Educator's Voice

NYSUT's Journal of Best Practices in Education Volume VIII, Spring 2015

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Developing Mathematical Thinking in the 21st Century

How Modes of Expression in the Arts Give Form to 21st Century Skills

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Critical Thinking and Problem-Solving for the 21st Century Learner

In this issue . . .

Authors go beyond teaching the three R's. Critical thinking and problem-solving for the 21st century learner means preparing students for a global society that has become defined by high speed communications, complex and rapid change, and increasing diversity. It means engaging students to use multiple strategies when solving a problem, to consider differing points of view, and to explore with many modalities.

This issue showcases eight different classrooms teaching critical thinking through inquiry and expedition, poetry and music. Authors investigate ways to make teaching and learning authentic, collaborative and hands-on. Students learn to problem solve by building working robots and go beyond rote memorization in math through gamification. Early learners use art to generate their own haiku, or journals to document their experiences with nature, and high school students learn earth science through outdoor investigations. Students in these classrooms are engaged in learning through Socratic dialogue, project based explorations, in-depth observation, critique and self-directed learning. It is a collection that demonstrates best practices for all learners who, as future citizens, will play a critical role in defining the knowledge society.

A Publication in Support of NYSUT's Initiative to End the Achievement Gap

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Dear Colleagues,

I am happy to announce that *Educator's Voice*, NYSUT's Journal of Best Practices in Education, is going digital. We are moving from our print publication to one that can be accessed through a variety of digital devices, so we can go wherever you go. Beginning with our first mailer that includes a QR code allowing readers to pull up the entire journal on a Smartphone or tablet, to our new interactive Web features, we are embracing 21st century technology.

While *Educator's Voice* will no longer be offered in print, we are expanding our online features to make the journal a more interactive and accessible experience for you, our readers. Our goal is to reach as many of you as possible, to make *Educator's Voice* available to all of our NYSUT members across the state. The use of multiple forms of technology will enable us to share these innovative classroom practices more broadly.

One of the new interactive functions "Educator to Educator" allows readers to post a comment to any of our authors. Tell them your reactions to the article or describe how you adapted the ideas in your own classroom. We are also introducing our featured author's video interviews. Learn more about an article of interest in a 3-4 minute video presentation from a selected author.

Please join us in celebrating these exciting changes. Share the link to our website, download the PDF's to your computer or mobile devices, and share your feedback with the authors. Help us to make *Educator's Voice* a true 21st century member-to-member experience.

Sincerely,

Catalina R. Fortino

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Vice President, NYSUT

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The Editorial Board wishes to thank the following individuals for their contributions to the development of this volume: Barbara Back, Clarisse Banks, Cynthia DeMichele, Glenn Jeffers, Susan Lafond, Terry McSweeney, Melanie Pores, David Rothfuss, John Strachan, John Strom, Bernice Rivera and Carolyn Williams.

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Critical Thinking and Problem-Solving for the 21st Century Learner

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Inquiry-Based Learning: Preparing Young Learners for the Demands of the 21st Century

SUMMARY

In this classroom early learners are challenged to explore a hands-on investigation in science. Using inquiry to inform the process, students are led through a carefully developed and exciting study on the life of worms. Across observations, rich discussions, and nature journals, a multi-sensory experience unfolds in one urban classroom.

Learning begins with a sense of wonder

— a sudden spark that ignites a curious mind and propels it into action. Children are born with this innate sense of wonder. They begin their lives already demonstrating the skills of a scientist, observing and questioning the environment in order to make sense of their place in the world. They totter to and fro, experimenting, fumbling, wondering and thereby creating their own understandings. Unfortunately, in this educational climate's push toward standardization and a one-size-fits-all curriculum, it is all too easy to lose sight of the natural curiosity piping from young children. As early childhood educators, it is our responsibility to nurture and defend the threads of curiosity and the wisps of wonder in order to best equip our youngest learners with the skills to become the future problem-solvers, researchers and critical thinkers of the 21st century.

The learners of the 21st century are poised to join a workforce that requires them to ask questions, problem-solve and think critically, pursue investigation and share and apply their findings through multisensory lenses. Many of today's jobs require workers to think outside of the box and problem-solve from different angles, always being ready to construct and defend a new way of thinking. In order to provide

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Melissa Fine, United Federation of Teachers
Lindsey Desmond, United Federation of Teachers

the learners of today with the tools to participate fully in this challenging workforce, the understandings of teaching methodology in the classroom must be altered.

Gone are the days of regurgitation of facts and figures or filling in bubbles on an examination. John Dewey in *Education and Experience* (1938) described this rote process of learning as "static," referring to traditional education as an "imposition from above and from outside" (p. 16). Instead of teachers filling young minds with isolated skills and required subject matter, Dewey advocated that children should be actively involved in their learning and help co-construct knowledge that has both interest and meaning to them. In order to facilitate this progressive branch of learning, he maintained that the image of the role of the teacher should change from that of an "external boss or dictator" to that of a "leader of group activities" (p. 45). It is essential that we take a cue from Dewey's research and begin to transform teaching and learning into two-way dialogues that prompt active participation for our 21st-century learners.

Inquiry-Based Learning

Our pedagogical method of choice is *inquiry-based learning*. This approach invites children to take center stage in their own learning. Children pose meaningful questions and are encouraged to solve problems by experimenting and evaluating possible solutions. Teachers guide children to apply this newly constructed knowledge to broaden, analyze, critique, and ultimately defend new hypotheses. The teacher's role within this framework is that of a facilitator, guiding learners to explore their questions and decide on a course of action. Teachers pose carefully crafted, open-ended questions that allow learners to deepen their thinking and investigate further, rather than respond with one correct or incorrect answer. These open-ended questions are a pairing of the teacher's goals and learning objectives but also follow the lead of the children's own thinking. Teachers actively listen and reflect upon the thoughts of children in order to provide resources and provocations to extend the learning. They document the process of learning and make it visible to others through such mediums as photography, narratives, transcripts, videos, or audio recordings.

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Many of today's jobs require workers to think outside of the box and problem-solve from different angles, always being ready to construct and defend a new way of thinking.

To channel this level of engagement in the classroom, our youngest students must be actively present and instrumental in their own learning.

The Benefits of Inquiry-Based Learning

Inquiry-based learning is a method of teaching and learning that extends across content areas. Inquiry, as characterized by the National Science Education Standards (1996), refers to the multifaceted process of gaining information through diverse levels of investigation. The standards compare the inquiry process in the classroom to the activities and thinking processes of real-life scientists. Inquiry in both realms requires all participants to make observations, pose questions, actively engage in the research process and share their findings. In order to channel this level of engagement in the classroom, our youngest students must be actively present and instrumental in their own learning. This inquiry model echoes the constructivist theories of Freire, suggesting that children must be active participants in their learning, as opposed to vacant minds waiting to be filled with preordained information (Freire, 1970).

From the preschool to university setting, research points to growing evidence that inquiry-based learning fosters problem-solving, critical-thinking, and meaningful ways to co-construct knowledge (Wells, 1992). Samarapungavan, Mantzicopoulos, and Patrick (2008) compared the learning outcomes from a kindergarten guided butterfly inquiry with those of a comparison kindergarten group lacking the inquiry component to the butterfly study. Results showed that learning outcomes were richer and the level of student engagement was higher when teachers allowed students to follow the leads of their own questions and engage in authentic exploration within the inquiry group. Students were encouraged to make predictions, observe, investigate, and share their findings through discourse, drawings, and book readings (Samarapungavan, Mantzicopoulos & Patrick, 2008).

Inquiry-based learning also enables children to find their individual voice (as opposed to that of their teacher) and critique their own thinking. Research conducted by Hamlin and Wisneski (2012) emphasized the powerful learning that preschoolers engaged in when simply responding to an open-ended "what if" question posed by their teachers (p. 82).

Conezio and French, designers of a preschool science-based inquiry curriculum, also noticed a correlation existed between inquiry and the strengthening of literacy and language in the classroom environment. When students were engaged in a rich discourse about their learning, both receptive and expressive language skills were exercised (Conezio & French, 2002). A discourse between children involves the ability to actively listen to others and take note of different

perspectives or opinions. Ellen Doris in *Doing What Scientists Do* (2010) emphasizes the importance of this exchange of information as children collaborate to deepen their knowledge and understandings.

The Beginnings of A Worm Inquiry

In our urban public school on the Upper East Side of Manhattan, an inquiry process unfolded within a worm and composting investigation done in collaboration with a kindergarten and first-grade classroom. Our classes began the year engaging in weekly nature walks to a nearby park, accompanied by teachers and family volunteers. The children were tasked with collecting samples, sketching interesting findings, and jotting down ideas and observations in their nature journals. Through the course of several outings and rich discussions about the children's questions and observations, we noticed a propelling interest surrounding worms and the mystery of their life underground.

We gathered the children's initial understandings about worms through conversations, drawings, and written facts. This dialogue served as a formative assessment of the children's original understandings about worms.

Sample facts from the classes included:

"Worms help trees."

"Worms eat in a compost."

"Worms eat mud sometimes."

"I know about worm's doo doo. This is soil."

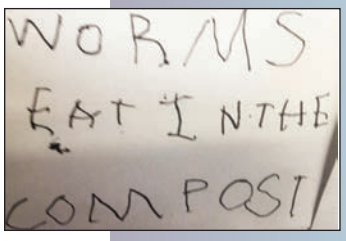
"Worms can grow a part of their body back if it gets cut."

"Worms eat dirt."

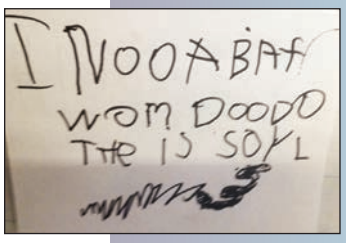
"Worms only live underground."

Both classes engaged in direct, hands-on exploration of a worm bin with Red Wiggler worms to allow children to further their observations and begin to pose wonders. The children took part in setting up the habitat and spent time observing and interacting with the worms.

Children examining worms during a nature walk to the park.

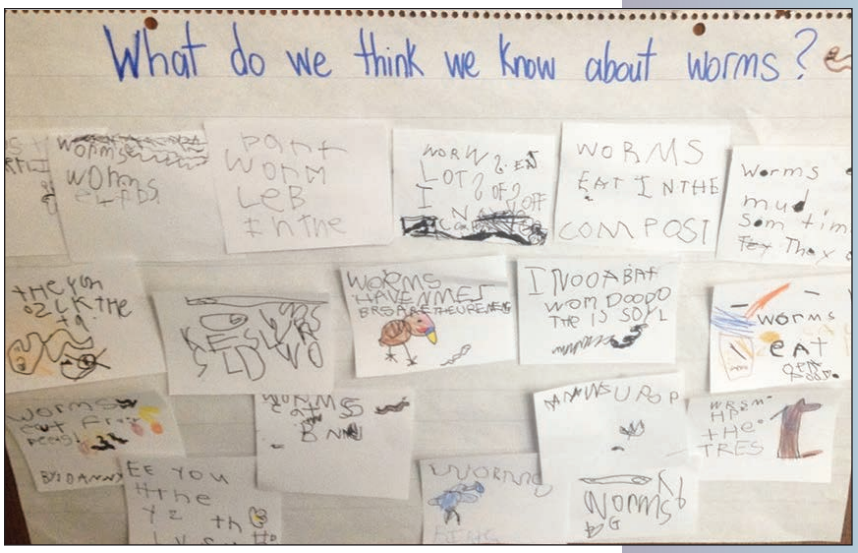


"Worms eat in the compost."



"I know about worm doo doo. This is soil."

Formative assessment interactive chart



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Children prepare the worm habitat by gathering strips of newspaper.

The strips of newspaper must be damp. The children are dipping the paper in water.

The worms are placed into the bin.

Kindergartner and first-grader exploring worms during buddy time.

During these observation times, we filled our notebooks with the thoughts and questions of the children.

"Do they like light or dark?"

"Do they like to be touched?"

"Can they hear?"

"How long will they get?"

"Why do they squirm?"

"Why do worms curl up?"

"Where are their eyes?"

"What is the ring around the body?"

"What do they like to eat when they go outside?"

"What do the babies look like?"

"Do worms have mothers?"

"Do they grow in their mother's belly?"

"Why are they wet?"

"Do worms have a heart?"

"Where are their teeth?"

Posing Questions and Seeking Answers

Through observation, experimentation, book research, interviews, and videos, the children began exploring and seeking answers to their many questions. An interview with an expert from the Lower East Side Ecology Center provided the children relevant information about the parts of the worm, their habitat, and how to feed them properly. Families from both classes contributed to our investigation by sending in food scraps for the new compost bins to help feed the worms. The pictures and captions in nonfiction books helped the children investigate the inner workings of worm bodies, including how they eat, reproduce, and survive in the wild. The acquisition and sharing of worm facts began to permeate the classroom on a daily basis, and we recorded conversations to document and reflect upon the learning process.

> "The worms in our worm bin have it easy!"
>
> "They don't have to worry about any predators and their food is delivered every week!"
>
> "I can't believe a worm has five hearts! Can you?"

Excitement filled the air as the worms acclimated to the bin and children explored and investigated. The children were eager to observe, dig, hold, measure, weigh, and prepare food for the worms.

Worm bin became a favorite activity in the classroom during choice time, and family members were encouraged to volunteer to help facilitate centers.

Children designed many contests to discover who could find the most babies or hold the most adults in one hand or prepare the new bedding the fastest. Boys and girls equally engaged in exploration and observation. One child enthusiastically noted, "Even though this is poop, it's not gross!" They had discovered that worms are, in fact, quite clean.

Sharing Learning Together

The children used photography, drawing, sculpting, and writing to share their findings with classmates. One group of students wrote the script for a puppet play and performed it in the class shadowbox theater, highlighting the day-to-day life of a worm in a worm bin.

> "I'm a Red Wiggler worm.
>
> I live in Classroom 205.
>
> I love to eat fruit and veggies but only after they are rotten.
>
> I squirm and dig and my poop is good for the Earth."

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Children prepare food to feed to the worms. The food comes from families and leftovers from the school's cafeteria.

Worm exploration at worm center.

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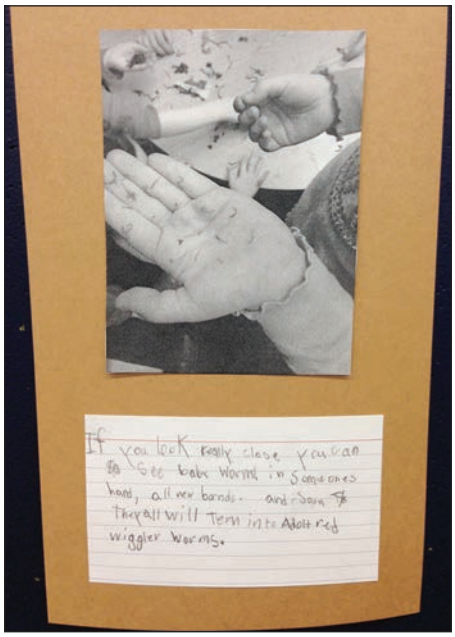
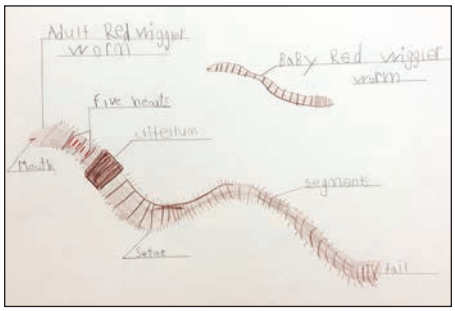
Another group crafted worm books in the "how-to" genre. Books with such titles as: *How to Care for Worms, How to Set up a Worm Bin, How to Get Rid of Fruit Flies,* and *What Worms Like to Eat* documented the learning children had acquired through observation and experimentation.

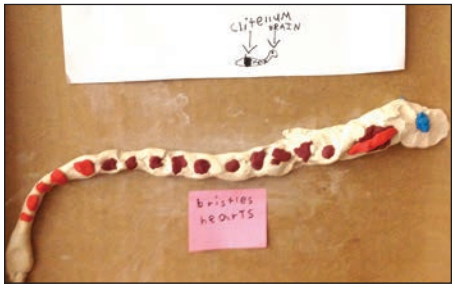
Posters and sculptures detailed the life cycle and labeled diagrams explained the body parts of worms, as well as their functions. Writing filled the rooms.



A student documents her observation of baby worms

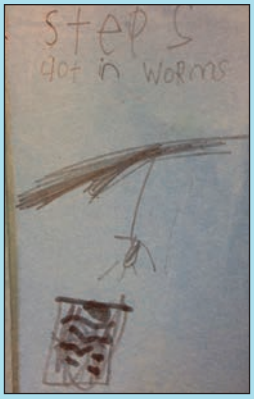


Student-created poster documenting the parts of a worm



Sculpture of the parts of a worm made with modeling clay

Excerpts from Student-Written Book: How To Care For Worms



Step 1
Get newspaper. Cut it. Soak it.

Step 2
Put in worms.

Step 3
Get vegetables, fruit or egg shell. No banana but peel OK. Make sure not a lot of water in it.

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Over the course of several months, the children hunted for cocoons and baby worms.

They sorted larger worms into categories such as adolescents and adults by looking for the clitellum (the ring around the head). Conversation began to revolve around questions and observations of the reproduction activity in the worm bin.

"What are the tiny yellow balls?"

"Look at the tiny newborn worms ... they look like strings!"

"What are we going to do with all these baby worms?"

"Will we ever see any dead worms?"

"When a lot of worms get close together it is hotter than when they are apart."

"Did you know that a worm can be a girl and a boy?"

Another research group became interested in exploring the food chain. The children marveled at the interdependence of animals for survival and imagined scenarios in which they might have eaten an animal that, at one time, ate a worm. As they learned about producers, consumers, and decomposers, children crafted their own plays documenting these life cycles.

"Worms eat plants.

Birds and frogs eat worms.

And even bigger animals eat those."

A Bend in the Road

Springtime brought new and exciting change to the worm bin. Children began to notice the worm castings (vermicast) filling up the bin.

"Sometimes the food gets eaten up fast and sometimes it stays in there for a long time."

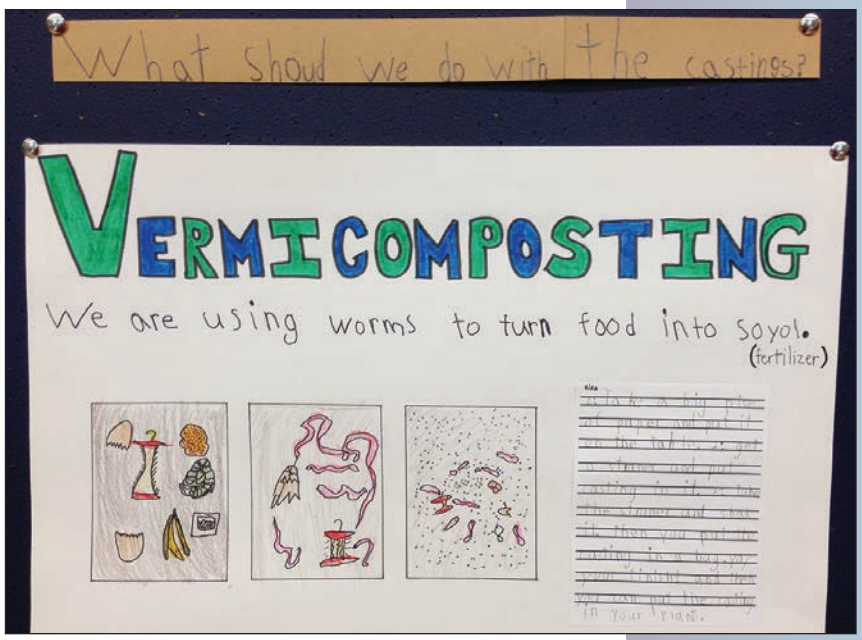
"Where is all the food going?"

"Why is it filling up with brown stuff?"

"It's starting to smell just like dirt in here!"

"Why is the worm bin getting so heavy?"

After reflecting on the content within questions such as these, it was clear that the children were curious about the process of *vermicomposting*.



Vermicomposting results from using worms to turn left-over food into soil.

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Students fertilize the soil of a young miniature daffodil plant with some vermicast compost.

We asked the children to determine what to do with these rich nutrients. By taking a vote it was decided that the vermicompost would be harvested and scattered in our local park to give back to the community. We would also use some of the vermicompost in the classroom to help our plants grow.

Giving Back to the Community

Plans dramatically shifted, however, when a third-grade teacher expressed interest in obtaining some of our vermicompost for her personal vegetable garden. Suddenly the learning constructed from our classroom inquiry was directly impacting a teacher in our school community, as well as her garden and all the animals and insects that called it home. Pride and purpose radiated from our classes as the children eagerly collected several gallons of vermicompost for the teacher. She brought in a fresh salad after the garden produced lettuce with our vermicompost. She later joined us for an interview to share how the vermicompost helped fertilize her garden and grow nutritious vegetables for others to enjoy.

Above: Children collect vermicast for a third-grade teacher's garden.

At right: The third-grade teacher shares a home grown salad with the class, completing the cycle of nature.

As the year and study came to a close, we reflected on the inquiry-based learning process in which our classes engaged. By allowing the children to pose their own questions, problem-solve and investigate, children became deeply invested in their learning and, as a result, formed and shared their own theories and findings with others.

A Student Shares His Findings With Classmates

An investigation into the life cycle of a worm had naturally evolved into a much deeper inquiry into food chains, decomposition, and environmentalism. In the process, our inquiry elicited exciting social action, research, writing, drawing, sculpture, puppetry, performance, and much more. Children portrayed a sense of compassion for the worms. Furthermore, the worm bin acted as an entry point into a deeper understanding of the worms' livelihood and environmental protection. Perhaps one child's thoughts best reflected the awareness to the connections within our natural world as well as a personal connection to the worm inquiry experience.

