Chapter 15
"How"—The Key to Knowledge-Building Pedagogy Success in Supporting Paradigm Shifts for Student Growth and the 4Cs of Future Education

Sandra Lund-Diaz, Mireia Montane and Penelope Beery

15.1 Introduction

Over the past few decades, societies have transitioned from being industrialized and existing in isolation to being globally-entwined and based in knowledge. Classrooms have been transformed from factory-era teaching to a different type of learning for the Knowledge Age, where ideas are the main source of economic growth. The future of education is here today, where new pedagogies are needed to facilitate real-world learning, where students are able to acquire skills and competencies they need to achieve academic success, and where educators can become coaches and facilitators of learning AND co-learners rather than simply deliverers of pre-determined content. Knowledge Building is manifested in different types of classroom-based learning, primarily in student engagement, where content is contextualized and a curriculum is based in phenomenon learning, or "teaching by topic". It incorporates technology with methodologies that allow learners to interact with the content of classroom instruction in a deep and thoughtful manner through an interdisciplinary approach. Students and teachers alike are co-learning, gaining knowledge from the experiences of others to achieve their learning objectives around the production and continual improvement of ideas. Knowledge-building classrooms create opportunities for students to acquire 21st Century skills that support real-world problem-solving, related to so-called STEM skills, particularly analytical skills and the scientific method. We refer to these skills as the "4Cs of Future Education"—**Critical thinking · Collaboration · Communication · Creativity**—that will prepare students for success throughout the education continuum. These skills will also contribute to their preparation as engaged citizens and as productive workers in an era of volatile economies with surging unemployment

S. Lund-Diaz (✉) · M. Montane · P. Beery
Knowledge Building in Action, Miami, USA
e-mail: info@altlearningecosystem.com

N. Lee (ed.), *Google It*, DOI 10.1007/978-1-4939-6415-4_15

and under-employment, particularly among young adults, and a rapidly changing, globalized labor market.

The Alternative Learning and Teaching Ecosystem (ALTE) is a model for the 4Cs of Future Education mimicking education systems in countries consistently ranking high on skills assessments that have successfully reimaged learning and teaching. ALTE blends knowledge-building pedagogy and teacher training while promoting UNESCO information and communication technologies (ICT) competency framework for teaching (CFT) as well as OECD standards. The ICT CFT supports a teacher's development in *Technology Literacy* for more efficient learning, *Knowledge Deepening* that enables students to acquire in-depth knowledge of their school subjects and apply it to complex, real-world problems, and *Knowledge Creation*, enabling students, citizens and the workforce they become, to create the new knowledge required for more harmonious, fulfilling and prosperous societies. The ALTE model was built on knowledge-building principles with methodologies specifically developed to support these three approaches to 21st Century education.

Across time, men and women have accomplished great feats that did not seem possible in their wildest imagination… building the great pyramids by positioning stones seemingly impossible to move; discovering far-flung lands despite the common-held belief that the world was flat; man taking flight, reaching for the stars and landing on the moon. These are just a few examples of feats accomplished in spite of what many thought were insurmountable challenges. They required courage, persistence and faith, accompanied by a single-syllable word…"HOW?", propelling these accomplishments into our human history. By answering "How?", mankind pursues solutions to problems and situations of great consequence to all the peoples of the world, continually amazing disbelievers. Answering "How?" accomplishes what many thought to be impossible, and the impossible not only becomes possible but common place. "How?" withstands the testament of time and continues to provoke the innovation, ingenuity and creativity of those who dare to dream of accomplishing something great. And contemplating "How?" is the key to knowledge-building success.

15.2 A Model for the 4Cs of Future Education

Knowledge Building exploits those same traits—scientific curiosity, ingenuity, innovation and creativity—that supported the greatest discoveries of mankind as opportunities to engage students in interactive learning, beginning at a young age. These students will one day become our future scientists, educators, workforce and leaders, and through knowledge building they acquire critical skills that will prepare them for success in school, and later in life. These are the 21st Century skills that support real-world problem-solving, related to so-called STEM skills, particularly analytical skills and the scientific method. We refer to these skills as the "4Cs of Future Education"—Critical thinking • Collaboration • Communication • Creativity —that will prepare students for success throughout the education continuum. These

are the skills that will also contribute to their preparation as engaged citizens and productive workers in an era of volatile economies with surging unemployment and under-employment, particularly among young adults, and a rapidly changing, globalized labor market.

