

What is the point of STE@M? – A Brief Overview

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STE@M is a new framework of subjects which has been evolving to support a new educational theory.

STE@M is based on STEM education, which can be defined in two ways:

1. the more traditional way, I like to write as S-T-E-M education, as it is the individual ‘silo’ fields of science, technology, engineering and mathematics education. Each has evolved to formally include elements of the others within their own standards and practices.
2. the newer trend is the concept of integrated STEM education. It includes the teaching and learning practices when the subjects are purposefully integrated. When taught, one field may be the dominant base field, or all may be blended unilaterally.

Commonalities

While studying the common factors of teaching and learning across the disciplines of S-T-E-M, I found it hard to not include the influences of the arts disciplines. I started thinking of how to develop an educational framework that could formally link the study of the hard sciences to that of the divisions of the arts. This investigation led me into a deeper study of each of the main subject areas with the hope that I would be able to classify the finer educational divisions within each silo. The following classifications are the result of that investigation:

Science	Physics, Biology, Chemistry, Geosciences & Biochemistry
(mixed)	Biotechnology & Biomedical
Technology	Construction, Production, Agriculture, Communication, Transportation, Power & Energy, Industrial Arts & Information Technology
Engineering	Electrical, Computer, Chemical, Aerospace, Mechanical, Industrial, Materials, Ocean, Environmental, Fluid & Civil
Mathematics	Algebra, Geometry, Trigonometry, Calculus & Theory
Arts	Physical, Fine, Motor, Language & Liberal (including; Sociology, Education, Politics, Philosophy, Theology, Psychology, History & more...)

I continued my search by reviewing how each of these divisions are linked to each other and the fields of the arts in both practice and study. I delved farther into the fields of the social, fine, manual, physical and liberal arts to understand how they expand outwards to influence and be influenced by the studies and practices of the hard sciences.

Functional Literacy

A significant common thread is that each primary division promotes a need for students to develop a proficiency in the subject that would make them literate enough in the discipline to be able to

continue to adapt to and learn about the basic developments that the field takes. When looking across the breadth of the categories, I can point to a significant amount of research done on how to instill scientific literacy, technological literacy, the design process, mathematical literacy and language literacy in students. I would argue that this leads to a conclusion that students need a literacy of a breadth of the primary disciplines which would include an ability to transfer knowledge with higher order thinking between disciplines, or to use my term, students need to obtain a *functional literacy*.

Constructivism

Another primary cross-disciplinary link is the concept, that within the education fields, constructivism is a primary learning theory which most fields are working towards formally incorporating into their pedagogies. Under the umbrella term of constructivism fall the practices of; problem and project based learning, inquiry learning, authentic, contextual and experienced based learning, deductive reasoning and discourse, small group interactions, collaborative and community learning, modeling, critical and higher order thinking and other aspects of learner centered learning.