"Without these worms, lots of things would change."

Calling all 21st-Century Learners

The current workforce is demanding that we, as early child educators, guide children to cultivate the skills to become the future problem-solvers, critical thinkers and inventors of tomorrow. Traditional teaching practices that mirror a one-way line of communication and cater to one-size-fits-all curriculums are failing to prepare children for the road ahead. Our yearlong worm inquiry opened our eyes to the endless possibilities that arise when teachers provide children with the tools, time, and trust to become key players in their own learning. It is time to start building the foundation for teacher practices, such as inquiry-based learning, that will promote the skills needed for 21st-century thinkers. The time to begin this journey starts today.

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By allowing the children to pose their own questions, problem-solve and investigate, children became deeply invested in their learning and, as a result, formed and shared their own theories and findings with others.

Developing Mathematical Thinking in the 21st Century

SUMMARY

Critical and mathematical thinking are cultivated through an interactive process of discovery that uses gamification instead of rote memorization to teach higher order thinking skills in the secondary classroom. These authors explain how this approach can be used in varied contexts to increase mathematical understanding while increasing students' enthusiasm for math.

Just so we get this out of the way and the whole thing doesn't feel awkward later on, we should let you know that we're going to use the words gaming, gamers, and gamification in this article. But wait! Give us the next paragraph before moving on.

We know: You're a math teacher. You're not, for example, counting the minutes until you can play Candy Crush or Red Dead Redemption for 10 hours straight (though, alas, you might). Nor are you thinking that your students should do anything of the sort (though, alas, they might). What we will share in this article, however, are ways to use gamification to power up the teaching and learning of mathematics in the 21st century.

To be clear, when we discuss gamification, we don't mean just video games, but advancements made in the area of video games and gaming have taken learning to another level. That said, you don't need a wired classroom stocked with the latest-and-greatest technology to "gamify" anything. Gamification isn't necessarily about creating games or making learning fun either. Moreover, gamification isn't necessarily about offering rewards, points, and badges to "incentivize" students to learn.

Rather, gamification involves the strategic use of "game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning, and solve problems" (Kapp, 2012, p. 10). We contend that the real power of gamification rests in its ability

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Christian P. Wilkens, United University Professions College at Brockport, SUNY

to inspire people, especially adolescents, to want to learn, keep learning, know what they're learning, and want to learn more. With this in mind, we offer ideas about how to harness the power of gamification and "learning like a gamer" to develop what some call mathematical thinking.

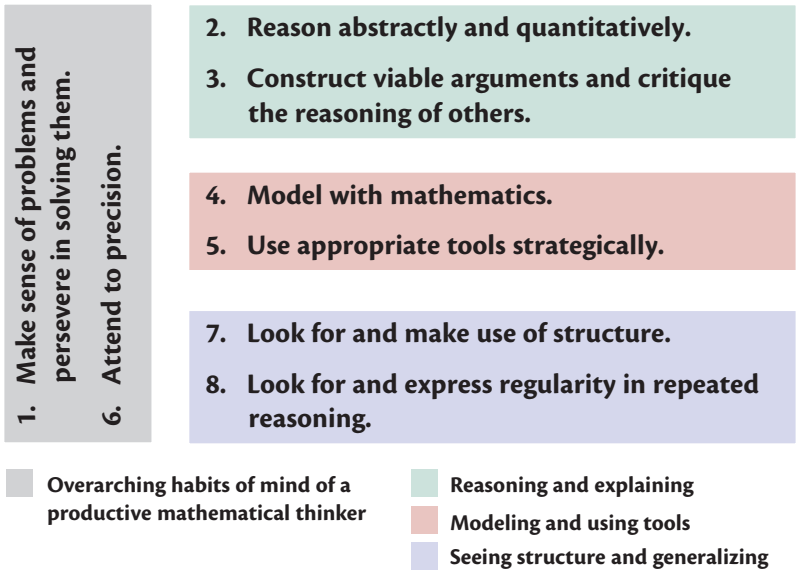
Mathematical Thinking in the 21st Century

At the heart of the Common Core State Standards in Mathematics (National Governors Association, 2010) are eight Standards for Mathematical Practice. These eight principles combine the NCTM (2000) process standards (communication, representation, reasoning and proof, connections, and problem-solving) and the National Research Council's (2001) five strands of mathematical proficiency (conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition). As such, the Standards for Mathematical Practice represent the aggregate of mathematical knowledge, skills, abilities, habits, and attitudes deemed essential to "producing mathematically able students well-equipped for 21st century life and career(s)" (Devlin, 2014, p. 3). Figure 1 depicts what these practices are and how they relate:

"Every technique and method I learned in obtaining my bachelor's and doctorate in mathematics can now be outsourced. What makes me still marketable is mathematical thinking."

— Keith Devlin, Ph.D., 21st Century Mathematics Conference: Stockholm, Sweden (April 2013)

Figure 1: Higher-Order Structure of Standards for Mathematical Practice



Source: http://www.ascd.org/ascd-express/vol8/805-parker.aspx

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The real power of gamification rests in its ability to inspire people, especially adolescents, to want to learn, keep learning, know what they're learning, and want to learn more.

As a whole, these mathematical practices embody the kind of mathematical thinking important to understanding modern-day mathematics as the science of patterns:

Mathematical thinking is more than being able to do arithmetic or solve algebra problems….Mathematical thinking is a whole way of looking at things, of stripping them down to their numerical, structural, or logical essentials, and of analyzing the underlying patterns (Devlin, 2011, p. 59).

To develop the kinds of innovative mathematical thinkers needed now and in the future, Devlin recommends that we, as teachers, need to focus less on computational skills and learning procedures to solve problems, and focus more on helping students "learn how to learn" and develop "a good conceptual understanding of mathematics, its power, its scope, when and how it can be applied, and its limitations" (p. 21). So how might we do that? By *gamifying* learning and instruction.

Mathematical Thinking and Gamification

Recent developments within the field of mathematics and math education suggest that the development of mathematical thinking occurs when learning is approached as a highly interactive process of discovery and serious play rather than as a set of operations to memorize or follow (Devlin, 2012, 2011; Wallace, 2013). In a similar vein, research on the effects of video gaming in the world of work suggests that we need to seriously rethink how we're approaching teaching and learning in general — on-the-job or in classrooms. When it comes to learning in the 21st century, video gaming is clearly a game changer. Carstens and Beck (2005) argue, for example, that "games and their powerful interactivity and reinforcement of particular behaviors [and ways of thinking]" have created an entirely new generation of workers and learners who are "hardwired" in ways that significantly differ from previous generations (p. 22). They say games have not only changed how gamers think about themselves, but "how the world should work, how people should relate to one another and … the goals of life in general" (p. 23).

Currently, 91 percent of our youth in the U.S. (between the ages of 2 and 17) play video games, with 99 percent of teenage boys and 94 percent of girls playing video games in some form or another (Granic, Lobel & Engels, 2014). Given these statistics, now is definitely the time to think about this new generation of learners and how learning is accomplished. What we do know about the "gamer generation"

(or those who have grown up playing videos games since the early 80s) is that when it comes to learning, they:

- require very little formal instruction
- freely trade information with other gamers
- strive to achieve meaningful goals
- face and overcome challenges that hold interest and value (Carstens & Beck, 2005; Beck & Wade, 2004)

These developments are what informed our decision to use gamification to develop mathematical thinking at the secondary level. Accordingly, in the next section of this article, we share a co-planned lesson that was taught multiple times to diverse learners in varied contexts (7th-, 11th- and 12th-grade students and college students [and nonmath majors] enrolled in a graduate-level course). Regardless of the learners' experience with, knowledge of, or interest in mathematics, all reported gaining a greater understanding and appreciation for mathematics in general and functions in particular. In this lesson, we highlight aspects of gaming used — specifically **discovery, serious play, striving toward meaningful goals** — to promote mathematical thinking around the concept of functions. In our discussion of this lesson we hope to make clear how important engagement, autonomy, mastery, and a sense of progression (through risk-free trial-and-error) are to gamification efforts of any kind.

Discovery: What is a machine?

Like all people, gamers appreciate, value, and take pride in the learning they discover themselves. Devlin (2011) suggests that learning through discovery motivates gamers "to put in the often considerable effort required to polish" their discovery but also "make good use of it" (p. 79). As such, the use of formal instruction and frontloading of information should be minimized (if not avoided). This may seem counterintuitive, but actually, it's more in line with what we know about how people learn how to problem-solve (Kapp, 2012). Using Kapp's definition, problem-solving is "any activity that involves original thinking to develop a solution, solve a dilemma, or create a product" (p. 144). One of the first things you can do to gamify your lesson is to create a dilemma or problem (or situational interest) that catches and holds your students' interest and immediately immerses students in the learning. It doesn't have to be an especially difficult or troubling situation, but it should engender sufficient situational interest. The key is to start first with mathematical concept and, as

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Games and their powerful interactivity and reinforcement of particular behaviors [and ways of thinking] have created an entirely new generation of workers and learners who are "hardwired" in ways that significantly differ from previous generations.

We honor something that gamers greatly value: The ability to work cooperatively and freely trade helpful information with each other. Doing so also creates a learning environment conducive to the kind of risk-taking critical for problem-solving and innovation.

Devlin (2011) advises, strip it down to its numerical, structural, or logical essentials and underlying patterns. After all, mathematics is the science of patterns! (Note: Devlin says aspects of algebra, formal logic, basic set theory, elementary number theory and beginning real analysis are particularly well-suited to this task.)

For this lesson, we wrestled with how to help students discover key concepts and procedures important to the concept of functions in a fundamental and accessible, yet challenging and intriguing way. This led Derek Stoll, one of the writers of this article, to conceive of functions as machines and dynamic puzzles of sorts — something goes in, something comes out, and somewhere in between are relationships worth understanding. We must confess: Game thinking is the most important and the hardest aspect of gamification. Much like mathematical thinking, game thinking involves reducing an abstract to its bare essentials, connecting to an everyday experience that all learners would have some understanding or knowledge of, and then converting that understanding into an activity that features game-based elements such as exploration, collaboration, levels, and storytelling. We suggest doing what we did: Ask others to game-think with you. Here's the result of that thinking: To engage students and motivate action important to gamification, begin the lesson by telling a story that provides a learning goal posed as a compelling question:

> *On a day much like this one, Jay and his father are taking a walk in the park. Jay's eyes catch something in the distance. "What is THAT?" he asks.*
>
> *Jay's father replies: "Why it's a MACHINE!"*
>
> *"Huh?" Jay quizzes, "How's THAT a machine?"*

At this point, Mr. Stoll turned to the class and asked, "Hmmmm ... what IS a machine?" He prompts further, "How would you describe it? How does it work? What are some examples and non-examples of a machine?

Students record their responses on a blank sheet of paper using pictures, numbers, words, or anything else that helps them show what they understand. (Sample responses include: Does a job/task or some kind of work, makes things easier, creates a product, has a specific purpose, a group of parts.)

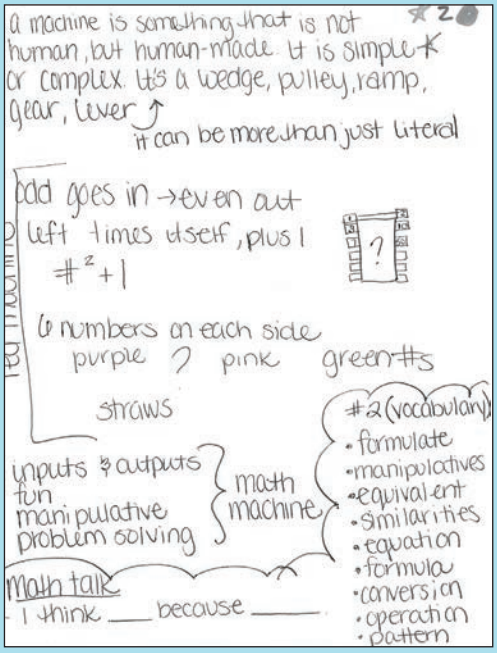
As students share their responses, we do something else gamer-like: We encourage them to record anything their classmates say that helps them. There is one rule (yet another element of gamification), however: Students may not erase their answers for any

reason. "Simply cross out what you no longer think," we advise. In so doing, we honor something that gamers greatly value: The ability to work cooperatively and freely trade helpful information with each other. Doing so also creates a learning environment conducive to the kind of risk-taking critical for problem-solving and innovation. All ideas (and contributions) are valued but can change, if not evolve, as more information becomes available. In this way, learners can interact with their ideas and each other without penalty or judgment. This gamified (and growth) mindset, in turn, encourages learners to continue learning and helps learners collectively and individually power up as they progress to the next level or challenge.

Serious play: What makes a machine a *math* machine?

To refresh, the purposes of using game-based elements and game thinking are "to engage people, motivate action, promote learning, and solve problems" (Kapp, 2012, p. 10). Gamification guru Karl Kapp clarifies, however: "Gamification is a serious approach to accelerating the curve of the learning, teaching complex subjects, and systems thinking" (p. 13). The notion of serious play — to promote worthy learning while at the same time staving off premature "death of play" — emerges as important. Ultimately, you want to purposely sequence your lesson in ways that grab and maintain your students' interest from start to finish and leave them wanting more. We suggest creating a series of progressive "tasks, missions, and activities that force the learner to synthesize knowledge from several sources" (p. 155).

What is a Math Machine?



At this point in the lesson, we return to Jay and his father, using story to employ another element of gamification — *assuming a role* — to invite deeper exploration of functions.

> *To help Jay understand what makes a machine a machine, Jay's father shows Jay a machine that he has been working on in the workshop. Jay is excited yet slightly confused. "This 'thing' doesn't look like a machine at all. It contains numbers, colors, different parts, and other confusing elements." Jay embarrassingly tells his father, "I am not really sure I understand what that machine is …"*

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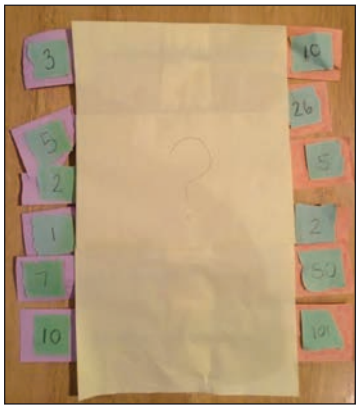

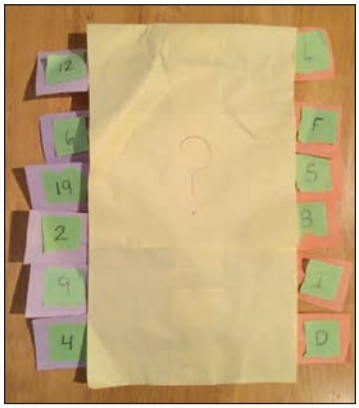

Examples of student "math machines".

"That's because it's not just any machine, it's a math machine," his father replies. "A math machine? Whoa. Math? Machine? I've never seen one before!" Jay says.

"Think back to when you were a child," Jay's father says kindly. "What did you do when you didn't understand something? What questions did you ask?"

Rather than give students a list of questions to ask, we turn to the class for their help and expertise: "If you were Jay and you didn't understand something, what questions would you ask?" Once students both identify and answer the questions raised, we return to the task at hand: "Now, let's return to this idea of a math machine: If Jay's dad says that his machine is not just any machine, but a math machine, what would make it a math machine?"

Groups of students are assigned to study math machines located throughout the classroom. Examples of those machines are provided at left.

As students examine their assigned math machine, they are prompted to think about patterns they notice. More specifically, "What types of values are going into the machines?" and "What types of values are coming out?" The idea of noticing and noting patterns is critical and fosters a modern-day definition of mathematics as the "science of patterns" (Devlin, 2011, 54).

Once students identify and analyze patterns they noticed with their respective math machines, they describe the particularities of their specific math machine and report their findings to the whole class. Words and phrases such as *input, output, uses symbols and/or data (i.e., numbers or letters*) and *shows relationships* or *it's a process* bubble up across groups. Once again, we urge students to record anything in their notes that their classmates say that helps them better understand what makes a machine not just any machine, but a *math* machine.

We then return to the story:

"Now that you have observed my math machine, do you think you can create one of your own?" Jay's father asks. Although inspired, Jay is unsure.

"Let's come up with some examples to help Jay out!" we say, but with these parameters:

- Each machine should contain at least four examples.
- All four examples should illustrate the machine's rule or function.
- The machine can use numbers or symbols.
- The machine can connect to anything of interest to them.

- As long as you can defend your work, all ideas are worthy.
- To see if your machine works with others, you will trade machines with at least two classmates. If they can figure out how your machine works, you have successfully created a math machine.

At this point in the lesson, we upped the ante in terms of using a number of features important to gamification and mathematical thinking. Initially, we used a story to invite and hold students' interest and effectively set the stage for students to become actively engaged in problem-solving. The story now provides students with a quest or challenge where multiple solutions are possible and welcomed. Students are to create their own machine, test it (by sharing it with others), get feedback, and refine. Although parameters are given, students have considerable individual choice and autonomy nonetheless.

After students have had a chance to share and test their machines, they are asked to revisit their initial understanding of a machine with the following questions in mind: (1) "What have you confirmed?" (2) "What have you revised?" and (3) "What is new that you need to add?" The development of mathematical thinking therefore occurs as the story progresses. At every step of this lesson, every student can contribute and improve or "level up" his or her performance wherever they are.

Striving toward meaningful goals

We've illuminated how to use numerous aspects of gamification to develop mathematical thinking through a highly interactive process of discovery and serious play.

No doubt, the ability to problem-solve and innovate is at a premium in today's world. Helping students learn how to work well in teams, see things in new ways, and adapt old methods to new situations, therefore, produces greater rewards for all, especially in the world of mathematics (Devlin, 2011, 21).

Ultimately, the goal of using gamification is to create learning experiences where students are invested and thus, strive to achieve meaningful goals. What's clear is that students will strive to achieve goals as long as they hold interest and value for them. So what do students say holds interest and value? The same thing that we believe makes any math teacher's heart beat: gaining an appreciation for math. Following, for example, is feedback that students provided at the end of the lesson:

"*This lesson shed a different light on math. I found value in math.*"

No doubt, the ability to problem-solve and innovate is at a premium in today's world. Helping students learn how to work well in teams, see things in new ways, and adapt old methods to new situations, therefore, produces greater rewards for all, especially in the world of mathematics.

Instead of simply learning procedures to solve problems, students develop a deep understanding of underlying concepts and justify the methods and techniques they choose to use.

"*Now when I hear the word machine, I think function and inverse.*"

"*I am not 100 percent confident when it comes to math but I will try to take more math risks!*"

"*Seems like it [math] might be worthwhile in my daily life.*"

Mathematics "*is not necessarily numbers! It's problem-solving and patterns.*"

Conclusion

We cannot predict the future with any real certainty. Still it seems reasonable to conclude that mathematical thinking will continue to prove valuable to the 21st century and beyond. It's fair to say that the demand for problem-solving, critical thinking, and innovation is nothing new. Defining mathematics as the science of patterns is, however (Devlin, 2011). With this in mind, the goal of learning (and using) mathematics in the 21st century is more about noticing, identifying and analyzing abstract patterns as they arise in the world. Instead of simply learning procedures to solve problems, students develop a deep understanding of underlying concepts and justify the methods and techniques they choose to use.

Based on what is currently known about motivation and learning, there is also something to be said for engendering a high level of student engagement not by making tasks or problems easier, but making the thinking easier. Doing so allows the struggle of all good problem-solving and critical thinking to be not only enjoyable but worth it. As the legendary basketball coach John Wooden (2005) so wisely advises, there is considerable value in making "greatness attainable by all" (p. 178). No doubt, the principles of Universal Design for Learning — namely multiple and varied means of representation, action and expression, and engagement — promote the greatness within all our students *(http://www.cast.org/udl/)*.

This changed definition spurred us to think about functions in relation to patterns of motion and thus, a machine of sorts: Something goes in, something comes out, and somewhere in between are patterns (i.e., rules, functions, and hypotheses) worth discovering and testing. To this end, we contend this modern-day view of mathematics calls for both a changed "end game" and game plan. Mathematical thinking isn't taught. Rather, it's gained through learning experiences that feature some of what video games do especially well: 1) sufficiently catching and holding students' interest; 2) keeping overt telling and/or formal instruction to a minimum; 3) encouraging learning with and from other students; 4) communicating that everyone can play regardless of their current level of knowledge and skill, that everyone has something to contribute, that risk is necessary, and that failure doesn't hurt; and 5) providing multiple and varied opportunities

for every learner to improve, advance, and/or level up in meaningful ways.

If students are also hardwired to learn differently — as the research on video gaming and gamers currently suggests — we have good reason to rethink how we approach the learners now sitting in our classrooms, K-12. They've changed, but have we? No doubt, the strategic use of game-based learning is more likely to inspire these learners to want to learn, keep learning, know what they're learning, and want to learn more.

Certainly, we can choose to ignore or deny the call for change. But if we do, longstanding problems of student motivation and boredom common in middle and high school classrooms are likely to create even bigger challenges as we ask more of our students (Mitchell, 1993). For most adolescents (and people in general), the development of mathematical thinking is not easy or natural (Genovese, 2003). In fact, this is one of many reasons why we need formal education and teachers like you. We believe the strategic use of gamification provides us an especially powerful antidote. Given what is gained and by whom, using gamification to power up the teaching and learning of math in your classroom is an investment worth making.

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How Modes of Expression in the Arts Give Form to 21st Century Skills

SUMMARY

Through interviews with kindergartners in New York City, plus accompanying stories, artwork, and haiku, we catch a glimpse of the creative thinking, interests, and discoveries of young learners. The teaching process is described in rich detail and highlighted with student artifacts. The author also documents connections with current theories about how children learn, the Common Core Shifts in English Language Arts, and the new National Common Core Arts Standards.

