Case Study: A Multi-disciplinary approach to Phenomenon Learning – "Teaching by Topic"

An effective educator is one who has a lasting impact on students, embraces and masters technology to teach students born and raised in the digital age, and facilitates the acquisition of 21st Century skills for student success through the education process, in the workforce and in life. Effective educators are well-prepared to work in concert around a thoughtful, high-quality curriculum aligned to standards and supported by appropriate materials and assessments - elements that constitute a system that helps students to learn and educators to continue to improve. Effective educators also serve to guide their students toward success throughout the education continuum that will lead toward success in life. In their arsenals and toolkits of teaching are key strategies that facilitate their students acquiring cognitive skills and higher-order thinking that enables understanding, analysis, interpretation, precision and accuracy, problem solving, and reasoning when engaged in learning. The "big ideas" of content areas are also very important building blocks, and the computer-supported collaborative learning model on which our knowledge-building model rests promotes phenomenon learning around ideas while facilitating the acquisition of important 21st Century skills – the 4Cs of future education – ready for post-secondary education and training, and skilled for the 21st Century workforce.

We looked at several model education systems in countries, consistently at the top of international rankings of learning assessments such as PISA (Program for International Student Assessment) regarding reading, mathematics, and science literacy, and found they had built high-quality education system for their children in primary and secondary education by rethinking teaching and learning. Like Finland, they have drastically changed their education methods to introduce a curriculum based around "teaching by topic", where core subjects, such as Geography and History, are replaced by project-based learning, where students are taught cross-subject topics, such as climactic change, sustainability and economic trading zones that incorporate multi-disciplinary content. This "phenomenon learning", which can also be referred to as project-based learning around ideas, plus the effective use of technology for content delivery, learning assessments and the continued professional development of educators - teachers, principals and support staff – constitute the key to its success.

Utilizing technology effectively enables us to live, learn, and work successfully in an increasingly complex, information-rich and knowledge-based society. Technology can capacitate students within a sound educational setting to become proficient information technology users, information seekers, analyzers, evaluators, problem-solvers and decision-makers. They can become creative and effective users of productivity tools, communicators, collaborators, as well as informed, responsible, and contributing citizens. Through the effective use of technology in the schooling process, students have the opportunity to acquire important technology capabilities, with the key individual in helping students develop those capabilities being the classroom teacher. He or she is responsible for establishing the classroom environment and preparing opportunities that facilitate students' use of technology to learn and communicate. Consequently, it is critical that teachers in primary and secondary education be prepared to facilitate these types of opportunities for their students by learning how to execute, monitor, and regulate the knowledge-construction process. By aligning the curriculum of project-based learning in collaborative learning environments to standards supported by a knowledge-building model that bundles pedagogy and theory, methodologies, technologies and assessment, we value what content is learned; by supporting phenomenon learning environments, we also value how students engage in inquiry, enabling them to function as do professionals – scientists, business people, and community leaders – responding to real-world problems in learning communities similar to those in research and business. The model has been proven effective from over 30 years of research led by

the Building Cultural Capacity for Innovation (https://web.archive.org/web/20150215021806/http://ikit.org/bcci/) - a multi-nation design research project with a practical application in classroom learning in over 17 countries around the world. The Catalonia (Spain) Superior Council of Education Evaluation recently evaluated this knowledge-building model utilized in schools throughout the province under the auspices of the Catalonia Ministry of Education beginning in 2006. A thorough and rigorous evaluation at the highest levels of the Ministry of Education supported the announcement that the model representing the COMConeixer Project, currently known as the Knowledge Building International Project, was completed in 2014. Copies of the report are available upon request.