STS

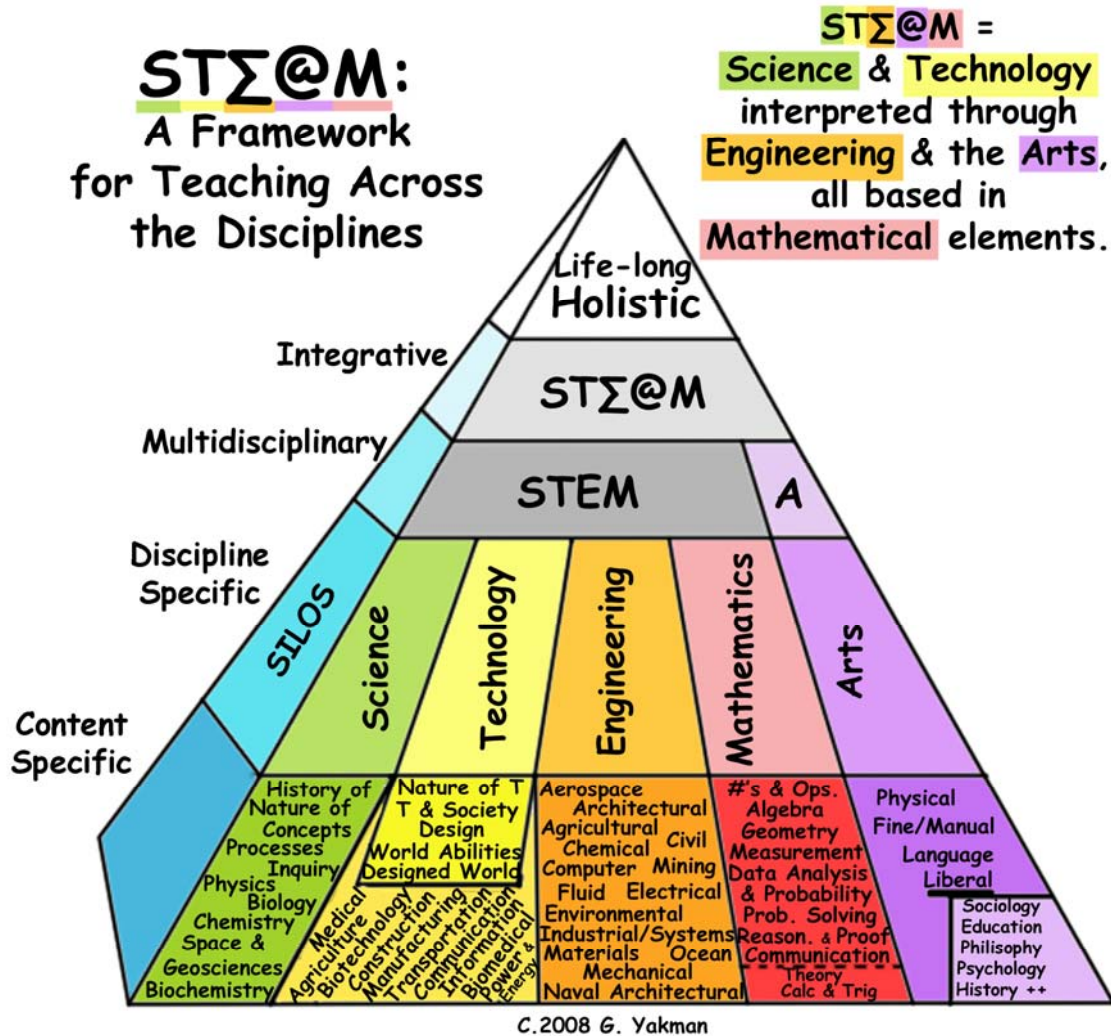
Studying these linkages pointed me towards investigating the movement of STS. I soon became intrigued by that field's divisions of the study of Science and Technology Studies versus Science and Technology in Society, and within each of those divisions the classifications of 'scholars' versus the 'activists.' Additionally, I was introduced to philosopher's perspectives on the nature of science, ethics, constructivism, co-constructivism and Bruno LaTour's Actor Network Theory, all of which, I think, includes implications for the field of education. I am currently looking into cross-analyzing the concepts of constructivism between the fields of philosophy and education.

Holistic Education

Throughout this investigation, I have also been studying aspects of attempts at formal and informal holistic educational models such as those of; indigenous tribes, Montessori, Ruggiero, Waldorf and home schooling movements. I will define my use of holistic education as denoting life-long learning; therefore I consider all purposefully planned programs of teaching that have been called holistic education, an attempt at it. I argue that holistic learning cannot be controlled or planned; it is the interpretation of each person's sphere, or universe, of influence. It significantly helps to shape what people do with what they are exposed to and what they understand. Since each person's perspective is different, holistic education cannot be delivered equally to students. I would consider indigenous tribal learning and some home learning settings, to be as close as possible to intended holistic education. Otherwise, educational trends geared at educating the whole learner, tend to have their pedagogy and curriculum fall under the titles of integrated, themed, inquiry, discovery or reality-based education.

Framework - STE@M Pyramid

From all of these investigations, I created the following diagram in order to establish a framework for giving structure to and analyzing the interactive nature of both the practice and study of the formal fields of science, technology, engineering, mathematics and the arts.



My first interpretation of how to explain the **STEAM** linkages was:

We now live in a world where; you can't understand **Science** without **Technology**, which couches most of its research and development in **Engineering**, which you can't create without an understanding of the **Arts** and **Mathematics**.

It was colorful, but contrived...

Primary Base

I persisted on meandering through the silos looking for more structural links. I started reading about the recent Kuhnian revolution in the field of mathematics education. This led me on to explore the intrinsic element that mathematics is among the other silos. Mathematics, and mathematics alone, is essential for the study of the other silos, it is even the base of the study of languages, which is the next strongest category to provide structure for the other silos. Mathematics is the primal language that cuts across all other field's boundaries. It is not just a primal language but a network of practical and theoretical divisions that interact both with other subjects as well as stands alone. I had found something that set apart the study of mathematics from that of science, technology and engineering, that thing was the need for it to be included in the other disciplines. This became a pivotal point in my framework system.