It is often difficult to know what comes first, the visual form, the dance, the music, the character on stage, or the verbal idea or feeling. The arts make the intangible tangible. Arts processes by their very nature incorporate multimodal opportunities for students to discover and solve problems independently and/or collaboratively. "All modes of communication are codependent. Each affects the nature of the content of the other and the overall rhetorical impact of the communication event itself" (NCTE, 2005, p.1).

Art forms are more evocative than literal. Ella Baff, Jacob's Pillow executive and artistic director, explains that "like music, dance has no linguistic equivalent. Dance is an art form of the body. It is nonverbal and therefore imbued with unique capacities to communicate across language" (personal communication, August 2014).

Work by leaders in the fields of arts education, education, developmental psychology, behavioral science, business management, and visual art clarify the connection between 21st century skills and arts education. Eisner (1992) explains, "Those who draw or paint do all their thinking within the medium in which they work" (p. xiv).

Trilling and Fadel (2009) present an art unit that demonstrates how the process and content of an art lesson contributes to the development of 21st century skills. It explains that "Critical thinking and problem-solving, communication and collaboration, and creativity and innovation are three top-drawer skill sets in our toolbox for learning, work, and life in the 21st century" (p. 60). The authors further explain that the 21st century skills of creativity and innovation are not in the curriculum guide but need to be engrained in the teaching process.

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Joan Davidson,
United Federation of Teachers

The arts education teaching process by its very nature provides experiential opportunities and skills to think creatively. Eisner states,

"In the process of creation the arts stabilize what would otherwise be evanescent. Ideas and images are very difficult to hold onto unless they are inscribed in a material that gives them at least a kind of semi-permanence. The works we create speak back to us, and we become in their presence a part of a conversation that enables us to see what we have said (Eisner, 2002, p. 11)."

Tim Brown (2009) illustrates the need and importance for this image-making practice, "When I use drawing to express an idea, I get different results than if I try to express it with words, and I usually get to them more quickly. I have to have a whiteboard or sketch pad nearby whenever I am discussing ideas with colleagues. I get stuck unless I can work it out visually" (p. 48).

Over the past decade, The Partnership for 21st Century Skills (p. 21), a coalition of the business community, education leaders, and policymakers has identified and brought to the forefront a comprehensive set of skills that, along

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An Interview with the Young Artist

Birds fly to Manhattan
A falling star awakes
the New York City morning.

Maya, a 5-year-old artist, reveals her critical and creative thinking and spotlights the delight she experiences as she watches her ideas and discoveries take form on her paper. Her thinking process is fluid and pregnant with possibilities.

Interviewer: How did the image come to your mind?

Artist: I was thinking about birds doing something and I thought about birds flying.

What gave you the idea to put the star?

I wanted to make a star that was falling. (Maya gets up and makes falling motions until she ends up on the floor). I wanted to make the star dropping from Manhattan.

Tell me about these (points to the front boxes).

They are trampolines for people to jump on. There are people in the picture. (Maya points to the people).

What came first, the trampolines or the star?

The trampolines.

Tell me about this yellow part.

The yellow part (she points to the yellow on the building) — that is the crack where the star touched the building.

Tell me about this green line.

Oh, that is to outline the buildings.

Did you look at your neighbor's picture to get ideas?

No. I wanted to make my own picture. I don't like people copying me so I didn't want to copy them.

How did the haiku come to your mind?

I looked at my picture. Here are the buildings and they are different buildings that go all around and are connected. I was thinking of Manhattan and the wind. (Maya makes sounds of the wind. During the lesson students were asked to make different sounds described in the haiku and to act out what was described.) It is Manhattan and the birds are flying to another part of Manhattan.

Do you think it is a good idea to write about your work?

I think it is a good idea to draw pictures and tell about it because then you begin to learn how to make stories and you can make a book.

What is the benefit of a book?

You can look at the pictures of the other children, and parents like to see the book.

with content mastery, are what all sections agree are essential for success. The 21st Century Skills Map describes how 21st century skills are integrated in the arts discipline. "Business leaders and visionary thinkers concerned about preparation of students for the future know that the ability to be creative — a key 21st century skill — is native to the arts and is one of the primary processes learned through arts education. The examples in the 21st Century Skills Map illustrate how the arts promote work habits that cultivate curiosity, imagination, creativity, and evaluation skills. Students who possess these skills are better able to tolerate ambiguity, explore new realms of possibility, express their own thoughts and feelings, and understand the perspectives of others" (Partnership for 21st Century Skills, 2014).

Creative Thinking

For young children it is their willingness to enter into the artist's world and to express their feelings about the work that stimulates them to give form to their ideas. Gardner (2006) explains, "All young children partake of the elixir of creativity. They are willing to transcend boundaries of which they are at least peripherally aware; they throw themselves into their play and work with great passion…" (p.50).

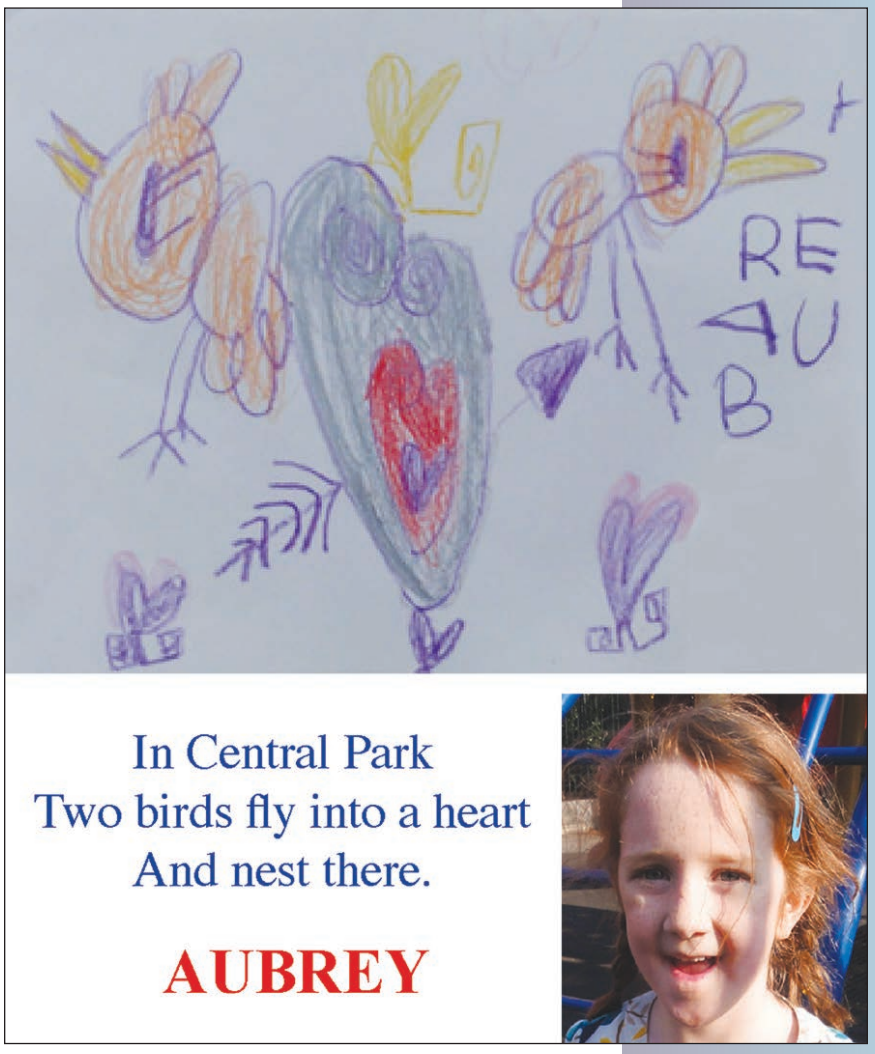
The unit on Image Making and Haiku is introduced by examining four art reproductions, and this activity sets the context for the unit. It gives a sense of importance to the image-making. The activity requires an openness to feel and see the work and then an understanding of the symbols and language of the arts discipline. Observation, discussion, and reflection on works of art (visual and performing arts) contribute to creative thinking, critical thinking, and communication.

The process of drawing in conjunction with writing expands the creative and critical thinking process, supports the English language arts and literary Shifts, and gives parents an opportunity to understand what and how their children are thinking. The process can be likened to putting two disks in a computer, an art image-making disk and a telling/writing disk. Each disk gives an opportunity to see something from a different perspective. Davidson (2008) explains, "The drawing and writing process involves documenting layers of thought and using each layer as a stepping stone to another layer. Picture a delicate, smooth-skinned red onion, whose aroma gets more pungent as you peel away each circular, slippery layer" (p. 36). As children draw and as they tell stories about their work, multiple ideas become solidified and other images/stories come to

mind. The haiku structure encourages further discovery as students explore a personal impression that emerged as a result of describing their image.

Literacy in the Visual Arts strand explains that "the careful observation of a work of art resembles the close reading of a text — one that includes making observations and drawing inferences. The visual arts provide students with inexhaustible subjects about which they may read and write, as well as engage in accountable talk" (The Blueprint for Teaching and Learning in the Visual Arts, 2007, p. 4). The resulting unique artwork documents that the children have the ability to make a transfer, to be energized by what they feel, observe and notice, and though they might not be able to verbalize their process, they engage in critical thinking and want to communicate their ideas.

Young children are active and exuberant explorers. Artistic images capture the physical and sensory aspects of their discoveries. They love to express the movement, feeling and tactile qualities of animals, places, and people. They tell stories by combining their observations with their inner worlds of fantasy and include details that capture the important parts of their ideas. Art-making becomes an important spur for the use of imagination (NYC DOE, 2007).



Engagement in the arts prepares students for lifelong learning. Tharman Shanmugaratnam, former Singapore minister of education, explained that the goal of education is "to give students the room to exercise initiative and to shape their own learning. The students have to become engaged learners — interested and proactive agents in the learning process" (Darling-Hammond, 2010, p.186). In addition to project work visible in nearly every Singapore classroom,

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Students' capacity to create and express themselves through the arts is one of the central qualities that make them human, as well as a basis for success in the 21st century.

children were extensively involved in music, arts, calligraphy, physical education, sports, and an amazing variety of clubs and self-initiated activities aimed at building creativity and entrepreneurship.

The arts provide opportunities for students to empathize with, and learn from, artists and their peers. In so doing, a lifelong appreciation of the arts is cultivated. The inquiry method for examining works of art encourages critical thinking and awareness of different points of view. Individual and collaborative reflection experiences provide occasions for students to develop and expand their ideas.

This article documents how young artists discover, expand, and clarify their ideas as they engage in one or more of the art-making processes such as image-making, acting, moving, sound-making, storytelling and haiku. The quality and individuality of the included images and writing are evidence that artwork is a form in which students engage in critical and creative thinking. "Students' capacity to create and express themselves through the arts is one of the central qualities that make them human, as well as a basis for success in the 21st century" (Partnership for 21st Century Skills, 2014).

An Art Education Teaching Approach

Setting the Stage

The art education teaching approach incorporates 21st century skills by providing opportunities for creative and critical thinking and a context in which students are motivated to communicate their ideas in artistic form. A nurturing culture is essential to this. The classroom is structured to create a caring collaborative community of learners. The formation of this culture is intended to sustain the learner's curiosity, love of play and experimentation, and to develop the dispositions of a lifelong learner.

Building a community of learners in the classroom requires a focus on an overall plan and process. Cooper and Jenson explain, "A nurturing culture is one that is open to many ideas and possibilities, but not in the sense of anything goes. The role the teacher takes on is critical. Teachers must still be in charge, still take responsibility for the quality of the curriculum delivery, and for providing a physically safe and disciplined work environment; but they must do this more as a collegial facilitator than as an autocratic dictator." (2009, p.19-20). Gelb describes the working process of Leonardo da Vinci, "Despite mistakes, disasters, failures, and disappointments,

Leonardo da Vinci never stopped learning, exploring, and experimenting" (2004, p.79).

Getting Started

To ground the project, a broad theme is selected. In this unit the theme is connected with our classroom curriculum on the study of birds. Around this, essential questions are posed, and students are encouraged to play with ideas by acting out their image alone or with the help of peers. Risk-taking and experimentation are encouraged. They share their work with peers and ask questions of one another and then listen and respond to peer questions and/or suggestions. By observing, listening, and responding to each other they gain affirmation and encouragement.

Models in the form of art reproductions introduce the lesson and are looked at again in addition to books and stories about birds during a later session to help students get and/or expand their ideas. By examining the many different ways in which artists include birds in their work, divergent thinking is modeled.

To optimize creative outcomes, the working environment must be structured so that both successes and failures are honored. Formative assessment and final assessment feedback help students clarify their ideas. During sessions in the "Busy Bird and Haiku" unit, students are encouraged in their effort to find ways to communicate their ideas and are encouraged to continue. Students are asked to tell about their picture and are asked questions that help clarify their thinking and keep them on task.

Reflection/assessment times provide an opportunity for students to speak about their work, to explain how their ideas came to them, and to receive feedback. This can be done collaboratively with other students and/or with an adult. Students build knowledge and clarity through discussion of how their image or story/haiku came to be and gain ideas of how it could be improved. Students also build knowledge by viewing other students' images and listening to other students' stories/haiku and responses to questions.

Planning

A lot of planning preceded the unit. The central question was: How can we orchestrate an image-making and story-writing activity based upon the theme, suggested by the classroom teacher: Birds? The art teacher began with a mind map, described by Brown (2009) as a way of looking at the whole and discovering connections. In the center of the mind map were the tags:

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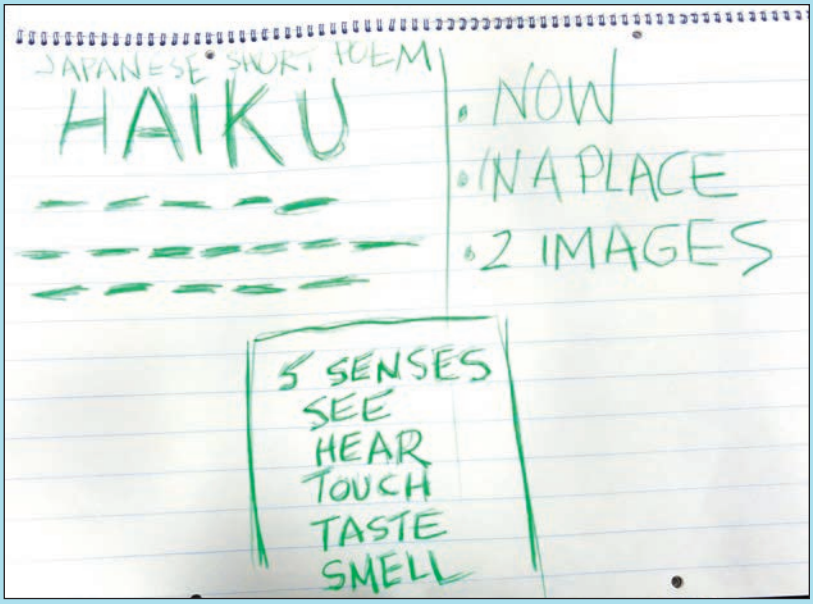
The inquiry method for examining works of art encourages critical thinking and awareness of different points of view. Individual and collaborative reflection experiences provide occasions for students to develop and expand their ideas.

Constructing a Haiku



drawing, images with birds, and writing. Planning included developing objectives for each session in the unit; and essential questions to ignite the interest of the students and as a basis for students examining art reproductions and reflecting on their work. For example: Art reproductions are selected to show different ways that artists use birds to communicate their ideas. Though they each contain birds, the content of the following paintings is very different from one other. For this project some of the resources include: *Persian Illuminated Manuscript* by Shahnameh Baysunqur; Faith Ringgold's *Tar Beach II*; Rene Magritte's *The Return*; and Archille Gorky's *Water of the Flowery Mill*. Students ask and respond to open-ended questions about the different paintings and give evidence in the painting to support their observations. An abstract painting is included to show how artists use the elements of art to communicate a feeling without the picture containing a recognizable subject. As we examine the works together, questions are used to prompt student thinking:

> *Which work interests you and why?*
>
> *Tap the picture to show how your eye moves around the painting; what sounds might you hear in the Tar Beach painting?*
>
> *The artist did not use words, so how did the artist communicate to you what he wanted to say?*

Haiku are identified that reflect the lesson theme or include sensory experiences (sound, gestures) that the children can act out. Also researched is how haiku came to be and how to communicate the haiku structure to students who do not know how to read or write.

Resources are identified to motivate the students and to provide new directions for thought. For example "sense" objects were put together in small bags for each child to touch the marshmallows, smell pine cone branches, and smell individual tissues full of different spices. A sequence of activities is planned to scaffold the learning experiences, and a plan to organize, distribute, collect, and clean-up selected materials is developed.

Students engage in a number of warm-up activities before they develop their final image. For example, acting out ideas to feel in their own body what the haiku is about and drawing quick sketches based on the five senses and images suggested by a haiku, and experiencing the smell, taste, touch, and shape of distributed "sense" items.

Haiku that lend themselves to familiar images were selected containing movements or ideas that students could help to create images. The haiku form builds on the five senses. The short rhythm can be clapped easily and can describe a moment — something the children can illustrate in one picture (this was an essential activity to help the students understand the structure of haiku since they were not yet able to read or write). It usually contains few actions or sounds and is similar to a painting and other art forms, in that one line affects another line. Haiku is a fun form for students who are sensually based. It is a wonderful form as a vehicle for discovery and expression. According to Howard Gardner's (2006) multiple intelligence theory, "Some students will learn from linguistic entry points, others from artistic or personal or logical entry points. Through those multiple approaches, one activates different clusters of neural networks. To the extent that numerous networks are activated and eventually connected one obtains a solid and

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Inside the Lesson: What Students Do

Resources: Examination of Art Reproductions on display. Haiku guidelines and samples of haiku were provided.

Materials: Crayons were selected because they give students an opportunity to move and think quickly in their drawing using a variety of colors. Materials were prepared for the students — a 12-by-18-inch sheet of manila paper was folded into eight boxes, held vertically, and numbered horizontally in the upper left corner from 1-8.

Drawing activities: The first session after haiku was introduced included warmup exercises that would encourage students to put their first thought down and see how their drawing represented, more or less, their interpretation of the given prompt. "All engineering, all invention and all innovations really start with a drawing" (Doodle 4 Google 2014 Award Ceremony). Warmup exercises were provided.

Motivation for first session: Examination of art reproductions; introduction of haiku though clapping to the rhythm of haiku; haiku are read and students participate by acting out — becoming a moving character described in the haiku, visualizing the moment by closing their eyes, completing a two-line haiku by adding a third sentence.

Motivation for second session: Comparing warmup drawings; distribution of sense items; to connect students to their senses so their "sense" experiences will be fresh in their minds as they draw their pictures.

Motivation for third session: Summative whole class assessment of completed images and stories and then formative assessment in small groups or with individual students of work in progress. During the last session for the purpose of recognition and reflection, students present their work to the whole class, and the art teacher encourages peers to tell what they like about the picture and ask questions, but not to say anything negative. In this way students learn to offer useful feedback without criticizing. In some cases the art teacher asks students questions such as: Explain how you got your idea; what was difficult about the process and how you solved your problem; what do you like about your work or your process.

Formative and Summative Assessment Questions:

Tell me your idea; What sense(s) are giving you the idea for your picture?; What feeling do you want to express? What colors might suggest that feeling? What details might you add? What might you *exaggerate* to bring attention to your idea or a part of the picture? What can you do to use the whole page to tell your story?

Introduction to Haiku

Teacher reads haiku poems and students act out, move, make sounds in response.

Teacher says:

From a picture you get ideas/feelings you might want to share in words.

From words you get ideas/feelings you might want to share in a picture

We are going to listen to and act out a form of writing called a haiku: a Japanese poem that has three lines of five, seven, and five **syllables**.

In the verse something happens now in a particular place. The moment is described using two images.

HED: Teacher Background (move to p18)

What are the characteristics of a haiku?

A haiku tells you:
Who, What, Where (location), When-now

Haiku is characterized by:

1. **Present tense-now**, a realization of a moment in daily life. Potentially anything can serve a subject for haiku as experienced through the five senses.
2. **Concrete images** that are fresh and vivid, not similes, metaphors, or abstract words.
3. **Two images side by side**
4. **Unrhymed**, 17 or fewer syllables, usually three lines. No need to hold to 5-7-5 syllable pattern in English

Teacher tells the students:

People would sit around in a circle and one person would start the first line and another person the next line and a third person the next line. It was a game to see who could complete the poem.

We will play a game, too.

enduring mental representation of the topic in question" (p.50).

Motivations in all four sessions engaged students either in examining art reproductions by artists or the artwork that they or their peers created. Playing with haiku by acting it out, dancing it out or visualizing what was happening engaged them kinesthetically in the verse. To heighten their sensory perception, students were able to use the "sense" objects.

Activities were planned as a scaffold to the final activities that were to "Draw a bird or birds doing something in a moment" and to create a haiku to tell what is happening in your picture. The need and interest and excitement to give form to ideas about "birds in a moment" was the result of memory, body, and sense experiences.

Session I: Setting the stage for image making and storytelling and haiku making

First, students *examine* reproductions of artwork. They are encouraged by the art teacher to share their feelings about the paintings. They discover similarities and differences between the paintings and analyze why the artist used the bird(s) in the painting. They identify elements of art (such as patterns) and discover a way to demonstrate how the pattern is created in the painting. They

identify colors that were the same and discover how these colors changed as a result of being next to different colors. They demonstrate by touching the image, a principle of design. For example: how the artist used the repetition of color to hold the painting together, to unify the painting.