The 4Cs of Future Education are integral to Knowledge Building, which also supports deep learning through which students will develop a set of competencies to master the subject matters of their curriculum and instruction. They are able to understand academic content and apply their knowledge to problem-solving by engaging the 4Cs: thinking critically, working collaboratively, communicating effectively in the classroom, and applying creativity to come up with innovative solutions to the problems of the world. After all, the ability to imagine, create or discover should not fade as a person grows; rather it should be nurtured and strengthened before students are crippled by the norms of an industrial-era education system that is currently mainstream for learning and teaching. With the 4Cs, students will also develop academic mindsets for the classroom as well as for a job later in life. The 4Cs prepare students to achieve at high levels and gain mastery of core academic content, whether in traditional subjects or in interdisciplinary fields that merge several key fields of study. It is here that knowledge-building pedagogy and methodologies are most effective, giving the students tools to ask the right question to effective learning—HOW?

In creating an effective model for the 4Cs of Future Education, we looked at several education systems and focused on 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. We found that they had built high-quality pathways to learning for their children in primary and secondary education by rethinking teaching and learning [1]. They had drastically changed their education methods to introduce a curriculum based around phenomenon learning. This is where subject-specific lessons in core subjects such as Geography, History, Math, Economics, Biology, Earth Sciences and others become interdisciplinary studies through project-based learning aligned to standards. In phenomenon learning, students are taught cross-subject topics, such as climactic change, sustainability, nutrition, and economic trading zones that incorporate multi-disciplinary content from traditional subjects to answer the question, HOW?. This is the phenomenon learning of those model education systems, and the effective use of technology for content delivery and the continued professional development of their educators is key to success.

These models also reimagine learning, where the format of the traditional, more passive approach to learning is replaced by a more collaborative method of learning. Instead of sitting and listening to the teacher standing in the front of the classroom, students are encouraged to work together to discuss and solve problems in a collaborative small-group learning environment as co-learners, led by the teacher who becomes a facilitator of learning rather than a transmitter of pre-determined content. We based our model for the 4Cs of Future Education, the Alternative Learning and Teaching Ecosystem (ALTE), on lessons learned from the phenomenon learning of those countries that have successfully reimaged learning and teaching.

ALTE blends knowledge-building pedagogy and teacher training, mimicking those high-quality education systems by supporting the following elements:

- Computer-supported collaborative learning around topics through the use of education technology developed specifically to support the highly-researched principles of knowledge-building pedagogy [2];
- Teacher training in the use of education technology developed to support collaborative learning around topics through a multi-disciplinary approach while promoting proficiency in information and communication technologies and UNESCO's competency framework for teaching [3];
- Bringing education technology into the classroom and utilizing embedded assessment tools to track student growth and conduct formative and summative assessments in real time;
- Partnering classrooms world-wide to build relationships between students and between educators, including teachers, principals and technology staff.

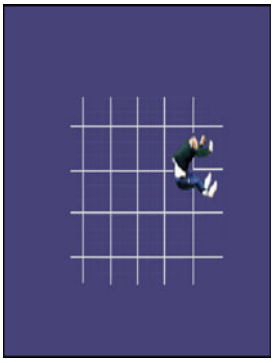
15.3 Contextualization and Personalized Learning

ALTE 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. They examine the issues at hand through the HOW? lens, applying the 4Cs of Future Education in a methodical, systematic approach based on scaffolding. 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.

CASE STUDY: A Multidisciplinary Approach to Studying Math…..

Welcome to the ninth grade math class of Mr. Hamilton, working with his students asking HOW they can improve the long jump for an upcoming sports competition. Students create digital media that trace their practice sessions, and by watching their videotaped performances in long-jump trials and comparing their performance to grids and charts, students study important math and physics concepts - angles, momentum and distance. But they also study physiology and begin to understand how muscles work, and human health topics where they also learn how nutrition and adequate sleep contribute toward the formation and maintenance of healthy muscles.