STEAM to STE@M

In order to explain that point, I have to explain another field that stands apart from the traditional 'hard sciences' club. This 'hard sciences' club has received so much recent emphasis that it has created a new educational branch, STEM. It is my argument that since the arts discipline houses the study of education, how can education itself be formally excluded from the study of STEM education? But, more than that, *the arts contain all of the divisions that interact with the pure possibilities of the other fields to shape the direction of development.* Eureka! That is the missing element to this paradigm. There is now a new interpretation of how all the fields of STEAM linked together, and due to it, STEAM became STE@M.

The new definition of the framework became;

STE@M = Science & Technology,
 interpreted through **Engineering & the Arts,**
 all based in **Mathematical** elements.

It is still colorful, but less contrived and more pure.

Application

This is where you, the reader, may say, 'So, what are you going to do with your pyramid?' (Hopefully not, hopefully, you, the reader, is saying... how does that apply to the practice and education of my field? and how does that effect my concepts of and interactions with other fields? what applications does this framework have in practical reality?) The possibilities of answers to these questions and more, have only begun to be explored

As you may notice, the pyramid has other labels along its sides as well. These are the keywords that I have associated with the concepts that I am working on affiliating with the various levels of the classifications that I have assigned to the fields. Let me explain my definition of the levels.

At the very top of the pyramid is the *universal* level. This correlates to the concept of holistic education, which I described earlier, as being the interpretation of each person's sphere, or universe, of influence. It cannot be planned or avoided, even when sleeping, people are constantly learning from and adapting to their environmental influences. The results of these influences, both internal and external, greatly shape what people do with what they are exposed to and what they understand. For these reasons, I have associated this first level of the pyramid with *life-long* education.

Integrated Level

The second level of the pyramid I have labeled the *integrated* level. It is at this level where students can obtain a broad scope of all the fields and a basic overview of how they inter-relate in reality by teaching them with a purposefully planned and reality-based interdependence. An excellent way to teach about natural inter-relations in practice is to teach thematic concepts that allow for transference to the realm of education. For example, teaching a unit on ship building would allow for broad or in-depth studies of;

- ❖ the science of water, structural materials and buoyancy factors and geography,
- ❖ the technology of machines, concepts and skills that allow for the construction, production, transportation, communication and power and energy,
- ❖ the engineering of planning and design with any constructs,
- ❖ the mathematics needed to comprehend and develop ships at all levels,
- ❖ the physical, manual, fine and liberal arts used for both large and intricate elements of ship building including the history and politics and
- ❖ the language arts to research, convey and report on all of this knowledge.

It is at this stage that students begin to understand what and how to explore all areas of opportunities in the educational realm. Instructors have the choice of focusing in depth on specific areas or covering a broad scope of the topic. Teams of teachers can work together to provide in depth coverage of their areas of expertise while reinforcing what students are learning in other specific areas. For these reasons, I have associated this second level of the pyramid as being most relevant to *primary and middle school* education. However, I find the integrated STE@M approach to be excellent for all levels of education.

Multidisciplinary Level

The third level of the pyramid I have labeled the *multidisciplinary* level. It is at this level where students can obtain a scope of specifically chosen fields and a concentrated overview of how they inter-relate in reality. An excellent way to teach about natural inter-relations in practice is to teach reality-based/authentic units. When purposefully planned to cover certain fields and concepts, instructors can still easily use themed education, however, fields not focused on should not be all together excluded from the curriculum, but instead, at least explained as being an element of the scope that would occur in reality. Any of these methodologies, and more, helps allow for transference of learning from the realm of specific topics to all related topics.

Current trends in education have already established STEM as a relevant block of core fields. Trends have also shown many of the branches of the arts being more and more marginalized. In public education, only the language arts and social studies are still formally given substantive attention as having importance outside of the STEM areas. To me, this is a tragedy, as it eliminates many primary ways for students to obtain contextual understanding. Therefore, as students are exposed to prominent and marginalized fields, they begin to understand the hierarchy and politics of both education and practice. It is here that students might begin to have a concept of specific areas of interest to explore as potential career paths. For these reasons, I have associated this third level of the pyramid as being most relevant to current *transitional or middle-school education*.

