should the carts be for students? All of these ideas were discussed and tested. Finally, what artwork should be added to make use of the carts more appealing? Thus the SCRAP Cart was created. It wasn't perfect but after a few tweaks, the cart was put into action. The team started with an educational campaign. They then started using it and began to measure the results. Lunchtime landfill waste was reduced by 83%. Compost for school gardens increased. The District saved money by reducing trash removal costs. Most importantly, students, staff, and the Green Team learned that their actions could make a big difference when the DREAMS model was used.

Design, research, engineering, art, math, and science make up DREAMS education. This new STEM based learning model has the potential to inspire an entire new generation of students to follow their dreams.