Students work together in small groups to share their ideas on how to improve their long jump and increase their distance. They do research on the different subjects incorporated into what started as a math class transformed into a multi-disciplinary study of subject matters relevant to their lives.



This case study demonstrates an important aspect of the ALTE Model—personalized relevance of the subject matter being studied. Mr. Hamilton's students are motivated to learn because they are studying THEIR muscles, THEIR performance and unlocking THEIR potential. Another important aspect to consider—how engagement in hands-on activities changes not only the student but the teacher as well. Case in point: many of the students in Mr. Hamilton's class volunteer to become peer tutors to work alongside their teacher, to produce digital media that reflect the curriculum and standards that high school students are expected to master. Mr. Hamilton taps into his own creative potential by overseeing the production of content tailored to his student population. Under the status quo of teaching, mathematics teachers are expected to be content conveyors, following pre-defined curriculum in preparation for accountability tests; they are not expected to be creative in producing content or products. However, by producing these video presentations of students performing long jumps, Mr. Hamilton becomes an effective, creative agent at the complex intersection of navigating mathematical content and student cognition.

This multidisciplinary approach to learning complementary areas of studies has a direct impact on the focused subject matter or discipline. As in the case study of Mr. Hamilton's math class, not only do these group exercises allow the entire class to master the math concepts and content being studied, but they also learn complementary aspects of biology, physics and life sciences, thereby acquiring a deeper understanding of the subject matter and performing better on tests. This multi-disciplinary, multi-media student-driven approach is ideal for closing the achievement gap for students with learning difficulties, moving learning away from being literature driven and into a realm the student can easily grasp, which also serves English language learners well. It also taps into personalized learning, where the knowledge-building pedagogy on which ALTE is based tailors the learning experience to meet different needs of the students in small group learning environments. And when teachers from other subject matters interact with students they may not normally have contact with, the learning is enriched through an inter-disciplinary approach. This interaction can come from a teacher across the hall or around the world.

The ALTE computer-supported collaborative learning paradigm promotes discourse around ideas, with learning based on collaborative problem-solving rather than memorization. The use of ICTs and specialized knowledgeware support the constructive use of authoritative information in acquiring knowledge around a theme. Students learning 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 community. When students work 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, again taking a multi-disciplinary approach to studying different subject matters. By partnering with other classrooms around the globe, an international exposure is brought to the work students do on building knowledge around problems affecting their community.

Knowledge Building in Action [4] is the umbrella 501(c)(3) nonprofit organization providing the infrastructure for ALTE. During past school cycles, it facilitated the participation of U.S. classrooms in the Knowledge Building International Project (KBIP), a successful multi-year international collaboration between classrooms and the COMConeixer project [5] (translated from Catalan into "building knowledge together") in Catalonia, Spain, on which ALTE is based. Teachers selected water—which is of vital importance to everyone on this planet—as the common theme of their inquiry-based collaborative learning. Educators in U.S. classrooms participated in KBIP, where the ALTE module of teacher training and student learning was incorporated into the curriculum. Ms. Anderson's 6th grade social studies at the 68th Street School in South-Central Los Angeles focused on public sector efforts to supply clean water for their citizens and learned about the importance of conserving water so that there would be a sufficient supply for the entire world; Ms. Erlington's 6th grade social studies classes featured project-based learning within the context of Knowledge Building, and students in Mr. Aviles' 6th grade math class studied a prototype water piano to listen to different sounds based on water volume and density. Ms. Morales' 8th grade history class at the Lou Dantzler Middle School, also in Los Angeles, explored how great civilizations were formed around water sources and the conquest of societies made possible by navigation on the seas and oceans. Mr. McKenna used the ALTE model for his Project-Based Credit Recovery class of Special Education students at Malaga Cove Academy in Palos Verdes, CA, studying history from a multi-disciplinary perspective. Mr. Crabtree engaged his 7th and 8th grade honors science students at Rizzoli Academy for Gifted and Talented Students in Hartford, CT in exploring scientific concepts, and Ms. Riad's class of 9–11 year olds at Lake Trafford Elementary School in Immokalee, FL, studied their core subjects of social studies utilizing the ALTE Model to understand ocean currents and the Gulf Stream, focusing on wide-spread effect of the Deepwater Horizons oil spill.