Students engaged in knowledge-building classrooms where the teachers are proficient in ICTs to help them learn and acquire skills and knowledge based on a broad set of competencies are able to seek out information and research answers to problems, learn to analyze oftentimes complex materials, and able to distinguish between useful and irrelevant material. Learning becomes relevant, as students study common themes related to the real-world challenges their own communities face. Major changes in society have been brought about by information, knowledge has become the central, key resource in multicultural societies with borderless geography, ideas have become an important source of economic growth, and "knowledge workers" constitute the fastest-growing sector of today's global work force. Societies have transitioned from the industrial age to the Knowledge Age, where knowledge and ideas constitute valuable resources and important sources of economic growth. When dialogue around ideas can be supported in learning environments whose members can share knowledge that will benefit all reciprocally, individual ideas can be transformed into action from the collective knowledge accumulation of the group. These are the Collaborative Learning Communities of 21st Century education, business, and government that support sharing ideas, information and work on common issues and problems to achieve a common goal. This collaborative work translates into knowledge-building classrooms in primary and secondary education, where small group learning revolves around common topics, and where scaffolding and discourse on issues establish a classroom setting that functions as a scientific community of learning.

Sample multi-disciplinary learning environments

The American inventor Henry Ford once said, "Coming together is a beginning. Keeping together is progress. Working together is success." What better success than to solve problems that constitute a commonality such as water, impacting every man, woman and child on earth. Challenges arise when there is not enough of it, as with drought, and when there is too much of it, as with flooding and rising sea levels. Water nurtures the planet's ecosystems and connects people, and can be viewed from multi-disciplinary perspectives. People can come together to work toward refining ideas around the challenges based in water utilizing methodologies supporting collaborative learning through Knowledge Building (KB), created and developed for a community of learners to create knowledge.

Knowledge-Building Theory goes hand-in-hand with UNESCO's Competency Framework for Teaching[1] that sets forth standards for educators to help their students become collaborative, problem-solving, creative learners. It also aligns with OECD's competencies for 21st Century learning[2]. The following case study demonstrates how a constructivism approach to reimagining learning and teaching through the use of computer-supported KB methodologies helped students come together to discover, dissect, apply creativity and collaborate on finding solutions to the challenges around the common topic of water:

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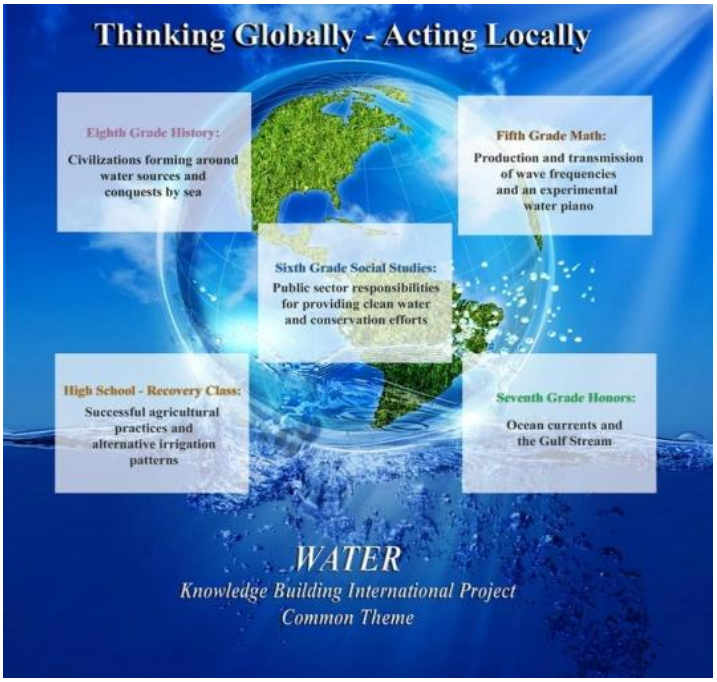
1. UNESCO's Information and Communication Technologies (ICT) Competency Framework for Teaching (CFT) addresses aspects of a teacher's work, arranged in different approaching to teaching: Technology Literacy, Knowledge Deepening, Knowledge Creation

2. OECD's seven transversal principles to guide the development of learning environments for the 21st Century: Learners at the Center, The Social Nature of Learning, Emotions are Integral to Learning, Recognising Individual Differences, Stretching all Students, Assessment for Learning, Building Horizontal Connections