Next, students *experience* haiku. After listening to the qualities of haiku and how haiku came to be, students are asked to clap to the rhythm of the 17 syllables and three lines of the haiku. Haiku is read and students respond by visualizing a haiku and acting it out; moving as described in a haiku; completing the haiku after a sentence of a haiku is read. In this way students experience being "inside" a haiku, and this helps them to understand how to create one.

Finally, there is a warmup drawing activity. In response to descriptions given by the teacher they *draw* a picture in each of eight boxes — the first picture drawn in box #1 and the second picture in box #2, etc. The teacher gives students 1 to 2 minutes for each picture so there is little time to get anxious about the work. Students are encouraged to think quickly and fluidly. At the end of the drawing session, students work in small collaborative groups to compare their image with peers. They are encouraged to reflect on the work of peers but are cautioned again not to say negative things, to ask questions of their peers and listen to responses, talk about the differences and similarities they notice in the images and to give praise if they notice something they like and to explain why they like it.

The reflection process provides an opportunity for students to be part of a community of learners in which risks can be taken and unique ideas can come forth and be honored. Giving a visual form (drawing) based on the teacher's prompts and reflecting on the work engages students in creative and critical thinking.

Sample Haiku Poems

Why does the bird envy the butterfly?
Ah, the sad expression in the eyes of that caged bird
Envying the butterfly!
— *Issa*

(Source of an image — see it, feel it)

The autumn wind
Blowing across
people's faces
— *Onitsura*

(Source of an image — where might you be? What insects might you hear?)

No place
To throw out the bathwater —
Sound of insects
— *Onitsura*

(Act out — see the old pond, see the frog, leap in and listen to the sound.)

Old pond...
A frog leaps in
Waters sound
— *Basho*

Source: Higginson & Harter, 1985

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The reflection process provides an opportunity for students to be part of a community of learners in which risks can be taken and unique ideas can come forth and be honored.

Session IA

Small group instruction with the art teacher: children draw "Moments in the Life of a Bird or Birds" and work collaboratively to develop a haiku based on their image. Students are empowered when they can help each other and they gain the confidence to think in new ways.

Session II

*1. **Formative Assessment*** of eight box drawings with the whole class directed by the art teacher. Drawing subject examples: The sound of a bird in the morning; a stretching tree; taking a bath or a shower; flying.

The objectives of the formative assessment of the eight quick sketches are that students will have an opportunity:

a. to learn from each other by noticing, through guided questions from teacher and other students and by individual reflection of each work, the different ways peers responded to the given problem. In terms of the ELA Common Core Shifts, the students come to understand other perspectives and cultures and can build on others' ideas.

b. to communicate their ideas to others.

What the Formative Assessment tells the teacher:

Teacher can use these initial drawings and dialogue as the basis for the "moment" drawings in case the student doesn't have a clue where to begin.

*2. **Distribute sense items***
The objective of distributing the sense items is to connect students with their senses so they will transfer this recent sensual experience to their art-making experience.

*3. **Students respond to handling and smelling the sense items.***

*4. **Students draw on the theme:***
Moments in the life of a bird or birds.

*5. **Formative Assessment as students draw*** to help them expand their ideas.

Question examples include: Tell about your work. Where is this happening? How is the bird feeling at this moment?

Session III

Summative Assessment of completed work "Moment in the life of a bird or birds" (whole class) to communicate their ideas to peers and to get feedback and to listen to ideas of peers. Give students an opportunity to learn from each other.

Students examine art reproductions to expand their drawing ideas.

Listen to a new haiku and act it out to refresh their ideas about haiku.

Students who are finished work on a variety of projects:

Do another drawing and haiku on the same theme; students can tell another story about their same picture; create a drawing and haiku on their choice of theme; create a play to act out their story.

Engaging in arts experiences gives students direct experience with behaviors that are included in the ELA Common Core Shifts. Appendix I shows in a condensed form the sequence of lesson activities and their link to the ELA Common Core Shifts.

How Learning Outcomes are achieved

For curriculum planning and to capitalize on student strengths and engage them in the learning process, teachers must identify how children learn. The following rubric is for the purpose of identifying the graphic characteristics of the students in terms of interpretation of the theme, clarity of image, differentiation of form and size, and inclusion of details. Examining the work in categories such as these informs the teacher

Teacher Rubric Guidelines

Questions

[1] Does the drawing interpret the theme?

[2] How clear is the image?

[3] How well does the story/haiku connect with the image?

Scale

Emerging Effective Highly Effective

Elements

Clarity of idea
Differentiation of Form
Differentiation of Size
Spacial Clarity
Details
Written or verbal statement connected with artwork.
Student was able to present ideas clearly to audience.

Rubric Key:

Form differentiation: How much form was differentiated from lowest level — a circle to a naturalistic representation.

Spacial representation: Lowest level forms are floating in space with no order; higher level forms give you a sense of an order and setting in the background — maybe even a feeling of three-dimensional space.

Size differentiation: From everything the same size to size as is in nature.

Use of details: Shows the student is able to graphically represent more literally what is observed.

Use of whole page: Ability of child to think of the whole space as part of the story — to connect with the whole world instead of being wrapped up in one little part.

Clarity of image: The ability of the artist to make clear what is happening to the viewer even though the image can be clear to the artist.

Teacher Rubric

Elements	Emerging	Effective	Highly Effective
Form Differentiation	Form of bird not clear.	Fewer than half of forms are differentiated from each other.	More than half of forms are differentiated from each other.
Spacial Representation	Forms are floating in space.	There is a definite order in space relationships and you can see where the activity is taking place, but some things might still be floating in space.	There is a definite order in space relationships and you can see where the activity is taking place. No objects are floating in space.
Size Differentiation	No size differentiation.	Fewer than half of forms show size differentiation.	Most body part shapes and other forms show size differentiation.
Use of Details	No details.	Details are evident in fewer than half of the forms.	Details are evident in most forms.
Use of whole page to tell the story	Can't tell.	Uses most of the page to tell the story.	Uses the whole page to tell the story.
Clarity of image in terms of verbal story/haiku	Image not clear in terms of the story/haiku.	Image is at least 50% clear in terms of the story/haiku.	Image is at least 90% clear in terms of the story/haiku.
Interpretation of the theme	Can't tell.	Theme is the basis of the image.	Theme is interpreted clearly and inventively.

about the child's ability to express ideas through the visual arts. Some students are image makers — they work expressively using color, line, form, space, and pattern to tell their story. They differentiate size and form and include lots of details in their work. Curriculum for students identified as image makers should include activities that capitalize on their strengths, such as responding to how a particular character felt in a story by having the student empathize with the character and show themselves feeling that same way in a setting of their choice.

Evidence of student success/learning outcomes is apparent in an examination of the drawings and writings as well as the successful engagement in the performance standard activities described by the current National Curriculum Core Visual Arts Standards (2014).

Characteristics to be reviewed in the drawings are interpretation of the theme "Moment in the life of a bird or birds"; clarity of the idea in terms of content and details included in the picture that relate to the theme; use of visual elements such as color and pattern; use of principles of design such as rhythm and unity; and use of the whole page to communicate their idea.

Characteristics to be reviewed in the art-making process and in the writing include ability to verbalize, to a peer or to an adult, what is happening in their picture.

Images were collected and grouped based on specific descriptive criteria and a rubric.

Reflection on the Process

Reflecting on your picture can spark new ideas. New ideas come to professional artists and young artists alike, as evidenced in Maya's behavior during her interview. She not only acted out her ideas, she wanted to draw another picture (see p. 13).

In a three-month study by Davidson (2008) of drawings and writing by third graders, she documented "How Drawing in Conjunction with Writing Contributes to the Thinking Process." She showed how formative assessment questions by the teacher, a written description of the artwork and the art-making process or peer interviews based on a reflection questionnaire or a self-assessment questionnaire became a jumping-off point for another picture. Following is an excerpt of an interview with a third grader about her series of work.

The arts give students something to say through an art form and something to talk about and respond to in a verbal form. All the students interpreted the theme, each in their own personal way. Two students used color expressively while most used color literally (as they see the color in nature) or just to distinguish one part from another. Almost all the work suggests a very active rhythm created by color, shape and pattern, and by applying the crayon in a particular direction. All but one student used

Interview with Carisse, a third-grade student

What changes do you notice from drawing #1 to drawing #3?

The bus wasn't in drawing #1. Only two people were in drawing #1; there are six people in drawing #3.

Why did you add the people?

I wanted more characters to be in it. Four characters were not enough.

What does a higher number show?

More characters show action and what they are doing. As I worked I got more ideas about what was happening and what people were doing.

Why did you decide to work from observation in drawing #3?

I wasn't doing my best in drawing #1 and #2, and I decided to do my best. My mother showed me from the window that if across the street looks like that, then my block looks like that. So I decided to draw it as I looked at it.

What is the difference in the drawing of figures comparing drawing #1 with drawing #3?

In #1, my mother is shopping. You can see by the handbag, and I am playing outside.

In #3 two friends, Richard and Jessica, are in the picture and I am behind them.

Which is your best picture? Why?

I think drawing #3. It shows more detail and more action. I did my best in that drawing.

Do you think your artwork helped with your writing?

Drawing tells a story. Sometimes I don't like to write a lot — I love to draw. It's my life. I was surprised at my writing. I never wrote something this long before. For me, writing didn't help my drawing, but drawing helped my writing.

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Presenting their work to classmates gives artists an opportunity to develop their ability to verbalize what is happening in their picture and to show how they connect their artistic ideas with personal meaning.

the whole page to tell their story. All but that same child were able to describe a moment in the life of a bird based on their picture.

Presenting their work to classmates gives artists an opportunity to develop their ability to verbalize what is happening in their picture and to show how they connect their artistic ideas with personal meaning. The questioning of the artist by their peers gives the young artist a reason to reflect on their work as they respond to the questions. The process also gives practice to members of the class to ask questions that are relevant to the picture.

Building an Audience: Community Involvement

The lesson concluded with the art teacher assembling a book of images and writings. Each student was featured in the book, which included photographs of each student and all of their artwork, their story and haiku. A page for each student was sent home with the students for their parents to see.

A bound copy of the book was available at school and on a CD for parents to copy. In this way, parents were made aware of what their children were learning and what they accomplished. Through the book, children had an opportunity to be recognized as an artist by their peers and their community. Students felt proud of what they had accomplished and carefully put the envelope that contained their page into their book bags. The classroom teacher displayed copies of the book during Parent Open School Morning. Many parents expressed their appreciation of their own child's page and explained they were so impressed by the presentation of the work of all the students in the book.

Closing Thoughts

The project engages students in creative processes that build on how students see their world and in so doing validates, triggers and expands their creative and critical thinking. For kindergarten students and older students the project opens doors to a host of experiential ways of knowing and learning.

As the children tell their story to a scribe, they must add details (evidence) to their drawings. The introduction of haiku into the arts experience expands, in a meaningful way, ideas for imagery and ways of telling and writing expressively. McTighe and Wiggins (2012) explain "A Common Core State Standard is an outcome, not a claim about how to achieve an outcome. While curriculum and instruction must address

established standards, we always want to keep the longterm educational ends in mind" (2012, p. 3). Douglas states, "Artist statements written by children or scribed by adults and older students accompany all exhibited work in choice-based art programs. When adult volunteers assist in the creation of an art show, they have the opportunity to experience the thought processes of the children through their artist statements" (2012, p. 16). This statement shows how parents and other adults are drawn into the experience and provides a viewer's point of view as to why and how the written work expands both thinking and understanding.

The content and process of this art unit empowered the classroom teacher to continue the work with her young students and to learn about the haiku form and ways to engage her students in talking about their artwork after she saw the products of her students. Pink explains, ". . . it's often difficult to do something exceptionally well if we don't know the reasons we're doing it in the first place. People at work are thirsting for context, yearning to know that what they do contributes to a larger whole. And a powerful way to provide that context is to spend a little less time telling how and a little more time showing why" (2011, p.117).

Preparing for ALL Children

"When a child is having learning difficulties, it is important to understand his or her cognitive modes as accurately as possible" (Gardner, 2006, p. 59).

The activities in this unit provide many opportunities for unique solutions. However, the English language learner could have problems creating a haiku. With the help of peers who speak the same language, they can make their stories understood. Visual reproductions can be examined by most of the children. As students give evidence by touching the reproductions of the painting or pointing to a specific area, English language learners may understand the concepts being clarified.

Differentiated Instruction suggestions:

Students can:

- Write or tell their story/haiku to another person who will write it for them.
- Use a variety of expressive forms (dance, music, theater arts) to communicate a given theme.
- Work with a partner/scribe/adult to develop their writing or verbal presentation.
- Modify materials. If crayons are difficult, use markers or three-dimensional materials.
- Modify content — encourage students to develop their own art-related task.

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Appendix I: ELA Shifts

ELA Shift #	Activity
Session #1	
2	1. Examine reproductions
2,4,6	2. Read haiku and students respond 3. Distribute art supplies
2	4. Students create eight drawings
Session #2	
5,6	5. Formative assessment of eight drawings with class 6. Teacher explains activities for the day
5,6	7. Teacher distributes "sense" items. Students engage in experience and respond in words to experience
6	8. Teacher asks questions to connect "sense" experience with image-making
2	9. Teacher distributes art materials and students draw
2,6	10. Formative assessment by teacher as students work
2,4	11. Students who completed art work tell their story to an adult or peer and create a haiku with help
Session #3	
2,5,6	12. Formative assessment in a collaborative group to complete drawing and/or story/haiku with the assistance of art teacher, classroom teacher and aide
2,4,6	13. Review a haiku and students respond
2,5	14. Teacher shows resources available
2	15. Students complete, revise image and/or story/haiku or create an image-based performance with a group
2,6	16. Final assessment with class

21st Century Real-World Robotics

SUMMARY

Building robots with viable programming and color sense capacities becomes a reality in this project-based, interdisciplinary learning unit for middle-level students in Brooklyn. This school employs both team teaching and collaborative learning in its dynamic approach to teaching science and technology.

Throughout his extensive research into the 21st century instruction possibilities of robotics, Mark Gura, Touro professor, author of several books on Lego robotics and founder of the Classroom Robotics blog, notes that Robotics challenges are a perfect vehicle to promote communications, collaboration and other skills essential to 21st century learning. Roboticist practitioners, Gura notes, need to communicate as they work together to journal their efforts and solutions (2007). Working from manuals, instructions, and programming the robots authentically involves 21st century real-world principles and functions of academic and special domain knowledge.

Robotics problem challenges are readily applicable to today's world. For example, robots are being used to search for missing planes and to destroy hidden mines. Students experience real-world seamless science, engineering, and cross-discipline problem-solving as they program the robots. Teachers collaborating from more than one content area to seamlessly model that in their instruction validate the cross discipline 21st century learning opportunities for robotics, which Gura stressed should be part of regular school day interdisciplinary learning (2012).

At Ditmas Intermediate School 62 in Brooklyn, technology teacher Angelo Carideo and David Liotta, a social studies and media studio teacher, set sixth graders off on a mission to build

Rose Reissman is a literacy support specialist and director of the Writing Institute at Ditmas Intermediate School 62 in Brooklyn.

Angelo Carideo is a technology and law teacher at Ditmas IS 62.

David Liotta is a media and social studies teacher at Ditmas IS 62.

Amanda Xavier is an ELA teacher at Ditmas IS 62.

Sofia Rashid teaches ESL at Ditmas IS 62.

Irene Huerta is a special needs paraprofessional at Ditmas IS 62.

Rose Reissman, United Federation of Teachers
Angelo Carideo, United Federation of Teachers
David Liotta, United Federation of Teachers
Amanda Xavier, United Federation of Teachers
Sofia Rashid, United Federation of Teachers
Irene Huerta, United Federation of Teachers

team robots with viable programming and color sensor capacities. Their collaborative teaming makes this Science, Technology, Engineering and Mathematics-infused robotics project thrive. Students work, communicate, and collaborate in teams to accountably produce a functioning robot. They later showcase their robots and present their work at a multi-project Writing Institute Expo run by Rose Reissman with the support of fellow Ditmas educators Liotta, Carideo, Amanda Xavier and Sofia Rashid.

The Ditmas robotics project is grounded in the research of Khanlari (2013) and Demetriou (2011), who note that the "use of robotics . . . can improve students' personal skills . . . problem-solving, communication, creativity, decision making, and teamwork" — all 21st century learning skills and outcomes. Furthermore, by interviewing seven teachers who taught robotics, Khanlari, in his study of the "Effects of Robotics on 21st Century Skills" suggested "that robotics can be used as an effective tool to improve 21st century skills, including students' creativity, collaboration and team working, self direction, communication skills, and … social responsibilities."

The Ditmas student robot project is done during the school day and involves the ELA educator, the literacy specialist and the ESL teacher. The teachers team to plan and to infuse — as the project progresses — specific literacy and second acquisition skills plus differentiated learner options so the project is "part" of an interdisciplinary end product-centered initiative which mirrors requirements of a 21st century workplace skills set.

Students experience real-world seamless science, engineering, and cross-discipline problem-solving as they program the robots.

Faculty Team Collaboration

Ditmas is a school whose culture is built upon collaboration. Principal Barry Kevorkian, who has spent more than three decades at Ditmas as a team teacher, assistant principal, coach, dean, and group leader, explains this culture: "Teachers can share thoughts and ideas and help one another to become more effective. The teachers'

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Team teaching: A model in collaboration

The success of the Ditmas robotics project is due in no small part to the cross-curricular, team-teaching approach employed by the authors. The educators met throughout the project to brainstorm how the project could meet the needs of all students involved.

When one educator suggested the robotics theme could be introduced to special needs students by having them focus on science fiction literature about robots, other educators on the team readily piped in with their ideas:

- Reissman, the literacy specialist, suggested Isaac Asimov's first story, "Robbie," written in the 1950s.
- The technology teacher, Carideo, noted students could update the story to the 21st century and script their own versions for a podcast.
- Huerta, a paraprofessional who extensively supports ELA development in spoken and written language, saw this as an opportunity to develop a product that would captivate her students and enhance their collaboration, communication, problem-solving, and critical thinking skills by using an approachable text.
- ELA teacher Xavier noted that even though the robotics project had only been funded for one group, having her inclusion classroom work with a commercially purchased robotics kit would also enhance and support Common Core learning.

In their planning meetings before and during the project, the educators themselves were active participants in the same behaviors they were teaching the students. This modeling of adult teacher discussion of the project challenges and opportunities for multi-content integration inspired the educators to help the students realize important life skills of taking initiative and being self-directed as they took on the robotics challenge.

actual collaboration models and supports their students to in turn grow academically, emotionally, and socially. These 21st century learning communication styles make students who 'team' better prepared for college and careers. To be successful on an economic, community or personal level, students need to experience collaboration themselves and are doubly enhanced by working with a team of joyously collaborating educators. As a principal and a former teacher ... I facilitate their collaboration and coordination of efforts on behalf of the school. To me the essence of leadership is collaboration of all team members and our staff model this real-world essential style for students."

As a result of their mutual ongoing creative and academic success with schoolwide programs, Carideo and Liotta were invited to work together on the robotics building project. They also worked with other educators to discuss how ELA, special needs, and ESL talents could be highlighted and engaged by the project.

The collaborative teaching team of Carideo, Liotta, Reissman, Xavier, and Rashid, represents teaching across the content areas (ESL, ELA, and CIT). In regularly scheduled team-teaching meetings, the educators discuss how Common Core ELA standards such as reflective journal writing and speaking and listening skills can be used to help students realize their 21st century learning goals. The team planned an introductory discussion for the robotics group of sixth graders, which includes some students who display Asperger behaviors, some ESL students, and a broad range of students with differentiated learning styles. The

team teachers use small groups and conferencing as part of their teaching so they can support the individual student groups by walking around and facilitating (Danielson framework, Domain 3). Groups are also constructed to support student strengths. In one student group, for example, a student who displays Asperger behaviors is identified as the videographer so he has to socialize with others; another student will "report" for the school television program as she is a visual learner and a natural on-camera performer.

A robotics project lends itself to myriad technical terms — *actuator, rotary, application, input, sensors, interface, linear, android* — and can help to develop academic and social language as students work together in small groups. Even where the words are somewhat familiar from science fiction or other technology kits or games, this project — with its attention to the manual-specific directions and need to get the special domain meaning of the specified robot function exact — forces students to learn the special domain-targeted robotics vocabulary, much as they will need to master job or workplace vocabularies as adults. This develops vocabulary as a necessary condition of robot-building success.

Reflection journals — student portfolios and artifacts — were especially beneficial to ESL students as they learned to express themselves in English using academic language. CIT (Collaborative Integrated Teaching) classes could work on argumentative pieces to defend their robot as the best challenge solution. The more verbally outspoken students could lead the way, while those with an Individualized Education Program used sentence frames to contribute their argument details.

The Robot Challenge Begins

With the teacher team having developed a framework, the students actually began their 21st century collaboration, critical thinking, and creativity. The robotics class was told from the start that they would be working in small groups to achieve the end product of constructing a functioning robot.

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First, there is a discussion on 21st century learning and innovation skills: creativity, innovation, critical thinking, problem-solving, communication, and collaboration. They are also taught about 21st century life and career skills such as flexibility, adaptability, initiative, self-direction, social and cross cultural skills, productivity, accountability, leadership, and responsibility.

The students get the kit and a deadline for building the robot to function and be presented for rubric-aligned assessment. They have to decide how to tackle the challenge. They self-direct and generally appoint a group leader to supervise and divide tasks of building, recording, group meetings, and addressing frustrations as the project evolves. The teachers may suggest students look at specific parts of the manual or work as a team to brainstorm solutions for problems that come up, but do not actually intervene or help them.