These U.S. teachers were slated to be partnered with their colleagues teaching the same age groups and subject matters in other parts of the world, still focusing on the common topic of water. These included teachers in Quebec and Toronto, Canada; Barcelona and Tarragona, Spain; Helsinki, Finland; Bari, Italy; Oslo, Norway; Porto and Lisbon, Portugal; Bogota, Colombia; Puebla, Mexico; and Hong Kong. Teachers from these other countries were also studying the water topic from both a local perspective as well as a global perspective. Several examples of questions posed by the teachers to their students included: "Why are the fish dying in the St. Lawrence River?" "How did an oil spill in the Gulf of Mexico reach the shores of Finland?" "What type of forests nourished with rainwater provide raw material for the housing boom in China and how does pollution impact the cycle?" "What is happening with global warming and sea levels rising?"

15.4 Promoting UNESCO's Competency Framework for Teaching

Student progress in the types of learning environments proposed by ALTE does not happen naturally without facilitation. Teacher intervention is needed to coordinate the small groups and mediate their interactions. Additionally, acknowledging the role of

the teacher in raising a student's achievement is of utmost importance. ALTE provides initial training, ongoing mentoring and support for teachers to serve as leaders, motivators and facilitators of learning while gaining proficiency in the use of technology in the classroom. It also supports the interactions between principals, technology staff and other faculty. An important objective of the teacher training component of ALTE is partnering educators with their peers and colleagues for mentoring. The ALTE Community of Practice facilitates virtual interactions, archived material, and an exchange of information as well as ongoing professional development.

Another important objective of the ALTE Model refers to efforts that promote UNESCO information and communication technologies (ICT) competency framework for teaching (CFT). UNESCO's ICT CFT supports standards that outline competencies that teachers need to master for student motivation, and the teacher's as well. The Framework is arranged in three successive stages of a teacher's development:

- *Technology Literacy* enables teachers to acquire competencies to incorporate technology, learning materials and ICT equipment to inspire student motivation to use ICTs in order to learn more efficiently.
- *Knowledge Deepening* enables students to acquire in-depth knowledge of their school subjects through multi-disciplinary approaches to content mastery around topics and apply it to complex, real-world problems.
- *Knowledge Creation* enables students, citizens and the workforce they become to create the new knowledge required for more harmonious, fulfilling and prosperous societies.

The ALTE model was built on knowledge-building principles with methodologies specifically developed to support these three approaches to learning and teaching. The model is a complete ecosystem consisting of knowledge-building pedagogy, educational technology, teacher training, and tools for formative and summative assessments of student growth, created specifically to support innovative approaches to 21st Century education. Through ALTE, we are able to partner classrooms in K-12 learning environments (standard classrooms, after-school programs, Department of Defense schools, alternative learning venues, international baccalaureate coursework, etc.) anywhere there is broadband. The actual educational technology consisting of the Knowledge Forum as an electronic workspace is also available for implementation on local servers. The Knowledge Forum is a product of 25+ years of research by an international network of educators and engineers [6], proven effective in supporting students acquiring 21st Century skills, particularly the 4Cs of Future Education and tools that help students ask the important questions of life.