Knowledge Building is manifested in different types of classroom-based and out-of-school learning environments, primarily in student engagement, where content is contextualized and a curriculum is based in ***phenomenon learning****, or "teaching by topic". It incorporates technology-based methodologies that allow learners to interact with the content of classroom instruction through deep learning. In a knowledge-building class, educators can become coaches and facilitators of learning rather than simply deliverers of pre-determined content. Knowledge-Building Theory supports students and teachers becoming co-learners, gaining knowledge from the experiences of others to achieve their learning objectives around the production and continual improvement of ideas. KB classrooms create opportunities for students to acquire 21st Century skills that support real-world problem-solving, related to STEM skills, particularly analytical skills and the scientific method. Here, students become self-directed learners, researching the topic of water from a multidisciplinary approach and formulating their theories on what could become innovated solutions to the problems associated with the topic. Learning is not only relevant but engaging, interesting, and fun - primarily because the students are preparing for threats they themselves might come to face or problems impacting their own community.*

Knowledge Building supports higher-level thinking skills such as metacognition, problem solving, and critical thinking. Knowledge–building classrooms function in the same way as scientific communities, where members of small groups are able to formulate theories and utilize scaffolding to arrive at answers and to defend their theories in dialogue with their peers, which encourages learning from a reality-centered point of view around ideas. Theme-based learning and exploration, coupled with activities based on real issues applicable to everyday life, convert the classroom into living labs, engaging teachers and students alike in personalized, meaningful learning through a methodical, systematic approach. The results: a multi-disciplinary perspective to improve student growth and academic achievement through deep learning, supporting mastery of core academic content, and building skills critical to academic and professional success in the 21st Century. Students in knowledge-building learning environments not only develop competencies and increased literacy skills because they are constantly reading and writing, but also come to see themselves and their work as part of a society-wide effort to advance knowledge frontiers. They are able to create new knowledge from the workings of the group for applications in a global society. They can access the platform Knowledge Forum (currently in version 5: KF5 – www.knowledgeforum.com), which forms the foundational basis of knowledge-building collaborative learning, through the Internet or hosted on a local server. This electronic workspace facilitates students working collaboratively on revolving their studies and research around a common theme, they are able to apply the "act locally/think globally" philosophy to turn local issues into global issues. The following illustrates how a multi-disciplinary approach was used to study water:

- *An Earth Sciences class studied the Humboldt Current to learn how pollutants from an oil spill in North America reached the shores of the European continent.*
- *A Social Studies class focused on government's responsibility for providing clean water to its citizens and water conservation.*
- *A Mathematics class studied wave frequencies on an experimental water piano.*
- *A History class studied how civilizations were formed around water sources such as rivers and lakes, and how conquests were made by sea.*

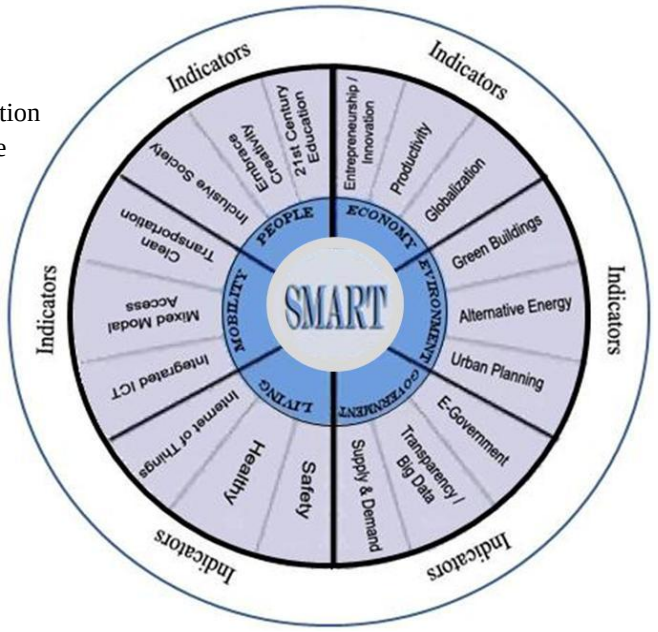


By partnering with classrooms in other cities around the globe, an international exposure is brought to the work students do on building knowledge around problems affecting their community, such as with the example of water.