In their teams, students had to be flexible as they worked with others to follow the instructions in the manual. They had to adapt to one another's learning style and style of work. They had to be self-directed if members of the team did not work together. Some had to assume leadership and take responsibility for getting the robot ready to perform and function by the deadline date.

Each team member had to collaborate, communicate and often create solutions when what they did at first did not "work." Much of their effort involved "fixing" a part or aspect of the robot and dealing with the frustration that required another potential intervention strategy.

In their small groups, the students focused on how to interpret these special 21st century words into ongoing writing assignments and discussions. Before breaking up into small groups, a large group team meeting focused on the project objectives.

Throughout the process, students take notes for their journal entries and, with personal comments, can reflect on the team's progress as a whole. Some students enjoy recording, while others "voice" the material. Some illustrate or draw cartoons.

Excerpts from students' written work and discussions (voiced in formative and summative assessment journal responses) demonstrate powerful learning outcomes.

21st Century Flexibility

Just as with complex jigsaw puzzles and in real life when you plan an event, teach a class, or run a company, issues come up which were not and cannot be anticipated. Unlike some simpler erection or science kits students may have played with, the robotics kit is not assembled easily or immediately. Some students felt they had "lost" pieces, or they were "following instructions precisely," yet the parts did not fit. In addition, just as in any adult life enterprise or social effort, some students assigned specific roles do not come through and others have to pick up the slack. Many discussed how hard it was to execute the step-by-step programming detailed. They talked about team members who took over — or deserted. They journal anger at members who dominate, not collaborate. Khaliphkai noted that many within her group were focused on the building, but not the programming of the robot, an issue of accountability. Lizbeth revealed that the concept of teamwork in building the robot did not excite her since she wanted to work alone.

For some, this exercise highlighted the efficacy of being flexible. Others saw how they might need to develop that quality or suffer the consequences when things did not work out as they wanted.

Missing Pieces

The project has an explicit emphasis on problem-solving, critical thinking, flexibility, self-direction, accountability, responsibility and leadership skills. The following passage describes a snapshot of students working with their robots in the classroom:

> *Janiah actually got to the point of thinking about "breaking the robot" because it "would never work."*
>
> *Yarellis noted that parts in the box refused to go in properly, although obviously they were manufactured for the robot.*
>
> *Theresia put it literally, not realizing she had come up with an apt metaphor for the process and its frustration: "One ... problem we had is the missing pieces. One day we had all the pieces; the next day, we don't."*
>
> *One team found they had installed the parts incorrectly and needed to change the wires.*
>
> *Other groups were upset after having done so much work to discover that there was still more work.*
>
> *Khaim's group found it exceedingly frustrating to get the robot codes to actually result in the robot making a full turn.*

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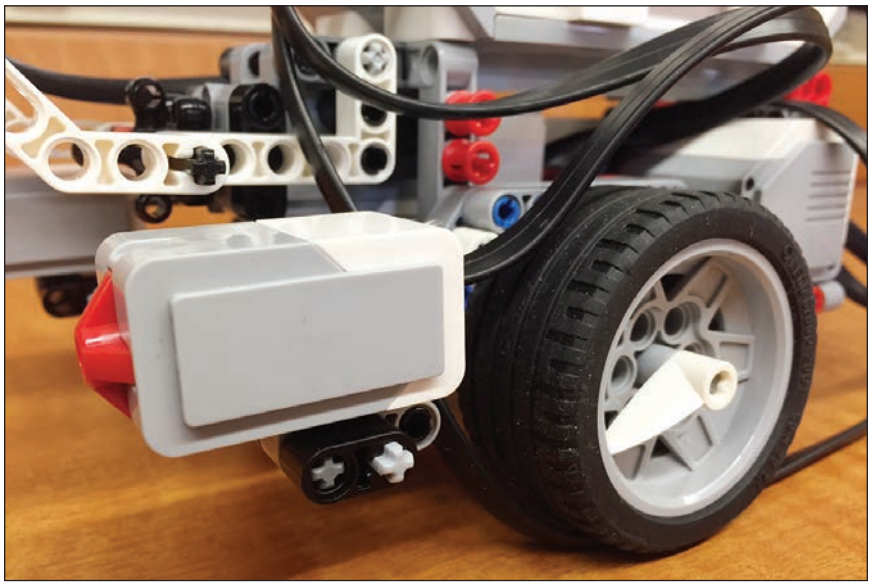
Robotics are a perfect vehicle to promote communications, collaboration and other skills essential to 21st century learning.



Just underscoring 21st century skills implicit in robotics was not enough; students had to apply it to their own lives and reason through real-life situations. Students were asked to brainstorm situations echoing the same "missing pieces" feeling. The students were also challenged to relate robotics reflections to their school social lives and family members' frustrations with other adults at home or at work in terms of communication and collaboration. Students went into their homes and communities to talk about the robotics project and their team work attitudes.

The students did a set of interviews with parents to find out the extent to which their lives involve chosen teaming. This culminated in an oral history. Finally, the students were given the option of developing arguments for and against teaming on projects. Some referenced a parent's feeling that the parent has to do "all the work" because others "goof off" or "disappear." One student said he felt that at home as well. He is responsible for the rest of his siblings in terms of cleaning up and preventing fights while other older siblings who are supposed to share this responsibility focus on themselves. Some students boldly argue that working alone is better because they can focus on tasks or assignments themselves. They can get these tasks done independently. Since the STEM teachers, Carideo and Liotta, are deliberately teaching as a team, their partnership and the collaboration by choice with a team of colleagues was compared and contrasted with the solo teachers.

Some students shared the pleasure of spending time on intricate jigsaw puzzles, only to be left unable to complete them because of "missing pieces." Students confessed to telling stories at school or to parents with deliberately missing pieces. For some students in search of birth parents, there were missing pieces. Discussion was reciprocal. The teachers shared the endless feedback and customizing of curricula for students that goes with teaching. They also considered how friendships, family relationships and even schools required ongoing and continued work to run well, far beyond what was originally anticipated as needed.

Once the students had vented their frustrations, the discussion and

reflective writing focused on how they had dealt with that frustration. Had they "fixed" the issues or problems or in some way bypassed them to get to successfully build a functioning robot? Their solutions were at first connected to robotics domain-specific issues.

Groups frustrated by the loss of crucial kit pieces brainstormed organizing and inventorying kit pieces by type and color. This facilitated tracking of the pieces so that any loss could be followed by focused search. The following classroom snapshot highlights some of the challenges students overcame during the project:

Shanay realized that programming the right codes required careful detailed reading of all the code descriptions. She personally undertook that task with another team member. This self-directed initiative led to identifying all the correct codes.

Joseph identified a leadership role as the scheduler/organizer. He scheduled each team member for four turns at building and four turns at programming. Most complied.

Luna's team applied the ELA class collaborative accountability speaking and listening conversations to group discussions about how things were going. As a team they came up with a plan to get their robot to work.

Janiah, who had initially vented frustration on the robot, reminded herself that she was the intelligent being in the equation. As she framed it, "It is not the robot's fault. It was my fault because I was doing something wrong." She disciplined herself to return to the computer. With this resolve, she was able to get the color sensors working. Having taken responsibility for her action, she was "really happy" when it worked.

The team with the mixed wire issue returned to the manual to get the wires placed correctly. The program actually worked, and that made all the difference in their mood.

Rashun came up with a plan for his team to have half the members build the robot and half start programming.

Azreen did change the name of the program to under 32 characters.

Several teams that had missing parts and couldn't find them simply went forward minus the parts, including a pivotal ball and a front bumper.

One team member tried delegating tasks, but when they weren't done, he wound up doing multiple tasks himself.

Just underscoring 21st century skills implicit in robotics was not enough; students had to apply it to their own lives and reason through real-life situations.

Since the journals and explicit discussion about aspects of the project beyond the robot-building had been a key element of the project, students could understand how they were actually doing much more than just building a robot.

Applying Robotics to other Real-World Situations

Finally, students worked on "fitting" these robotics "fixes" to real life, including real-world frustrations. We called this 21st century applied learning. In a closing session, Reissman challenged students to apply this strategy of robotics "fixes" to a real-life, career or job challenge.

Inventorying turned out to be a job one student's uncle had at a local 99 cent store. Another student recalled a hardware store clerk who had a written inventory of screw types available with a back order list.

Scheduling was something students schoolwide were familiar with in terms of limited scheduled access to gym, art, lunch and lab use. Many without computers at home also had to schedule access to computers in the public library.

Reading a manual slowly and carefully without emotion was a strategy students had seen work successfully for their parents or adults when using or setting up tech/exercise equipment, furniture, programming a cellphone and other tasks. Several students shared with pride their ability to read and interpret manuals.

In discussing multitasking when delegating tasks had failed, students mentioned family members, teachers, and coaches who ultimately made certain things got done on time. They were asked to identify multitaskers versus true leaders of teams in the news and in books. The idea of meeting a deadline by getting out a product that was not exactly the desired product, but still a viable one, was floated. What in real life got done, but not exactly how it was planned? Student response to this took awhile. Finally, a student artist noted that a mural he worked on in another school came out great, but was not his original design.

21st Century Born

Since the journals and explicit discussion about aspects of the project beyond the robot-building had been a key element of the project, students could understand how they were actually doing much more than just building a robot. They were able to look at their journals and listen to peers apply the skills they had demonstrated to the real world.

Students in this project all developed journals that reflected information writing, CCSS standards and robotics special skills (for which a rubric was created). They also programmed robots which all functioned and were rated according to a rubric. The students' visual and verbal group presentations were rated by CCSS Speaking and Listening-aligned rubrics.

Students were pre- and post-surveyed about the extent to which this project might be related to academic and social/real-world learning beyond the classroom. After all these outcomes and rubrics and the robots themselves are viewed, what stands out as an immediately infusible practice is the way in which robotics allowed students to practice real-world 21st century collaboration, communications, and creativity, and experience real-world skills and outcomes, as they "studied" sixth-grade required ELA, science, engineering and mathematics skills during the school day. They were not learning these key cognitive skills in isolation, but rather doing them as real-world persons — 12-year-olds functioning as 21st century learners.

Programming 21st century learning does not require an outlay of cash or the purchase of expensive materials. Rather it can and should be done through a team of collaborating teachers modeling in their partnership the ways content skills meld together for problem-solving, strategizing, and addressing frustrations. Robotics-building is an example of one ready opportunity for staff and students to engage in 21st century learning.

School curriculum maps are filled with other project-based literacy learning opportunities that can connect teachers as teams and students as peer-dependent teams working together on real-world products and productions during school time.

Robotics-building is an example of one ready opportunity for staff and students to engage in 21st century learning.

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"Caution, this will NOT be on the test!" Expedition Earth Science Prepares Students for the 21st Century

SUMMARY

Expedition Earth Science takes students on motivating journeys where they explore the natural world through an approach that emphasizes both the process and the development of problem-solving skills. The authors explain how collaboration, literacy, interpersonal skills, and content knowledge can be taught in a real world context and adapted by others in various settings.

On a Saturday afternoon, knee-deep in tea-colored lake water, Olivia and Riley pull and tug on the seine net as they drag it to the shoreline to see what they have caught.

The seine net, an aquatic survey tool, is loaded with leaves, small fish, and creatures from the bottom of the lake. It is the critters from the muddy and sandy bottom the girls are hunting. They are surveying the lake bottom for invertebrates that occupy the base of the food web and are often hard to find. The girls laugh and their eyes open wide when they see what they have caught. While the girls are pulling their net onto the shore, other student groups are collecting and identifying ferns, testing the water chemistry of the lake, drilling tree-ring cores to study climate patterns and tree growth, and mapping the bottom of a smaller lake. Make no mistake … this is school and the students have chosen to take on these credit-bearing tasks!

Riley (left) and Olivia pull a 20-foot seine net from a lake in central New York.

Jeff Peneston teaches earth science at Liverpool High School. Peneston is the 2011 New York State Teacher of the Year.

Andrew Calderwood teaches earth science at Liverpool High School.

Jeff Peneston, United Liverpool Faculty Association
Andrew Calderwood, United Liverpool Faculty Association

"At first I was surprised to find anything in the net, and then I was anxious about getting bitten! Ultimately I was excited to hold all of the small, living things."
— Olivia Sherwin

Olivia and Riley, along with the other 18 students that weekend, were participating in Expedition Earth Science (EES), an experiential education program designed to provide authentic learning experiences for ninth-grade earth science students at the Liverpool High School Annex, located in central New York. For participating in an expedition, students earn earth science lab credits toward the 1,200 minutes required by New York state and up to five points of extra credit on their quarterly grade.

More important, on the weekend expeditions, students learn many skills that are not measured on standardized tests. They collaborate in small teams, practice "just in time" learning as they work with new and unfamiliar scientific equipment (like the seine net), build resilience as weather conditions change and equipment fails, and, in the end, they also gather authentic scientific field data through creative problem-solving.

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Expedition Earth Science

The Expedition Earth Science program, designed in 2000, was established based on the following goals:

- **increase** the rate and retention of inquiry-based **scientific learning**;
- **enhance** student interest in **science throughout high school**;
- **encourage** students to pursue **science/engineering careers**;
- **act** as a **test** of an instructional model that could be applied to other courses;
- **foster** the use of existing **district technology**, such as laptop computers, data collection hardware and software, and online research services; and
- **develop** collaborative **relationships** with local businesses, agencies and science professionals.

Parental support for transportation and adult supervision during the expeditions are key to the success of the program. Involving parents gives them the opportunity to be a part of the child's educational experience and fosters a feeling of ownership in the educational system. Expeditions take place on evenings and weekends so that our time in the field does not impact other content areas or the students' weekday schedule. The EES program involves small teams of students working cooperatively to ask questions, solve problems, gather data, and report on their findings.

Seven to 10 expeditions are offered throughout the school year from October to May, giving each student an opportunity to be involved no matter what their schedule is like. About half of the expeditions cost the student nothing and the others range up to $65. There is no organized fundraising, and families choose what they can afford. Each expedition begins at an after-school meeting about two weeks before the trip, where the students form teams and receive detailed assignments describing the problems that they must solve by collecting scientific data in the field on the day of the expedition. Students are expected to create a finished product (reports, displays, presentations, etc.) from their experience. Expeditions typically consist of 15-24 students, two teachers and up to 10 parent volunteers.

"Caution, this will NOT be on the test!" Expedition Earth Science Prepares Students for the 21st Century

Students need to explore the real world through experiential education, using teamwork, research, and critical thinking.

EES Rationale

Students today will become the parents, employees, leaders, and voters who will inherit and lead this country with scientific literacy. They are the generation that is increasingly expected to prove themselves through performance on tests even though they have a decreasing experience with authentic scientific problem-solving. Unfortunately, these students have less contact with the natural world than any generation before them. Dhanapal & Lim (2013) report findings that have proven, " . . . that indoor and outdoor learning complement each other in improving students' academic performance and have also showed positive responses among the students in choosing outdoors (rather) than indoors for learning science."

Educators at all levels need to be encouraged and supported to engage students in authentic problem-solving. Students need to explore the real world through experiential education, using teamwork, research and critical thinking.

> ***"Expedition Earth Science . . . changed my life. I experienced firsthand what science is and how it works in places I never imagined." — Mark Alessi, Cornell University, meteorology major***

Experiencing real work environments and solving authentic problems is a very old and extremely powerful teaching/learning paradigm. Educators in today's classroom are working to lead students through demanding curricula, but they generally hesitate to utilize this oldest of approaches to learning. "Hands-on" has become a term that is often trivialized and overused by educators. We can also fail to see how a one-inch cube of rock or a satellite image of an approaching storm pales in comparison to the on-site experiences that real scientists have when exploring a geologic field location or working outdoors during the storm. Many aspects of science education are very poorly attempted in the best of classrooms. Students find it difficult to become enthusiastic about careers in science when their exposure to the exciting nature of those careers is limited to traditional teaching methods (Larmer and Mergendoller, 2010).

> ***"Before this experience I had never considered a career in science, but this helped me realize I could potentially have a career that combined my passion for the outdoors with problem-solving." — Sara Coffey, University of Hawaii, geochemistry graduate student***

The EES program provides an intimate learning environment where students are provided the opportunity to select a task or problem of their choice and collaborate with one or two other students. In this way, students are practicing critical thinking and problem-solving skills for 21st century learning.

21st Century Skills

While education in the last century often focused on content-driven curricular objectives, we all know that in this digital age, the content of our world is largely available to the literate. The 21st century will require people to gather, process, and produce their own content and solutions (Trilling and Fadel, 2009). Our current students will become the adult citizens of the future and the research describes the types of skills we need to help them develop. In the broadest context, we want our students to have the power to choose educational and career trajectories that will interest them and enrich their lives. As a society, we will need our students to become the problem-solvers who are experienced at working collaboratively in groups with the interpersonal skills and resiliency to complete complex tasks as a team. They will also need to be adults who know how to find and use authoritative sources of information (literacy/research tools). We also know (Larmer and Mergendoller, 2010) that adults in the 21st century will need to be able to use those sources of information and their own creativity to generate original approaches to accomplishing the tasks of life.

The EES program is less concerned with the traditional content knowledge and emphasizes the processes of problem-solving and the development of these skills. EES starts by allowing students to select an outdoor expedition and a research problem that interests them. Next, students form teams and learn about their project goal through meetings and background research. The teams travel to field locations to collect specimens, data, or to perform a task. Finally, they practice literacy skills as they create a final product or presentation that they can share with others. Throughout most expeditions, we expect the authentic nature of field science to provide the teams with unexpected problems from equipment malfunctions and weather challenges, to opportunities to experience unplanned events and discover things that were unexpected. We joke with our students that the subtitle to the Expedition Earth Science program is "caution, this will NOT be on the test!" and we admit that few of the lessons learned will directly transfer to the high-stakes, year-end exam. But,

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As a society, we will need our students to become the problem-solvers who are experienced at working collaboratively in groups with the interpersonal skills and resiliency to complete complex tasks as a team.

"Caution, this will NOT be on the test!" Expedition Earth Science Prepares Students for the 21st Century

One goal of EES is to place students in authentic situations and locations where they feel their work mirrors what might take place in the real world.

we also know that the summative evaluations that await them in their adult lives will draw heavily from the skills developed on our expeditions.

> ***"I've always been a 'hands-on learner', so this experience was beneficial to me because I realized a career where I could be doing vs. reading would be beneficial to me."*** ***— Sara Coffey***

Collaboration — Student groups meet prior to the expedition so the teams can research their chosen task and prepare themselves for the remote, outdoor field locations. They share ideas, make a plan for their research, take down notes, and print information sheets relevant to their area of research. This may include identification charts or directions for how to use equipment. Students may also spend time practicing the use of the actual equipment. During the trip students must work together to collect data in the field, paddle canoes, adjust to complications, or create presentations to communicate their work to an audience. Following an expedition, students meet during or after school hours to produce their expedition product, which for some trips include professional quality displays, short videos, or essays. For each one of these steps (before, during, and after the expedition) the team must communicate and work together to achieve their goal.

Authentic Setting — One goal of EES is to place students in authentic situations and locations where they feel their work mirrors what might take place in the real world. The use of authentic equipment and procedures is also crucial to the integrity of the program. For example, two of the expeditions on our annual list are collaborations with Hobart and William Smith Colleges (HWS) in Geneva, NY, where our students travel out onto Seneca Lake and work on a 65-foot research vessel owned by the colleges. The professional-quality equipment they use on those days allows them to collect data on the lake sediments, water chemistry, and planktonic life that become part of a growing database used by the scientists in the Geosciences Department at HWS.

> ***"I learned new things about the lake but also about being a scientist in the real world. The use of different instruments to collect data was a way to apply what we learned in class, expanding our knowledge about science." — Megan Corcoran, SUNY University at Buffalo, geology major***

Through grants and awards over the years, we have also been able to purchase a variety of professional scientific tools for our students to use that rarely would be included in high school

science programs. We have rock-cutting saws, environmental chemistry testing kits, and even an underwater video camera that we use to explore the depths of area lakes.

> ***"…standing on Rams Head on the Island of St. John in the USVI…I observed unrelenting 30 mph winds and direct sunlight which helped me to understand why Rams Head has a desert microclimate." — Mark Alessi***

Literacy — One of the foundational principles of the EES program is that the expeditions would not be a "passive visit" where we tried to walk "everyone" through an experience. We chose to limit the number of students on each expedition so there is the intimacy to allow student teams to work with the teachers. Each student team is required to create a finished product in order to qualify for course credit. Our goal is to have the students create documents that reflect what real scientists are paid to produce: Data summaries for a local college, slide shows to share with others, documentary videos, museum displays, and even live webcasts all require students to practice literacy skills at a high level. Examples of some of these videos and a student-created blog can be accessed at *http://teacherpages.liverpool.k12.ny.us/webpages/jpeneston/index.cfm*

The image at the top is a micrograph taken by a student. The watercolor artwork below was created by that student as part of a museum display.

Interpersonal Skills — Typically, classroom teachers attempt to design activities in which all of the tools and steps are provided to the students and the teacher has the maximum control of the process and the outcome. The

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"Caution, this will NOT be on the test!"
Expedition Earth Science Prepares Students for the 21st Century

teacher is also the one who is expected to help students overcome procedural problems. All of this can lead to correct answers and good grades, but it fails to reflect that most of the problem-solving in our adult lives is fraught with unexpected problems and the expectation that we have to rely on our teammates more than our employers. Students on EES adventures cannot complete the process or project without working in teams. Listening, sharing, leading, collaborating, and being flexible are as important as scientific knowledge. On some expeditions, students also get to practice living with other students and their teachers at our weekend and weeklong field camps. Learning to live with neighbors who snore and teachers who can cook chocolate chip pancakes are all part of the EES experience.