Discipline Specific Level

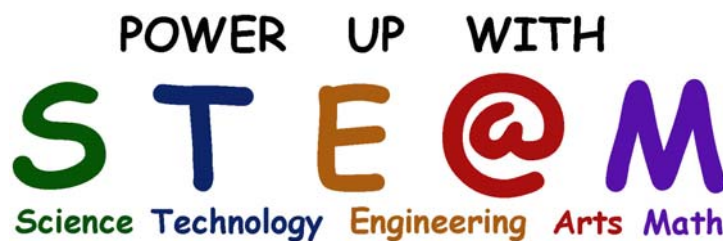
The fourth level of the pyramid I have labeled the *discipline specific* level. It is at this level where individual silo divisions of fields, or disciplines, are taught at focus levels. It is where individual subjects are the primary topic of focus. This is not to say that other subjects are excluded, subjects should still be covered contextually, however, the primary subject is explored significantly more in depth than the related fields. It is at this level where the specific divisions of each silo should be given an overview. This is the level at which to explore what areas of expertise a person wishes to acquire as career and hobby. Since this is very appropriate for young adults, I have associated this fourth level of the pyramid as being most relevant to *secondary education*.

Content Specific Level

The fifth level of the pyramid I have labeled the *content specific* level. It is at this level that specific content areas are studied in detail. It is here where *professional development* happens and students delve into the tighter realm of the specific content areas of their choice. Areas can be studied alone or in specifically grouped clusters from within their own silos or from across the fields. Again, this should still be relevant and contextual to the world at large, but this is the point where educational and professional practice most fully interrelate with each other's developments.

Marketing

When one looks at the field of Technology Education [TE], it is sadly apparent that the average person does not understand the scope of that field. The common person thinks of it in one of two primary ways; the more traditionally common, as the realm of manual and industrial arts, the newer common perception trend is that it is the study of information technology. Although both of these concepts are, in part, true, neither come close to defining the breadth or depth of this field. In an effort to avoid the complications that TE has faced, I have plans to integrate catch-phrases and definitions into the introductory literature about this newly developing framework. For fun, I have played around with catch phrases. Although, these are not as academically relevant pursuits as the rest of the scope of my inquiry, they are imperative for marketing this new theory. Among them, I have tried to appeal to students (young and mature), parents and guardians, community members, educators, administrators, business leaders, politicians and agencies. I have also tried to make them succinct so they can be easily remembered and used in various forms. Some early examples of catch phrases include; STEAM Powered, Full STEAM Ahead, Power up with STE@M, Don't Waste Your STE@M, Don't Blow Off STE@M, Full STE@M Ahead Into Life...



Middle and High School Programs

Recently I have been thinking about development of STE@M-based middle and high school programs and schools. I am currently putting more emphasis on transitioning a Technology Education middle-school level program to one called 'What's Your Point?' This program would be a stand alone STE@M course which could be introduced to any middle school. It would be used as a seed for developing integrated curriculum throughout a school.

It would be initially implemented as a way to expose students to a large range of skill sets and career choices through reality-based integrated learning. Students would perpetually evaluate their points of interest, experience and talents in relation to a diverse spectrum of careers and the related discipline skills. They will also be involved in evaluating local, regional, national and international career path opportunities and developments in historical, current and potential contexts. A portfolio process would help organize students to further explore potential career paths through projects and assist them in planning a program of study to meet their personal long-term goals. It will be promoted to have these personal goals align with regional and national goals as well.

School Buildings

I have also thought about the physical structure for a school to support integrated learning. I have been perpetually working on combining a lifelong interest in architecture and spending a lot of time in local K-16 schools/universities to continually refine ideas for tangible spaces to support a structure designed for integrated learning. I have also worked on ideas to support the transitions for traditionally structured schools become integrated learning centers.

School Day Structure

The nature of integrated learning has led me to have more realistic thoughts on how to solve some current issues with school day scheduling structures. Many teachers dislike trying to fit their subject into individual time slots, as it doesn't afford enough time to get into depths of topics. Others have a dislike for the four-block system, as it allows students to go a whole semester, and sometimes a year, without taking a subject (sometimes math and science, the subjects that this country's students are least able to grasp.) Integrated learning centers would allow for students to have a more uniform exposure to all of the disciplines.