Our case study of Knowledge Building around common topics shows how students come to understand the science of water – its origins and sources, its use, its treatment, technology around water, and all kinds of information that benefits – and is relevant – to people around the world. An example of multi-disciplinary studies around agriculture gives another perspective of the effectiveness of phenomenon learning, or learning around topics:

- *An Economics class studies supply and demand of agricultural products.*
- *A Civics class looks into government control for quality, disease abatement, and interstate or inter-province and import/export commerce regulations for agricultural products.*
- *A Chemistry class studies soil composition and the nutrients needed for healthy agricultural crops.*
- *An Earth Science class studies how challenges around water impact agricultural practices and lead to alternative methods of crop production such as hydroponics.*
- *A Biology class learns how the agricultural sector produces the many foods needed for healthy bodies, including GMOs and organics, as well as vermin control needed for healthy crops.*
- *A Geography class sees how the local topology is suited or not suited for crop production and look to alternative solutions such as vertical gardens.*
- *An Urban Environment class studies how cities are promoting the idea of citizen gardens for mini-crop production.*
- *A History class studies how past agriculture practices have led to those infused with technology.*
- *An Information Technology class studies systems needed to cultivate, harvest, transport and commercialize agricultural products for domestic consumption and export.*

A further example of phenomenon learning can be seen in its application around the topics of Smart Cities. Urban centers around the world are demanding 21st-Century solutions to accommodate their growing populations, ones that not only maintain the quality of life but also improve it in a culturally-sensitive method. Much innovation is taking place to create or improve products and services that can be adopted and adapted to urban centers' needs to produce real value in communities being able to embrace:



- ***Smart Environments**, including green buildings, alternative energy and urban planning;*
- ***Smart Government**, including transparency and open data, and E-government services;*
- ***Smart Living**, including culturally vibrant, safe and healthy communities and inclusive societies;*
- ***Smart Mobility**, including clean/mass transportation and integrated information and communication technologies;*
- ***Smart Economy,** including entrepreneurship and innovation, productivity and global interconnections;*
- ***Smart People,** embracing creativity, and reimaging teaching and learning for 21st Century education.*

By implementing the knowledge-building model that bundles theory, pedagogy and methodologies, technology and learning assessment in the primary and secondary education classroom, new approaches to the study of traditional subjects, as well as laying the groundwork for an introduction of new sciences subjects, can lead to effective teaching. This is made apparent when the assessment tools provide a visualization and empirical evidence of student growth and subject mastery in real time throughout the school cycle. Assessments are performed on collaboration indicators to assure learning benchmarks are being met, and students are making substantive gains in mutual understanding and collaborative knowledge, and are progressing towards all other key achievements and goals. The assessment tools embedded in the KF5 platfrom support both formative and summative assessments.

Examples of questions in classrooms studying the common topic of water posed by the teachers to their students included: "How are forests nourished with rainwater to produce raw material?" "How will societies build new infrastructures for areas with populations displaced by rising sea levels?" "How does climate change affect weather patterns that produce drought and floods?" Notice the use of "How" when teachers pose questions to their students? Across time, men and women have accomplished great feats that did not seem possible in their wildest imagination by asking "how"… building the pyramids by positioning stones seemingly impossible to move; discovering far-flung lands despite the belief that the world was flat; reaching for the stars and eventually landing on the moon. By answering "How?", mankind pursues solutions to problems of great consequence to all the peoples of the world. Answering "How?" accomplishes what many thought to be impossible, and the impossible not only becomes possible but common place. Contemplating "How" is the key to knowledge-building success.

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CONTACT: Sandra Lund-Diaz, M.Ed.
Interim Executive Director, Knowledge Building in Action, Email: info@kbinaction.com