> ***"One of my friends who I had just met in earth science freshman year became my best friend during the trip and still is like a sister to me today. We laugh at the memories made on the trip. The expeditions not only helped expand students' knowledge of science but also foster relationships from the experiences shared on the trips." — Megan Corcoran***

Resilience — Teachers usually know the answers and are sure of the methods before they ask the students to attempt an assignment, and this leads students to believe that real science begins with a worksheet, 10 guaranteed steps and the equipment already set up in the lab.

Authentic scientific research often requires scientists to invest the majority of their time in the development and validation of data collection methods. Field scientists must be able to prepare and react to every type of mechanical breakdown and change in the research plan once they are in the field. EES encourages students to pursue questions that are beyond their teacher's knowledge and use original procedures. This often leads to discovery but it usually leads to things going wrong in the field. Students are encouraged to imagine every possible contingency before the trip and then the student teams are expected to solve the problems mid-stream.

"After months of planning to measure the differences in salt water salinity, we arrived on St. John and found that our salinity meter would not work. We had to quickly find a new topic and get ready to report our findings on the live webcast." — Alex Moore, 12th grader, Liverpool High School

Measureable Outcomes

In 2012, as part of a graduate course, Calderwood conducted primary research on the EES program. The question under study was: What, if any, impact does the EES program have on students' perceptions and attitudes regarding science? The study utilized a pre survey given to 180 students in eight earth science classes. The questionnaire encompassed 26 questions broken down into six sections. The six sections of the survey asked the students to identify their current academic level in earth science and if they had signed up for an expedition, their perceptions of science education, rank order words describing how science is delivered to them, complete a science favorableness scale, answer Likert-type questions dealing with perceptions of science process skills, and complete an open-ended question about their single best science moment.

The post survey was similar to the pre survey except where it asked the respondent to identify which expedition they attended, their comfort level prior to and after the experience, and an open-ended question asking them to describe their experience. The results were gathered in both qualitative and quantitative form. In summary, the data showed that:

- 69 percent of students signed up for at least one EES out-of-school, experiential education experience.
- The predominant reasons described by students for attending these expeditions included the fact that they were "real-world," "fun," "new," or "outside." These are often conditions not associated with school, where most learning takes place at a desk within the four walls of a classroom. Because the students see the EES program as a novel educational program, and because research has shown that the brain seeks out that which is novel, EES is very successful at drawing in students to the program.
- The data seem to indicate that students move from an impression of science being fun in elementary, to interesting in middle school, to an expectation of interesting (but also

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Listening, sharing, leading, collaborating, and being flexible are as important as scientific knowledge.

Students engage in literacy skills such as journaling and video production and have found that outdoor environments are great settings for encouraging those activities.

stressful) in high school. Also, the data showed that the anticipated stress level associated with science dropped from 30 percent prior to an expedition to 12 percent following an expedition. This may signify the building of resilience in students who attended EES trips.

- Students also listed "real-life," "outdoors," and "field trip" as the least teacher-utilized aspect of their science education. The EES program fills this gap for those students interested in this type of educational learning approach.

- The Thurston method of measuring favorableness resulted in academic students scoring 5.25 out of 7 (1 least favorable and 7 most favorable) and honors students scoring 5.70 out of 7. What was most interesting, however, was that students who attended an EES experience were still just as favorable to science but at a much higher frequency (for example, 84 percent agreeing on a statement for the pre survey, but 100 percent agreeing on the same statement on the post survey). The data suggests that there seems to be a strong relationship between attending an EES experience and students' positive view of science.

- The post survey also indicates that students are much more confident with the process of science following an experience with the EES program (29 percent of students self-selected as confident in the pre survey and that number increased to 52 percent following an EES trip).

- Finally, the open-ended question regarding "How would you describe your experience in terms of how this trip impacted your view or attitude about science" resulted in answers such as: "… would like to go on another trip," "more interested in science," "do it again in a heart beat," and "trip increased my already positive view on science."

Since students ranked the EES trips as highly scientific (8.8 to 9.3 out of 10), and with the sense that their perception and attitude regarding science was made more positive through an EES experience, it appears the EES program does not just supply a fun event for students to attend, but a meaningful learning experience.

Transferring the Model

Bryce and Liana are both elementary-aged students who have come along on an expedition to a salt mine in central

New York where 380 million year-old rocks are exposed. They have joined an EES trip to this location, north of Ithaca, NY, with about 20 ninth-grade students, a dozen parents, and three teachers to excavate, collect, identify, and build displays for the fossils of ancient sea life that can be picked from the quarry here. Excitement and surprise light up their faces with each new discovery. However, this trip has a twist. The third teacher on this expedition is an art teacher who works with the students after they have collected their fossils to refine their scientific drawing skills. This particular trip is a hybrid of sorts, mixing two very different and seemingly unrelated content areas — earth science and art.

Although this program is called Expedition Earth Science, we have always imagined it as a pedagogical model that was adaptable and transferable to other subject areas and age groups. Clearly, teachers in other high school science content areas can find value in field science but we know that teachers of literacy, art, history, languages other than English, and cultural studies would enjoy all of the benefits of this model as well. We have our students engage in literacy skills such as journaling and video production and have found that outdoor environments are great settings for encouraging those activities. Since most of our expeditions encourage parents and the occasional siblings to participate, we have the experience to show that this type of outdoor experiential learning works for multiple age groups from pre-K to grandparent.

Above, parents work alongside students on a fossil dig site.

At left, Liana looks up from a 375 million year-old sea floor where she has been finding her fossil trilobites.

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More than delivering content, EES prepares students beyond the three R's and helps them to become the effective communicators and creative problem-solvers of the next generation.

To date, more than 2,000 students and parents have taken part in the EES program. After 14 years and more than 120 expeditions, this approach to science education has repeatedly proven to benefit the earth science students involved, but it has also suggested unlimited opportunities for similar programs across grade levels and subject areas.

More than delivering content, EES prepares students beyond the three R's and helps them to become the effective communicators and creative problem-solvers of the next generation.

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Engaging Critical Thinking Skills with Learners of the Special Populations

SUMMARY

In this classroom portrait on critical thinking with special populations, the author describes the importance of teaching all students to pose good questions and to learn how to make meaning from complex ideas. Through Socratic dialogue, project-based learning, and other methods designed to engage all students deeply in the learning process, this teacher helps all learners to be engaged.

Essential to a student's success

in school as well as in the workforce is his or her ability to think critically. Higher order thinking skills such as problem-solving, application, synthesis, and evaluation are fundamental to students' intellectual growth. As educators our expectation should be that students engage in high levels of cognitive work as often as possible during instructional time. They should have multiple opportunities per class period to complete tasks that are cognitively demanding.

All students can and should be engaged with critical thinking applications. Language deficits, learning disabilities and limited knowledge of subject matter should not restrict students. Critical thinking is a vital component to 21st century skills and the foundation to the Common Core Learning Standards (CCLS). In order to ready all students for college and careers, we need to teach them how to think on their own. Young learners need to be fully responsible for their experience of making meaning from complex ideas.

Learning in the 21st century involves measurable applications of pedagogy that may be adapted and crafted to fit any population of learners: English language learners (ELLs), learning disabled, emotionally disabled, etc. Fundamentally, teaching and learning with a focus on the 21st century learner involves imparting a blend of expertise, critical thinking, skill, content knowledge, and reading ability integrated with innovative technology supports that help students master the multifaceted, multitasked and multidimensional abilities required of them in the college and career workforce. It is a real and powerful mechanism of change for an antiquated teaching and learning system that teachers have

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Stacie Deyglio, Hawthorne Cedar Knolls Federation of Teachers

relied on for decades. Twenty-first century learning involves more than integrating social "webs" and mobile digital devices. Twenty-first century learning is about moving a classroom of learners to a threshold of learning that engages students to think relevantly while learning skills that will lay a foundation for their own future, individualized paths through life.

I am responsible for six classes of mixed cognitive ability, learning and emotionally disabled high school students in a 12:1:1 ratio setting. My students range in age from 15-21 years old. Most are living in a residential setting, some travel hours by bus from their home districts. We follow the Living Environment NYSED standards implicit with CCLS for literacy in history/social studies, science and technical subjects. Within the therapeutic environment provided by the school to meet the student's emotional disabilities and learning inabilities, students are academically required to follow the same NYSED curriculum as every other student in the state of New York. As their teacher I am mandated to comply with the APPR agreements of my district and the NYSED standards of my content area.

Engagement is the specific strategy I focus on the most in my classroom. Engagement may be defined as active learning that occurs when students are inquisitive, interested, and inspired by content or teacher interaction. Engagement does not include learning when students are bored, dispassionate, or disaffected. If the students are not actively engaged, then they are not actively learning. In a 40-minute period, students walk with me through a process of structured Socratic thinking that enlivens and engages the mind with scientific inquiry, relevance, and critical thinking applications. The lesson delivery corresponds to the unit scope and sequence. The level of Socratic method questioning never changes, just the content changes as we progress through the

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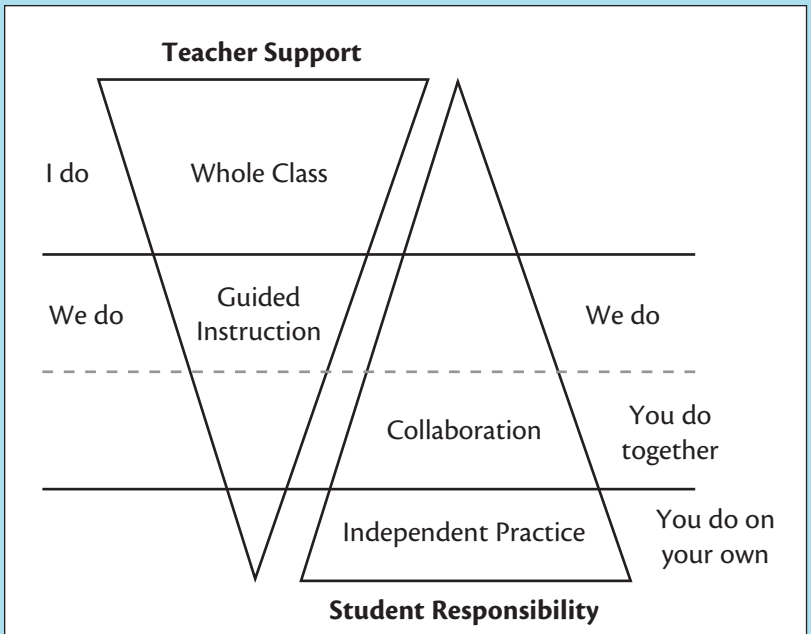
Individuals with Disabilities Education Act

The definition of emotionally disabled is a gray zone. The Individuals with Disabilities Education Act deems that for a child to be labeled with an emotional disability, the child must exhibit three characteristics:

- An inability to learn that cannot be explained by sensory, health, or intellectual factors.
- An inability to build interpersonal relationships with peers or teachers.
- An emotionally disabled child will show repeated inappropriate behaviors demonstrated in normal circumstances.

"Do Now"



Doug Fisher and Nancy Frey (2008)

year. With a focus on giving students questions, not answers (Socratic teaching) I model an inquiring, probing mind by continually probing into the subject with questions. I also follow the gradual release of responsibility or the "I do, We do, You do" model as outlined by Doug Fisher and Nancy Frey (2008). This instructional model requires the teacher to transition from taking on all the responsibility for learning to a condition where the students shoulder the academic responsibility. This methodology would ultimately result in confident learners who accept responsibility for their own learning, all the while directing this learning through the cognitive process.

Students continually struggle with engagement. The generation of youngsters we are currently training are inept at sitting still and focusing for longer than 20 minutes. When students are brought in as responsible parties, they are emotionally invited to sit alongside the teacher and transfer the responsibility of learning. As opposed to sitting, listening and doing (an older, out-of-date teaching model) the gradual release of responsibility strengthens confidence within the students as a community of the classroom as well as within themselves as individuals. There are no wrong answers, only learning moments to improve upon what we already know.

A learning goal is posted on the whiteboard. The learning goal is stated at the start, the middle, and the end of each lesson. An "Aim," in the form of a question, is posted on the board. The class starts with a "Do Now," motivator that gets students focused and into the academic "realm" of learning. The "Do Now" is always a rigorous question either of my own creation or a sample Regents question which is aligned to both the learning goal and aim we are covering that day. The multiple-choice questions or the higher order short answer questions of the Regents exam are easy to write on the board quickly. A scale is posted on the board that is aligned to the learning goal achievement. Another more basic scale is posted at the top of the board

and relates to the dynamic understanding of the aim, which will ebb and flow throughout the lesson. An agenda (expectations) is located at the far corner of the board, and as the students are copying the Do Now, I briefly review the agenda for the 40-minute period together, settle students, walk around continuously checking in with students, asking questions and managing the class.

Due to the nature of the special populations served in this classroom, the "Do Now" is embedded with an incentive in which students earn tickets for participation and correct responses. The incentive attached to their ticket is an engaging reward that motivates students to buy into the knowledge I am selling. An engaging reward includes a tangible such as a bottle of favorite lotion, an iPod charger, fruit, or other such item. The reward items are celebrated as a whole class, so that there is active buy in and engagement from the level of the teacher, teacher's aide and the students.

After the "Do Now," we move into the mini lesson. This can be a 7-10 minute teacher-driven, structured Socratic method content lecture relating to the aim and learning goal. This can look something like the following: I would start the lesson by saying "The learning goal states students will be able to identify the steps of the scientific method. Who in here has ever heard of the scientific method? Tell me what you know about it." Students respond with random words — "Oh, hypothesis Miss ... that's part of the scientific method" or they would say, "This means you have to make an observation and then test it, right?" Or they would say, "There's like some steps to this Miss, but I don't remember what these are." This will usually include a "leapfrog" event of the conscious minds involved in a classroom discussion. The students with lower confidence mutter to themselves or to the person next to them. The students with higher confidence raise hands or blurt out answers and identify rationale for role-modeling moments. The teacher celebrates every answer provided by a student. Celebrated responses from the teacher involve smiles, congratulatory remarks, high fives, hand pounds, hopping up and down and saying how proud I am of their attempt. This builds student confidence and ropes them into the content I am driving in the lesson. Now they want to learn more. They want to know about the scientific method because I (as the teacher) value what they know already and I want to see them succeed with this content. I want to see them know the steps to the scientific method and I want to see them

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Socratic teaching method

Socratic method teaching is an "in the moment" series of content-driven questions that are broken down into "digestible bites" for students to percolate over in their minds and then respond to verbally.

All students can and should be engaged with critical thinking applications. Language deficits, learning disabilities and limited knowledge of subject matter should not restrict students.

apply these steps to a real-life situation they should be familiar with. Next we move on to the mini-lesson and students are engaged to copy notes verbally or verbatim from a PowerPoint presentation and/or whiteboard. Then we move into a literacy-based task that involves whole group participation. This could be in the form of questions; a picture, figure or diagram; WISE or Web-based science inquiry; project-based work; a video, handout or actual projects or assignments; or other form of whole class task designed to incorporate every student's participation and buy-in. This "We Do" aspect of the lesson takes anywhere from 10–15 minutes.

The class then transitions to independent structured work in the last 10–15 minutes of class. In this, the "You Do" aspect, the students are provided with a more rigorous academic task that includes critical thinking, relevant questions that are either modified or direct copies of past Regents exam questions. The "You Do" task could be a literacy requirement based on the students' interpretations of the mini-lesson. This would include a summary, an explanation of the ideas discussed in class, a picture/drawing (that is labeled and briefly explained), a list, or sometimes any interpretation of the lesson derived by the students. For example, every Friday we complete a science journal entry. In one lesson, we explored the difference between organic and conventional foods. Students were shown an experiment performed by a third-grader on YouTube. In this experiment, the student grew potatoes of different varieties including organic from the supermarket, organic from a farmer's market and conventional from the supermarket. She grew the potatoes in water, qualifying how much potato eye growth was apparent after the potato spent a discreet amount of time in tap water. Students were required to answer the following questions about the video: How does exposure to certain chemicals alter a living organism? Which potato do you believe would be the healthiest to eat as a part of a regular diet? Describe the potato you would eat and explain why you chose it.

Students were given time to answer the questions and we reviewed these answers as a class. Then students were directed to write a summary of the video in their journals, on their own (individual work).

In another example, we watched a video or as a whole class read aloud a science article adapted from *Newsela*. The students were required to answer three questions about the article/video as a whole group. I wrote the answers on the board synthesized from the whole group discussion. Students then copied the responses into their journal notebooks. As their individual work for this assignment, students were required

to write a brief summary of the article/journal of five to seven sentences in their own words. The class would then end with students engaging in a round robin or teacher-driven probe for students to directly answer the aim. Students were provided incentive tickets throughout the 40-minute lesson for participating, peer support, positive behavior, transitioning from one task to the next, and task completion (Education, A., 2014).

Teaching critical thinking skills to the special needs populations requires educators to be flexible, to experiment, to have consistent patience, to employ academic rigor, to use evidence-based evaluation, and to be mindful of educating the whole child. It is a multifactorial approach that may yield strong results bridging the accountability gap and better preparing students for life outside of compulsory education.

Thinking is driven not by answers but by questions. When engaging a classroom with Socratic questioning it is important that:

- the discussion stays focused;
- the discussion remains stimulating with probing questions from the teacher;
- the discussion is intellectually responsible (for all learners involved, including the teacher);
- a student, group of students, or teacher summarizes what has or has not been discussed and/or resolved (this can also include a student recorder or teaching assistant acting as a recorder of important points); and
- as many students as possible are engaged in the discussion.

Questioning is the heart of critical thinking. Questions include any degree of ordered thinking that can elicit a response from a student. Open-ended questions are the best — this includes using "how-based" questions like "How did the scientific method become organized in steps?" as opposed to close-ended questions such as "What are the steps to the scientific method?" Open-ended questions cause the "wheels of cognition" in the mind to start to whirl and think. With this, students are engaged and are able to elicit responses that are intelligent and content-driven. In order to create an environment where engagement and intellectual curiosity exists, questions are essential. During the mini lesson, students are not sitting idle as the teacher drills knowledge in a lecture format. Instead the lecture integrates a flow of questions throughout. It is rare for students in my class not to be prodded with a question for more than 30-60 seconds at a time throughout the mini lesson. Incorrect

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answers are probed; other students are invited to assist or help out fellow classmates in answering questions and furthering the discussion. Successful answers are celebrated by the teacher's congratulatory verbal cues. Peers supporting one another to assist and answer questions together are celebrated, as well. It is important for me to impart upon my students the skill of asking questions in order for them to achieve the goal of thinking like a scientist. It is the process of generating new knowledge and using prior knowledge to back up, confirm or refute ideas that lead to new understanding (Community, T., 2014).

Students of special needs populations, specifically at-risk students who come from low income, non-English speaking households, have a decreased awareness of the appropriate skills that make them confident, secure learners. It is vital and necessary to embed within the lesson frame a structured flow of engaging (and therefore rewarding) experiences where the students are able to freely express prior knowledge, as well as assimilate the new knowledge the teacher is driving the lesson with.

For any population of students (general education, English language learners, **but especially with the special populations**) it is important to choose content aligned to the standards that students will actively participate in, including the use of Smart Board activities, videos and web-based science inquiries. This is key to the "buy-in" factor of the content knowledge being "sold" to students. It's important to choose topics current in the news that associate to the student's lives and that are relevant and significant to students, for example: A compression fracture that occurred on the court of a well-watched popular NBA game was a big hit to spur a discussion of the skeletal system in my classroom. Choosing topics to discuss that students can relate to gets students talking and engaged in the process of learning.

As the teacher, I spend a majority of prep time finding rich sources (videos, photos, art, interactive Smart Board games, web-based inquiries, live manipulatives, i.e., insects, physical objects to hold and work with) that connect to pressing, relevant content, which will fuel the discussions after the mini lesson. I follow up with a strong collection of questions that range from factual to analytical to connective to solution-based problem-solving. Here's an example: I had taken a class of very homogenously low-skilled students through a lesson of genetic variation. In doing so, I used a Living Environment Regents short answer question series relating to the common weed, the dandelion. The question set involved a short reading passage about a new variation of dandelion that showed up in a

science teacher's lawn. The new variation of weed was genetically short in stature and as a result, bypassed the lawn mower blades every time the teacher went to mow her lawn. The discussion was peppered with Smart Board pictures of dandelions and people mowing their lawns. In this lesson, the students became the active teachers and asked me questions and shared personal stories about dandelions, genetics, sexual reproduction, variation, etc. A fantastic discussion ensued. After the class was over, multiple students came back from lunch bringing me yellow dandelion bunches, flowers and stalks!

As part of maintaining the active discussion, the teacher should involve differing perspectives of the discussion, to a certain degree. This involves playing the role of "devil's advocate" by bringing up opposing views to dynamic situations. This is easy to accomplish in science, as there are many current, relevant and weighty situations students should be exposed to and on which they should formulate solutions or opinions. This can include the topics of stem-cell research, human impact on the environment, global warming, fracking vs. nuclear energy use, etc. It is important to give students controversial topics and let them hash it out. First and foremost it should be established that respect for one another must be upheld at all times. It is acceptable for the individuals in the group to "agree to disagree." This can be established by setting clear rules for voicing different perspectives. These rules must be founded in objectivity, such as finding a flaw in the evidence or the reasoning, not a flaw perceived to be based on subjective personal opinions. Then students can be taken through a short discussion from which they will need to compute (think) the thoughts, information and viewpoints spoken about, and transform these into a CCLS literacy-based assignment or individual task for the "We Do" and/or "I Do" aspect of the lesson.

To initiate the critical thinking process it is best to start with a prompt. Provocative questions are best to build arguments around. For the case of the dandelion example, the question of "How does genetic variation of an organism impact humans?" was the provocative insightful question (aim) that correlated to an insightful, thought-provoking and critically applicable lesson.