15.5 Conclusions

The ALTE model supports 21st Century education through guided student research within technology-rich collaborative environments for PreK-12 learning. The model partners classrooms around the globe through the use of computers, multimedia technology, the Internet and specialized educational technology known as the "Knowledge Forum™", an electronic workspace and platform that supports the scaffolding processes of scientific inquiry and embedded applets to perform the formative assessments needed to verify student growth [7]. The platform supports Knowledge Building both in the creation of notes contributed by the students and in the ways they are displayed, linked, and made objects of further work. Revisions, elaborations, and reorganizations over time provide a record of group advances, like the accumulation of research advances in a scholarly discipline. When notes (text, graphics, multimedia, videos, etc.) are added to the Knowledge Forum's database, students are able to search existing notes, comment on other students' notes, or organize notes into more complex structures. As the database grows, the workspace provides a progressive trace of how ideas have evolved in the class, and the database helps to formally show and document the classroom community's knowledge advancement while helping students further advance their ideas. Students build on each other's notes by agreeing, asking and answering questions, offering opinions, and establishing a culture of accepting individual difference. Scaffolds allow users to add a theory about a problem and build-on or critique a theory—of their own or of another member of their group. An endless improvability of ideas is supported by the ability to create increasingly high-order conceptual frameworks. It is always possible to reformulate problems at more complex levels, create a rise-above note that encompasses previous rise-above notes, or to create a more inclusive view-of-views. Notes and views can be revised at any time, unlike most discussion environments that disallow changes after a note is posted. Processes of peer review and new forms of publication engage students in group editorial processes. Published works appear in a different visual form and searches can be restricted to the published layer of a database. Analytic toolkits embedded in the Knowledge Forum platform are used to assess social network patterns when we are interested in collaboration dynamics, and vocabulary growth when we are looking at concept attainment. Knowledge builders monitor their work, and engage in self-assessment rather than being totally dependent on external evaluations.

These activities have a clear goal of co-creating new perspectives and advancing knowledge beyond the limit of an individual. Numerous research findings show that this approach, specifically the knowledge-building approach, induces motivation to learning, improves learners' higher order thinking (e.g. critical thinking, problem-solving), and fosters personal development (e.g. communication skills, interpersonal skills and lifelong learning attitudes). Through the ALTE model, they are able to share knowledge and tackle projects that incorporate features of teamwork, real-world content and the use of varied information sources, especially the use of information technology to access authoritative sources. Activity is directed toward

the need to educate students for a world in which knowledge creation and innovation are pervasive. The production and continual improvement of ideas of value to the "community", in this case making reference to the community of students, are central to Knowledge Building theory and philosophy. Learners are engaged in the full process of knowledge creation as preparation for entering college and/or the workforce. Every student is a contributor toward the collective knowledge of the group, and the success of the student community depends on the careful cultivation of ideas and the constant use and re-use of knowledge resources—cultivating skills and natural inquisitiveness for the ability to ask the right questions, including "HOW".

References

1. Darling-Hammond, L. (2010). "Steady Work: Finland Builds a Strong Teaching and Learning System", Rethinking Schools, Volume 24, Number 4. Retrieved online at http://www.rethinkingschools.org/restrict.asp?path=archive/24_04/24_04_finland.shtml
2. Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, Pedagogy, and Technology. In K. Sawyer (Ed.), Cambridge Handbook of the Learning Sciences (pp. 97–118). New York: Cambridge University Press.
3. United Nations Educational, Scientific and Cultural Organization. 2011. Transforming Education: The Power of ICT Policies. Paris, France
4. Consell Superior d'Avaluació del Sistema Educatiu. 2014. COMconèixer (How to Know). Assessment of the Project. Learning Through Virtual Communities. Barcelona, Catalonia
5. Institute for Knowledge Innovation and Technology (IKIT). Building Cultural Capacity for Innovation. Available online at http://ikit.org/
6. Knowledge Building in Action, 501(c)(3) nonprofit organization. http://www.kbinaction.com
7. Knowledge Forum electronic workspace.

Author Biographies

Sandra Lund-Diaz is the Founder and Executive Director of Knowledge Building in Action, a 501(c)(3) nonprofit organization created to gain traction for knowledge- building pedagogy and partner U.S. classrooms and teachers with their peers in other countries. She is currently co-Chair of the ATEE Global Education Community.

Mireia Montane is the Director of International Projects at the Catalonia College of Arts, Letters and Sciences, and formerly responsible for the proliferation of knowledge-building classrooms through the Ministry of Education of the Generalitat, the Catalan government entity responsible for K-12 education. She is currently the President of the World Federation of Associations for Teacher Education.

Penelope Beery is a Teacher Trainer at Loyola Marymount University and the Los Angeles School District, and the Director of Training and Professional Development at Knowledge Building in Action.