With the special populations it is important to identify ambiguous or subjective terms. In my classroom, students can identify with urban terms for human body parts/organs as opposed to the appropriate acceptable common knowledge terms we may use in daily conversation. Not every student enters

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Students have the right to think out their ideas — out loud — in the presence of the teacher and fellow peers. Classmates offer support and we arrive at the answer together — there are no right answers; all answers are a way of contributing to the class.

the classroom with the same amount or type of prior content knowledge. It is important to elicit responses from students. This may take patience on the part of the teacher to hold the class to the probe and wait for a student to come up with a response. All students have exposure to science knowledge through prior instruction, television shows, video games, etc., so it is appropriate for them to share these responses during instructional time. It is crucial for the educator to remain open and flexible with the discussion and amount of knowledge being discussed. I always have, in my back pocket, the highest achievement skill for each student. I have learned it is more important to work flexibly with students, to support their academic strengths while generously and tenderly working to improve their weaknesses (specifically with literacy-based skills).

Not every student is able to clarify and define common knowledge terms but every single student has the right to be able to do so. So in this manner it is important to act as a patient "guide on the side" to support lower skilled student ability in unpacking content, terms and applicable skills. The outdated emphasis on students getting the "right answer" every time is a model that discourages critical thinking and turns off the learning process.

Students have the right to think out their ideas — out loud — in the presence of the teacher and fellow peers. Classmates offer support and we arrive at the answer together, in most cases. I tell my students there are no right answers; all answers are a way of contributing to the class as a whole, absorbing the knowledge that is being "led" or driven by the teacher, who should be the highly qualified content authority.

According to the Individuals With Disabilities Education Act (IDEA) students with disabilities are required to have an Individualized Education Program. IEPs identify measurable education goals that reflect student skills and degree of academic capability. IEPs also include important life skills such as social and emotional skills, and self-efficacy skills that are not addressed by the Common Core (Samuels, 2013).

To assess whether students are learning to think critically, the teacher needs a window into their thought processes. In order to do this the teacher needs to establish a method of individualized recording, assessing and evaluating the constant stream of data generated by students through the classroom period. Teachers must challenge students to communicate back to them, utilizing integrative and creative methods of communicating authentic results. Essays, summaries,

experiments, project-based learning tasks, research papers, inquiries, Socratic discussions, and academically rigorous questions give students the chance to demonstrate their skills. This allows the teacher to evaluate student reasoning in a variety of individualized situations.

Research on classroom management and highly effective best practices (Bos, C.S., Vaughn, S. 2002 & Burden, P.R., 2003) has shown that children perform best in a classroom that is predictable, stable, and structured. We should challenge our students as often as possible with full confidence that they can think critically about the ideas presented in class. Teachers may need to offer support or fill in the holes, and this is our job to do so, but most of the cognitive work is the responsibility of the students.

Students will not ask for rigorous tasks. They will do what we ask of them and nothing more. We cannot wait for them to request a challenge. We must challenge them every day. If by the end of a task students do not understand or have not reached the learning targets set out for them, we can go back, reteach, or use the opportunity to ask a different set of questions that will stimulate their brains to active learning.

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Additional resources recommended by the author

https://www.youtube.com/watch?v=98S24g7ZZmw

https://newsela.com/

Living Environment NYSED standards (found at http://www.p12.nysed.gov/ciai/mst/sci/documents/livingen.pdf) implicit with CCLS for literacy in history/social studies, science and technical subjects (found at *http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf).*

We should challenge our students as often as possible with full confidence that they can think critically about the ideas presented in class.

Music Performance Ensembles: A Platform for Teaching the 21st Century Learner

SUMMARY

Performing ensembles give students opportunities to develop critical listening skills, to collaborate with team members, and to put critical thinking into action by making music. This author describes the importance of music education and some of the challenges faced by music educators in test-driven times.

In a progressive education system, it is easy to set aside the arts when Common Core dictates the expectations of our students. This past school year alone I lost a large handful of my most valuable instrumentalists when they were switched out of my band class to take a double period of ELA or math. My administrators viewed this decision as the best possible solution to boost our students' grades, a continuing pattern throughout many schools in many districts. Between demanding academic requirements and this addition of double periods in core subjects, music electives are often the first classes on the chopping block since they are not mandated.

However, music performing ensembles help students succeed in ways that are often overlooked while scheduling students for classes. My fellow NYSUT music teachers and I share similar questions that remain unanswered:

- Why do these students have to be removed from an ensemble when music-making provides ample opportunities for helping students develop individually and as team players?
- What about all of the cross-curricular skills students are learning while participating in band, orchestra, or chorus?
- What about students who have dreams of working in the field of music as a career, or simply need music in their daily lives to empower them in any direction they choose?

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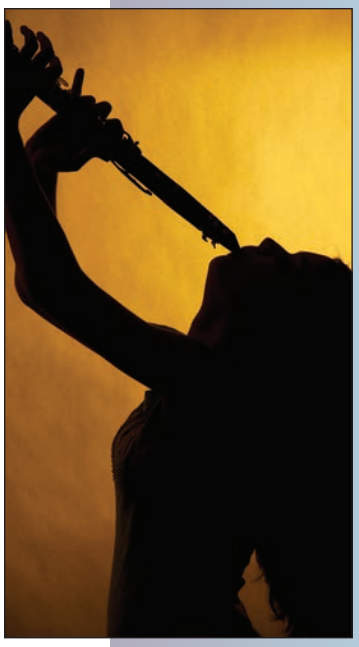
Audrey Rome, Roosevelt Teachers Association



Cadenza: Music-Making Fosters Solo Development

Performing music ensembles are more than just a school subject or a class period. Music classes provide involved students with a necessary prerequisite to their future livelihoods — their very first jobs. When students are part of band, chorus, orchestra, guitar ensemble or another performing group, they are fulfilling a role as a member of a functioning community where they are not only accepted, but also needed. Music performance ensembles provide students with a sense of responsibility that makes them feel important.

"Cynthia* doesn't even bring a pen or notebook to school, but she has that clarinet with her wherever she goes," one of my core-content colleagues once told me about one of our students. I explained that I knew Cynthia worked best when she was given a unique challenge, which was evident in the amount of pride she demonstrated in working toward performing at the New York State School Music Association (NYSSMA) Solo Festival on clarinet. Together, my colleague and I worked with this student to devise a strategy that would help her stay organized and on task. We assigned her a leadership role for that class and duplicated the practice log she was using for her NYSSMA solo as a homework log. Within a week or so, Cynthia was back on track in all of her classes and more motivated than ever.

Young musicians know that if they are absent from band, it doesn't just mean they have to make up the classwork and homework. An absence from band means other members of their section or ensemble might miss a cue because they rely on hearing another student's entrance at a particular measure, or another player has difficulty staying in line during a parade because of the hole in the block formation from one member's absence.

In addition to teaching work ethic, providing students with the job title of "ensemble member" helps foster social emotional development necessary for success in a career. In a typical school environment filled with cliques, bullying, stress, pressure, and high

Student's name has been changed for privacy purposes.

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expectations from all angles, fulfilling this role as an ensemble community member is crucial to students' self-esteem. If you didn't feel needed by your faculty or family, wouldn't you feel a sense of displacement? One of my alto saxophone players expressed her newfound confidence and sense of belonging in a recent letter to me: "The solos you have given me and how hard you've pushed me has made me such a better musician." The student continues later in the letter, "I am so proud to be a part of this band."

Furthermore, this particular student spent several consecutive days absent from school because of emotional distress from the drama that exists within her circle of friends. Perhaps it was a coincidence, but I would like to accredit the parallel between her solo assignment for our upcoming concert and her newly acquired pride and smile. "You can't be absent because I'll mess up *my* part!" another member of her section said one day during class, reiterating her significant role.

This confidence from rehearsing and performing in a music ensemble is necessary for our students to apply and interview for their first paying jobs and eventually their careers in any field. According to a study cited by the National Association for Music Education (NAfME) Advocacy Group, C.L. Jenlink conducted an experiment to find out if at-risk students had a raised level of self-esteem after their school put a heavier emphasis on its music program. The group reported Jenlink's findings (2014):

> The author concluded that the music program lessened students' feelings of alienation, promoted individual growth, and provided a common bond between the home and the school. Further, participation in the select musical performing group promoted goal attainment, teamwork, leadership, academic achievement, feelings of success, and cultural exposure.

For our 21st century students, these qualities are particularly important to prevent students from feeling lost and burdened by a variety of stressors, including school, home life, friendships, relationships, and cyber-bullying, to name a few. When students are used to interacting with other members of an ensemble, they learn how to treat one another and coexist in a professional way. For example, students in band and orchestra learn manners that become second nature, such as setting up for their stand partner or someone else in their section who may be running late. Students in an ensemble look out for one another and make selfless

decisions in the best interest of the entire group. This innate habit of helping one another is an extremely valuable asset for our 21st century learners in a world with an increasing number of self-checkout registers and single-player computer games.

Tutti: Music-Making Develops Interpersonal Skills and Teamwork Etiquette

Engaging in teamwork is a side effect of the individual growth that comes from being in a music ensemble. The ability to work well with others is a requirement for success whether students are in the classroom, participating in athletics, or becoming acquainted with fellow workers at a new job or volunteer position. Although students in music ensembles are often using and responding to non-verbal communication, they are still interacting with one another harmoniously. This is one of the most pressing reasons for students to stay involved in ensembles now more than ever. In our modern society where people of all ages are buried in cellphones and social media, music performance ensembles force students to interact and don't allow time for students to check their text messages or Facebook pages.

Whether I am buying sheet music or writing my own arrangements, I

strategically choose repertoire that keep each of my students actively engaged at all times. For me, this means giving my students music with copious percussion parts, since that tends to be my largest section. If students have more than eight consecutive measures of rest, I've openly invited them to check their cellphones and regress into an isolated state far away from my band. My percussionists know that missing even the smallest triangle entrance would mean messing it up for their entire team (and in my classroom, those teammates will let each other know what they think about that).

In addition, young musicians become accustomed to taking instruction and constructive criticism from section

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Music education exemplifies most of the skills the education establishment is trying to teach children in math and English language arts.

leaders, drum majors, and conductors — this is a necessary prerequisite to working for a boss or manager. Students in performing ensembles regularly react to directives, making them less likely to be fazed by feedback or various perspectives from authority in any environment. *The Washington Post* considered this one of the "Top 10 Skills Children Learn from the Arts" in a recent article: "Children learn that feedback is part of learning and it is not something to be offended by or to be taken personally. It is something helpful..." (Strauss 2013). This statement is evident in each class period since rehearsals are built around the evolution of music-making through constructive criticism.

Students in my band and any performing ensemble know that the phrase, "Let's fix those wrong notes at measure 32," is not an insult, but a mandatory classwork assignment without a tangible submission. Students also know not to get offended if another band member tells them that they are playing flat or marching out of line since music-performing ensembles comprise symbiotic relationships. Not only do students accept each other's critique, they thrive on this to shape them as musicians.

Accompagnato: Music-Making Reinforces Cross-Curricular Learning

While music performance ensembles prepare our students socially and emotionally for their successful journeys ahead, can they compare to the content taught in other areas? At the risk of speaking *con bravura*, I propose a resounding, "YES!"

Music performing ensembles are the perfect supplement and accompaniment to every content area. Students who sing or play an instrument develop practice habits that advance their individual learning styles. Through differentiated instruction in our classrooms and monitoring students' home progress with tools such as practice logs, music teachers can help students obtain habits to increase their productivity in all classes.

NYSSMA President David A. Gaines agreed in his latest contribution to *School Music News*: "Music education exemplifies most of the skills the education establishment is trying to teach children in math and Emglish language arts. Earlier this year, I worked with my staff to review the ELA Anchor Standards. It was interesting to see how many standards we address as an outgrowth of simply teaching music to children" (Gaines 2014).

When students sight-read sheet music, they are reading left to right and top to bottom while comprehending and communicating in the same manner that they would in ELA. "Practice in reading music notation makes the reading of linguistic notation an easier task," Ron Butzlaff (2000) explained in *Journal of Aesthetic Education*. Butzlaff continues, "Skill in reading requires a sensitivity to phonological distinctions, and skill in music listening requires a sensitivity to tonal distinctions. Perhaps experience in listening to music trains a general kind of auditory sensitivity that is useful in listening to music as it is in perceiving phonological distinction" (2000, p. 167).

Math skills are also sharpened in ensembles since students are gaining experience with rhythms, counting, mixed meter and *hemiola*. Using rhythm to teach math is a tradition that stems from ancient times. "Western culture has recognized the connection between music and mathematics since the time of the ancient Greeks. The Pythagoreans (of the famous theorem regarding the square of the hypotenuse of a right triangle) used harmony and rhythm as a basis for their mathematical ideas," explains the Southwest Educational Development Laboratory in its "Teaching Math with Music" issue of *Classroom Compass* (1998, p. 1).

Performing a variety of repertoire in an ensemble also helps students understand time periods that they are learning about in other subject areas. When core subject teachers and music teachers collaborate, the result is era-specific sheet music that can further expose students to these significant historical events. Music class can serve to reinforce students' studies of Harlem Renaissance poetry in ELA or the Civil War in social studies. National Public Radio (NPR) recently interviewed one music teacher who expressed his gratitude to "connect music with what students are learning in their other classes — like a classic spiritual they're practicing for Black History Month" (McCammon 2014). Band, orchestra, or chorus is often considered a "break" in the day for students; however, these ensembles are yet another opportunity to keep our students immersed in the content we are teaching.

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Singing or performing music might be just the type of differentiated instruction that students need to retain information when they are struggling to process context visually or aurally.

Music can also help students remember facts and information by offering rhythmic repetition and catchy melodies that may have otherwise been forgotten from a one-dimensional textbook or handout. "The Alphabet Song" proves that memorization through music is one of the earliest teaching strategies used in the American education system. "Psychologists believe laws, stories, and customs were presented as poems, chants and eventually, as songs, in order for them to be memorized and recalled, accurately," explains Henry L. Roediger III, professor of psychology at the Memory Lab at Washington University in St. Louis (Mitchell 2013). "People with exceptional abilities to recount lists and other data often create song-like structures to help with memorization and recall." Singing or performing music might be just the type of differentiated instruction that students need to retain information when they are struggling to process context visually or aurally.

Making music accelerates growth for our students in *every* subject area. While learning about diaphragmatic breathing and tuning their instruments, students are learning about their bodies and about the *science* of sound. Students involved in marching band are participating in *physical education* on a regular basis and are required to be as fit as any other athlete. Music students are fluent in terms and notation markings written in Italian, German, French, and of course, the *language* of music itself. The use of music notation software or the integration of technology such as a midi can help students become computer-savvy, which is a skill employers value now more than ever before.

Students who participate in music are even proven to be in better health than students who do not: "Music increases an antibody that plays an important role in immunity of the mucous system, as well as natural killer cell counts, the cells that attack germs and bacteria invading the body," Sarah Glynn informed *Medical News Today* in the findings of 400 research papers in the neurochemistry of music (2013). Furthermore, "Listening to and playing music can also lower levels of cortisol (the stress hormone), according to [Dr. Daniel] Levitin and Dr. Mona Lisa Chanda."

Participating in music provides students with self-assurance that is carried over into their academic success. "It's conceivable that kids who feel socially connected (say, as members of a school band) develop the confidence and self-esteem that can lead to intellectual curiosity, and better grades," states veteran journalist Tom Jacobs after assessing results from his recent research linking high grades with involvement in music lessons (2013).

Giocoso: Music-Making is Uplifting!

"Music offers a valued companion [and] helps provide a comfortable level of activation and a positive mood," researchers from *Frontiers in Psychology* summarized from the results of their recent study (2013). The researchers correctly hypothesized that "arousal and mood regulation" is one of the major benefits people experience from participation in music.

Of course, we can prove this statement true within our own classrooms. Several months ago, one of my students stumbled into my classroom, looking completely distraught. I asked him what was wrong. "I had a really rough night and only came to school today because I'm excited for our band performance tonight, Ms. Rome," he replied. After thanking him and telling him he could talk to me after class if he wanted, I took a minute to reflect on and truly feel the impact of that heartfelt statement. Some of our students experience stress beyond our knowledge on a daily basis, and music ensemble teachers provide each student with the opportunity to feel successful, safe, and welcomed. More importantly, we provide our students with an outlet of expression that they may not have had otherwise.

After a 40-minute rehearsal, this same student was joking around with his friends and laughing while packing up his instrument. I am privileged to observe those types of transformations on a daily basis; however, music class is not a privilege for our students — it is a requirement for their well-being.

Cesura: Stop! Music-Making is Necessary!

Before pulling a student out of music performing ensemble for extra help or a double period of another subject, take a moment to ask this young musician how being part of a performing ensemble serves as an incentive to excel in other areas. Empathize with your music students by reflecting on the way you may value music in your

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Singing or playing an instrument can help our students succeed by teaching them the necessary skills to develop responsibility, work well with others, retain and understand information in every content area and shine as a confident and capable contributor to our society.

life, whether listening or performing. Collaborate as a teaching team to choose repertoire and strategies that will help strengthen this student's skills in each of your subject areas. Your music teachers are here to work with all stakeholders to serve our children the very best we can.

Tom Horne, Arizona's state superintendent of public instruction, places music high on his priority list for K-12 students. "If they're worried about their test scores and want a way to get them higher, they need to give kids more arts, not less," says Horne, a classically trained pianist. "There's lots of evidence that kids immersed in the arts do better on their academic tests" (Smith 2009). Singing or playing an instrument can help our students succeed by teaching them the necessary skills to develop responsibility, work well with others, retain and understand information in every content area and shine as a confident and capable contributor to our society. To fully experience the benefits of music performance ensembles, join one yourself — after all, educators are 21st century learners, too.

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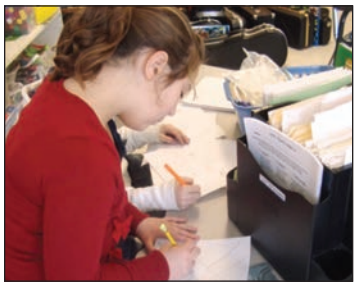

What is L.I.T.T.O.? Developing Master Learners in the 21st Century Classroom

SUMMARY

L.I.T.T.O. stands for learning, independence, teamwork, time-management and ownership. This author-designed innovation teaches fifth graders to take charge of their own learning while the teacher integrates 21st century cognitive and affective skills across the curriculum.

Effective, active engagement in the learning process is the key to academic success in our highly complex and interconnected global society. The successful student in the 21st century must move beyond the traditional system of rote memorization, right or wrong answers, single perspectives, and teacher-centered instruction. Twenty-first century students must become inquisitive self-directed learners who actively question and passionately search for ways to integrate the knowledge and information shared by others into their own thoughts and objectives.

The 21st century student is expected to demonstrate learning and innovation skills; information, media and technology skills; as well as life and career skills. These include: critical thinking, creative thinking, collaborating, communicating, information literacy, media literacy, technology literacy, flexibility, initiative, productivity, and leadership (Partnership for 21st Century Skills — A Resource and Policy Guide, 2008).

The challenge for educators at the elementary level is how to implement practices that will help children develop these skills in meaningful ways while at the same time meeting the expectations of the Common Core standards. L.I.T.T.O. is one answer. In L.I.T.T.O. a student is never just learning one thing at any one time. As with the old LOTTO game of my youth, each task, each interaction, and each reflection is a part of the larger picture of every child's holistic development as a master learner in the 21st century.

The activities on a given L.I.T.T.O. matrix contribute to a student's academic growth and learning in different and engaging ways based on the Common Core standards. The way in which they approach these tasks combines practicing of academic skills with

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Jean Hoins, Ballston Spa Education Association

developing interpersonal capabilities and metacognitive knowledge. This is accomplished through the use of weekly reflections on learning (Appendix 6), meetings and conferences, and rubrics based on the Ballston Spa School District Gradation Competencies (Dragone, Turner, & Smith, 2009) that assess academic and interpersonal behaviors.

Background

Research clearly shows that learners of all ages benefit from the integration of academic tasks and activities that require metacognition, or the reflection on one's learning behaviors and processes. "In this rapidly changing world, the challenge of teaching is to help students develop skills which will not become obsolete. Metacognitive strategies are essential for the 21st century. They will enable students to successfully cope with new situations" (Blakey & Spence, 1990).

That is where L.I.T.T.O. comes in. The ideas upon which L.I.T.T.O. was developed are not new, they combine ideas from Susan Winebrenner's "Teaching Gifted Kids in the Regular Classroom," published initially in 1992 (Winebrenner, Teaching Gifted Kids In Today's Regular Classroom, 1997). This work was extended to include considerations for the learning styles and challenges faced by children who have grown up in a culture of poverty, based on the works of Ruby Payne (Payne, 1996), who provides specific strategies for managing the development of cognitive strategies and learning process. "The support these students need are cognitive strategies, appropriate relationships, coping strategies, goal-setting opportunities, and appropriate instruction in both content and discipline" (Payne, 1996, p. 107). Payne's work led to the realization that the approaches that were intended to target gifted students were, in fact, even more appropriate for students from impoverished backgrounds and, indeed, equally beneficial for all regular education students.

Carol Ann Tomlinson's "Leading and Managing a Differentiated Classroom" (Tomlinson C. A., 2010) and professional training in 2001 on the responsive classroom-supported strategies for

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L.I.T.T.O.

L ...stands for learning and encompasses ALL learning – academic, interpersonal, and metacognitive.

I ... represents the independence that is learned through practice, reflection, organization and increased feelings of competence.

T ...represents teamwork to emphasize the necessity for collaboration and development of interpersonal skills.

T ...is for time-management strategies which are integral academic and life skills underlying the 21st century framework.

O ...represents the responsibility for the ownership of one's learning in all aspects of growth and development.

Figure 1

L.I.T.T.O. Rubric

Use this rubric to reflect on your work.
Celebrate your successes and target areas
for improvement in the coming week.

Competency	4	3	2	1 – Meet with Teacher
Time Management • **Self-directed Learner** • **Academically Skilled** • **Productive Worker**	**ALL** of the requirements of each task have been thoroughly met with **exceptional** care, accuracy and attention to detail.	**ALL** of the requirements of each task have been met.	**SOME**: You are missing one or more of the requirements, OR the requirements of one or more individual tasks have not been thoroughly met.	**Fewer than half** of the requirements have been met, OR the requirements of three or more individual tasks have not been thoroughly met.
Effort • **Academically Skilled** • **Productive Worker**	**ALL** individual projects demonstrate **exceptional** effort and care. Work is **exceptionally** neat and detailed.	**MOST** individual projects **consistently** demonstrate effort and care. Work is **consistently** neat and detailed.	**SOME** individual projects demonstrate effort and care. Work is **inconsistently** neat and detailed.	Please work hard on demonstrating effort and care. Work is **very difficult to read**
Information • **Information Manager** • **Effective Communicator**	Information is **exceptionally** clear & correct.	Information is **consistently** clear & correct.	Information is **inconsistently** clear & correct.	Please work on making sure that your Information is clear and correct.
	Work demonstrates the communication of **exceptional** reflective thought and purposeful engagement with the text.	Work **consistently** demonstrates the communication of reflective thought and purposeful engagement with the text.	Work **inconsistently** demonstrates the communication of reflective thought and purposeful engagement with the text..	**Work on** demonstrating the communication reflective thought and purposeful engagement with the text.
Independence • **Self-directed Learner** • **Academically Skilled** • **Productive Worker**	You are "on task" and focused on doing your best. You make good decisions about your learning.	You are **consistently** "on task" and focused on doing your best. You make good decisions about your learning.	You are **inconsistently** "on task" but you need to really focus on doing your best without distraction. Work on making good decisions about your learning.	You need to focus on doing your best without distraction. Work on making good decisions about your learning.
	Work demonstrates **exceptional** self-direction and/or productive collaboration.	Work **consistently** demonstrates self-direction and/or productive collaboration.	Work **inconsistently** demonstrates self-direction and/or productive collaboration.	**Frequent redirection** is required - self-direction and/or productive collaboration are not demonstrated.
Language Usage • **Effective Communicator**	You **always** do your best to use correct spelling and punctuation in context. Your writing is **always** thoughtful and reflective.	You **consistently** do your best to use correct spelling and punctuation in context. Your writing is **consistently** thoughtful and reflective.	You **inconsistently** use correct spelling and punctuation in context. Your writing is **inconsistently** thoughtful and reflective.	You **need to work** on correct spelling and punctuation in context. You need to work on making your writing more thoughtful and reflective.

designing a differentiated classroom, including the assessment of individual student's learning and development (Northeast Foundation for Children, Inc, 2014). Additionally, Regie Routman's book "Conversations," (Routman, 2000) defined the role of the teacher as a learner and mentor and provided myriad activities for classroom practice based on modeling the behaviors of master learners in responsive and reflective ways. These works particularly inspired me to practice a child-centered approach to learning by providing models that could be responsive to individual students while at the same time being academically challenging.

Winebrenner first introduced me to the idea of choice menus, or what she called "Extensions Menus." These menus were offered to gifted students who had completed assigned work in a given content area. She also described the use of "Product Choices Charts," which allowed students to demonstrate mastery of content in a variety of formats (Winebrenner, Teaching Gifted Kids in the Regular Classroom, 2001, pp. 79-144). Her work demonstrated the effectiveness of choice in the development of active engagement and ownership.

Tomlinson expressed the belief that "A teacher who honors the individual seeks to understand each student's particular progression of needs and to address those needs in a way that leads to both personal and academic growth" (Tomlinson C. A., 2010, p. 39). This belief is consistent with the premises supporting current trends in individualized instructional practices and many of the underlying beliefs that are at the foundation of the Framework for 21st Century Learning. In a 2011 presentation, Tomlinson commented on the relationship between differentiation, metacognition, and 21st century learning. "To solve the 21st century's challenges we will need an education system that doesn't focus on memorization, but rather on promoting those metacognitive skills we need if we perceive that our learning is not going well" (Tomlinson & Parish, Differentiating Instruction and 21st Century Skills: Preparing all Learners for the World Ahead, 2011, p. 6).

L.I.T.T.O. provides opportunities for students to think about their learning on a daily basis not only in school, but also in their work outside of school through the connection between the classroom work and the Reader Response Notebook entries completed in preparation for the next day's discussion and classroom tasks. Finally, the Responsive Classroom training that

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Process goals, in addition to content goals, must be established and evaluated with students so they discover that understanding and transferring thinking processes improves learning.

preceded the development of L.I.T.T.O. introduced several guiding principles for the development of a classroom community that would support student learning. Among these were the principles that:

- The social curriculum is as important as the academic curriculum.
- How children learn is as important as what they learn.
- The greatest cognitive growth occurs through social interaction.
- To be successful academically and socially, children need a set of social skills: cooperation, assertion, responsibility, empathy, and self-control (Northeast Foundation for Children Inc., 2014, p. 1).

Together these various philosophies and practices combined and modified over time have supported the transition to a child-centered classroom community that supports the intentions of the 21st Century Framework and the development of master learners at the elementary school level. Continued research supports the emphasis on self-direction through reflection (metacognition), collaboration (interpersonal skills), and differentiation to encourage students of abilities and backgrounds to actively engage in learning.

Over the years L.I.T.T.O. has adapted to the New York State Standards, the Common Core Standards, and now, the Framework for 21st Century Learning. Change is constant in the world of education and our global reality. The integration of these experiences resulted in the evolution of L.I.T.T.O. and a practice with an emphasis on the development of the student's awareness of academic, interpersonal, and metacognitive behaviors that can enable them to effectively adapt to and embrace change with agility and confidence.

The potential for this model is virtually unlimited and adaptable to changes in content and standards. "Problem-solving and research activities in all subjects provide opportunities for developing metacognitive strategies. Teachers need to focus student attention on how tasks are accomplished. Process goals, in addition to content goals, must be established and evaluated with students so they discover that understanding and transferring thinking processes improves learning" (Blakey & Spence, Developing Metacognition, 1990, p. 4).

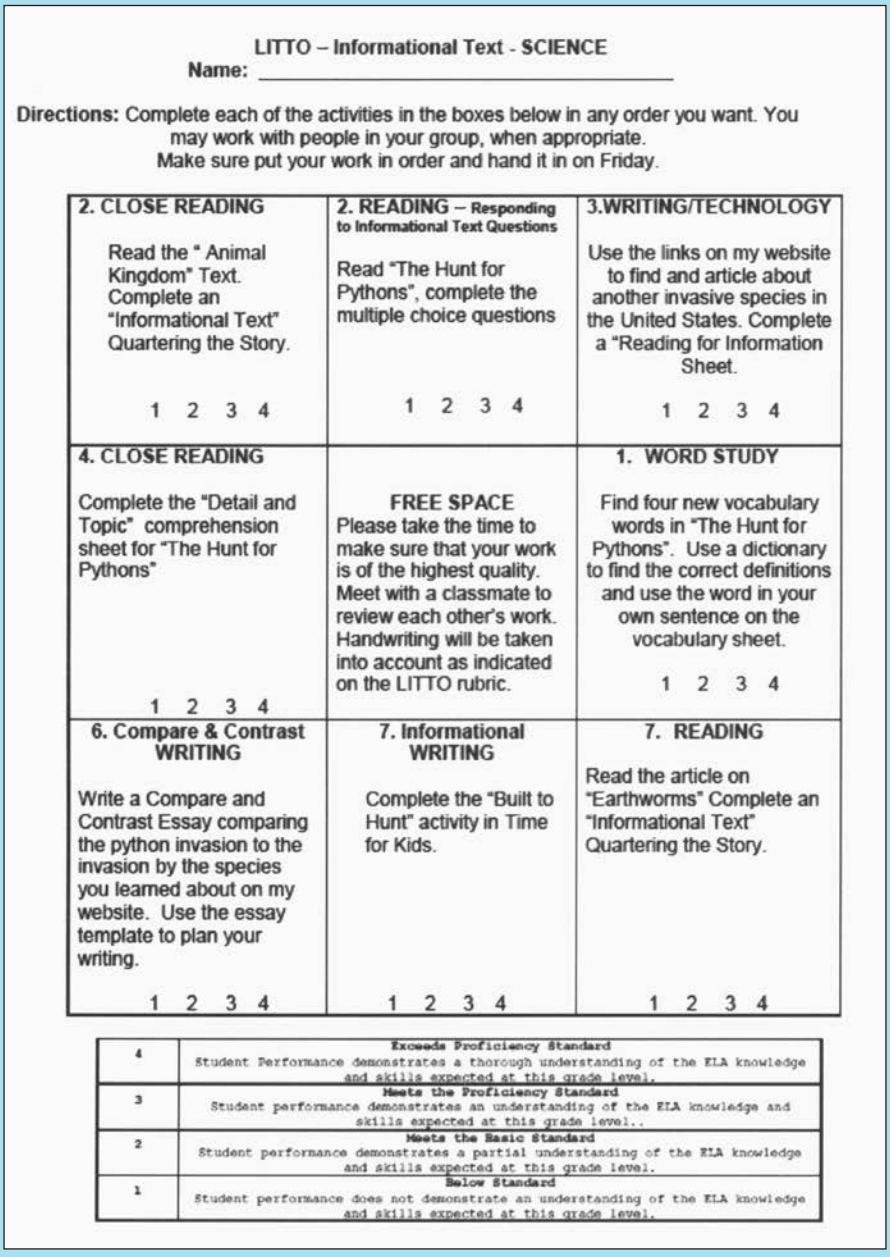
Figure 2 provides an example of a science L.I.T.T.O. intended to provide experience with informational text in support of a science ecology unit. L.I.T.T.O. matrices (see appendices) have been developed to meet instructional objectives in different content areas to meet the rigorous Common Core Literacy Standards and to provide access to content knowledge and expression in a variety of formats.

Each L.I.T.T.O. integrates a variety of components and tasks across the content area in order to build a sense of the interconnectedness of academic and content area disciplines. The L.I.T.T.O. program includes the regular use of:

- writer's notebooks and writer's workshop tasks
- interactive read-aloud
- reading response journals – tic-tac-toe and quartering the story
- daily sharing and conferencing
- content area journals, tasks and research projects
- technology
- teacher-selected and student-selected texts — narrative and expository
- multi-dimensional rubric assessments
- reflection on learning

By its very nature, L.I.T.T.O. is responsive to the ever-changing needs of all students in the 21st century. It is also intended to develop a learning partnership between the teacher who also practices the behaviors of a master learner, and the students in order to form a supportive and challenging community of learners focused on practice, reflection and growth. The L.I.T.T.O. experiences help young students develop an awareness of the habits of master learners and the opportunity to integrate those habits into their own practices. This is accomplished through daily classroom meetings, small-group and individual

Figure 2



LITTO – Informational Text - SCIENCE

Name: _____

Directions: Complete each of the activities in the boxes below in any order you want. You may work with people in your group, when appropriate. Make sure put your work in order and hand it in on Friday.

2. CLOSE READING Read the " Animal Kingdom" Text. Complete an "Informational Text" Quartering the Story. 1 2 3 4	**2. READING – Responding to Informational Text Questions** Read "The Hunt for Pythons", complete the multiple choice questions 1 2 3 4	**3.WRITING/TECHNOLOGY** Use the links on my website to find and article about another invasive species in the United States. Complete a "Reading for Information Sheet. 1 2 3 4
4. CLOSE READING Complete the "Detail and Topic" comprehension sheet for "The Hunt for Pythons" 1 2 3 4	**FREE SPACE** Please take the time to make sure that your work is of the highest quality. Meet with a classmate to review each other's work. Handwriting will be taken into account as indicated on the LITTO rubric.	**1. WORD STUDY** Find four new vocabulary words in "The Hunt for Pythons". Use a dictionary to find the correct definitions and use the word in your own sentence on the vocabulary sheet. 1 2 3 4
6. Compare & Contrast WRITING Write a Compare and Contrast Essay comparing the python invasion to the invasion by the species you learned about on my website. Use the essay template to plan your writing. 1 2 3 4	**7. Informational WRITING** Complete the "Built to Hunt" activity in Time for Kids. 1 2 3 4	**7. READING** Read the article on "Earthworms" Complete an "Informational Text" Quartering the Story. 1 2 3 4

4	**Exceeds Proficiency Standard** Student Performance demonstrates a thorough understanding of the ELA knowledge and skills expected at this grade level.
3	**Meets the Proficiency Standard** Student performance demonstrates an understanding of the ELA knowledge and skills expected at this grade level..
2	**Meets the Basic Standard** Student performance demonstrates a partial understanding of the ELA knowledge and skills expected at this grade level.
1	**Below Standard** Student performance does not demonstrate an understanding of the ELA knowledge and skills expected at this grade level.

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Effective, active engagement in the learning process is the key to academic success in our highly complex and interconnected global society.

conferences, reading and writing response notebooks, and teacher-student collaboration on tasks. The teacher communicates the idea that there is always more to learn, many ways to learn, and many ways to express what has been learned.

Thinking About Choices

Numerous studies have shown that opportunities to express preferences and make choices lead to greater motivation, academic gains, increases in productivity and on-task behavior, and decreases in aggressive behavior. Similarly, researchers report that student participation in goal setting leads to more positive outcomes (e.g., higher commitment to a goal and increased performance) (UCLA Center for Mental Health in Schools, 2008, pp. 15 - 16).

This approach to learning helps students actively practice making choices about the management of their learning in order to be effective, productive master learners. L.I.T.T.O. asks students to constantly think not only about the work they are doing, but about HOW they are doing it. (See rubric Figure 1.) Effective, active engagement in the learning process is the key to academic success in our highly complex and interconnected global society.

Successful students in the 21st century must become inquisitive self-directed learners who actively question and passionately search for ways to integrate the knowledge and information shared by others into their own thoughts and objectives. Among other things, a master learner is a student who is:

1. ***Inquisitive.*** Master students are curious about everything, and ask questions that generate clarification, which can lead to a better understanding of the material.

2. ***Able to focus attention.*** Master students become absorbed in the process or activity and keep their attention absolutely focused in the here and now.

3. ***Able to organize and sort.*** Master students can take a large body of information and sift through it to discover relationships. They can play with information; organize pieces of data by size, color, order, weight, and other categories.

4. ***Competent.*** Master students are masters of skills. When they learn formulas, they learn them so well, they become second nature.

5. ***Self-questioning.*** Master students are willing to evaluate themselves and their behavior. They regularly examine their lives (Ellis, 1985, pp. 29-33).

L.I.T.T.O. encourages a classroom culture of active engagement in the process of becoming a master learner by asking students to constantly think about how they are approaching their academic work. L.I.T.T.O. emphasizes an ongoing focus on each student's academic and behavioral choices (Figure 3) and the results of those choices as evidenced in their work. Students have the opportunity to observe their classmates and teachers to see the ways in which other learners approach tasks. This provides models for behavior and options for future conduct. It is all part of an ongoing process of reflection and growth that involves both an individual and collective awareness of decisions.

A student's ongoing experience with academic choice leads to the development of self-direction, interpersonal skills and metacognitive strategies. In the L.I.T.T.O. environment, a student becomes a more proficient learner through the regular practice of choice and active reflection on the consequences of each choice. (Figure 3) Responsible choice generates ownership of the learning processes and outcomes. For example, on reflection a student wrote: "The most challenging task was the quartering the story because it took me a while to do the task. I also talked to my friends a lot while working which slowed me down. I will overcome that challenge by working by myself or sitting with my friends but not talking so much." The reflective piece encourages each student to evaluate the effectiveness of their choices as evidenced by the quality and completeness of their work.

Elaine Blakey and Sheila Spence of the Educational Resource Information Center (U.S. Department of Education, 2008) identified several strategies for developing metacognitive behaviors in students. Among these they included planning and self-regulation, which require an awareness of and responsibility for the consequences of one's actions and behaviors.

Figure 3

As a Master Learner I will choose:

- which tasks I will work on
- when I work on them
- where I will work on them
- who I will work with
- how I will know that my work is "good"
- who to ask for help
- where to keep my materials
- which resources I will use
- which tools I will use
- when I will ask for en editor to review my work
- when my work is ready to hand in
- how I can continue to reflect on my work and set goals for the next week

Students must assume increasing responsibility for planning and regulating their learning. It is difficult for learners to become self-directed when learning is planned and monitored by someone else. Students can be taught to make plans for learning activities, including estimating time requirements, organizing materials, and scheduling procedures necessary to complete an activity (Blakey & Spence, Developing Metacognition, 1990, p. 2).

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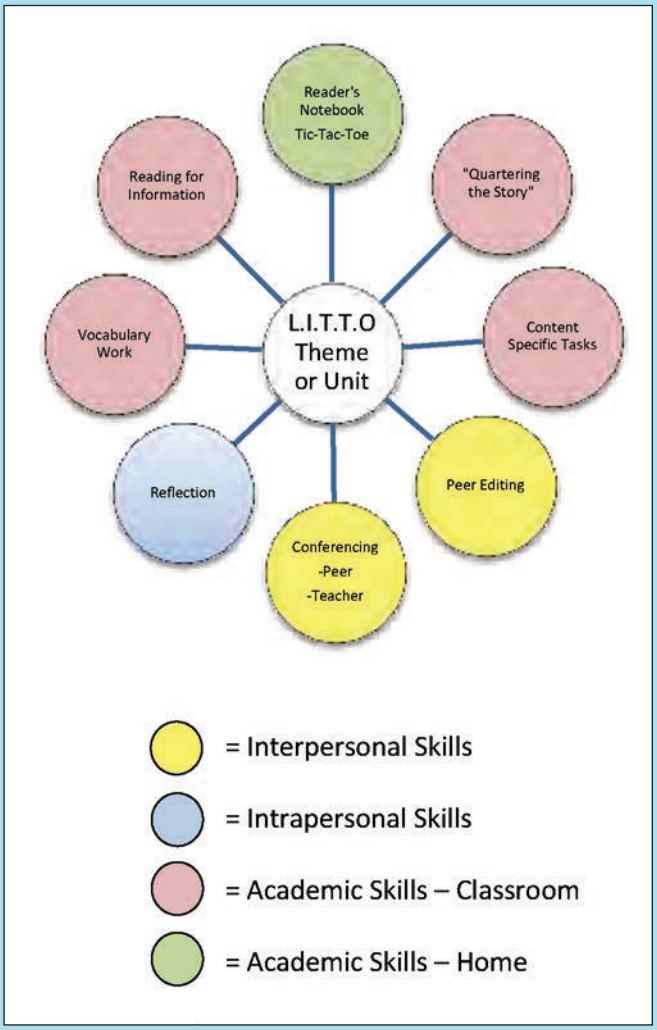
Figure 4



L.I.T.T.O. requires each student to engage in responsible decision-making processes on a daily basis. These decisions extend beyond the classroom to the responsible completion of reading and responding to tic-tac-toe questions in a reader's notebook. The daily sharing of responses and discussion of reading help to foster a community sense of expectation and support. Students learn from each other and about each other as they share their responses to text. They practice thinking about other students' work and develop the capacity to integrate methods and approaches into their own.

The integration of tasks, frequent conferencing and sharing, peer editing, the responsibility for honest dialogue about work and effort, coupled with opportunities for revision and modification, cause each student to identify personal strengths and areas for improvement in meaningful and productive ways. They recognize that every other student is doing the same and that they can support each other in their efforts.

How Does L.I.T.T.O. Work in the Classroom?

Matrices are developed based on Common Core standards that are associated with targeted areas or units of instruction. While the tasks may change from week to week, the expectations of responsibility and effort as described in the rubric (Appendix 1) remain constant, as does the expectation of thoughtful reflection. The L.I.T.T.O. may include explorations of literary genre, literary elements, and author studies, units based on the navigation of informational text or topics in math, science and social studies. The L.I.T.T.O. matrix (Figure 4) is accompanied by materials, directions, tasks, or projects that are associated with specific sections of the matrix. If necessary, mini lessons may be associated with some of the items in the matrix.

Whole group direct instruction is at a minimum except when introducing a new L.I.T.T.O., when there is an expressed need for clarification, or when specific skills are introduced.

Instead of whole group instruction, question and answer sessions, sharing, meetings and conferencing with individual students or small groups are integral parts of L.I.T.T.O.

Figure 5 shows an example of a narrative text L.I.T.T.O. that explores the literary concepts of identity and conflict. For this unit, students may select any work of narrative fiction with the help of the school library media specialist. The study includes a variety of books at various levels of difficulty and an ongoing read-aloud text that explores character identity development through conflict. The unit requires nightly reading and responses to tic-tac-toe prompts in a response journal. These journal responses are shared in the morning
in a whole group setting or within the literature circle group studying a particular text.

All of the student work materials are housed in a Desk Apprentice which is a revolving counter-top open filing system. The materials are sorted in folders with numbers that match each section of the L.I.T.T.O. matrix. The L.I.T.T.O. tasks may also be kept in a file cabinet or a series of bins as long as they are easily accessed by the students. Other materials and resources such as accompanying texts or descriptions of tasks are arranged on the table or another readily accessible setting so that student may access materials independently. All necessary supplies (texts, scissors, glue sticks, card-stock, colored pencils, calculators, lap-tops, etc.) are situated nearby.

Figure 5

LITTO – Literary Elements – Conflict & Identity – Historical Fiction

Name: _____

TITLE: _____

Directions: Complete each of the activities in the boxes below in any order you want. You may work with your classmates, when appropriate.
Make sure put your work in order and hand it in on Friday.

1. LITERARY ELEMENTS Read your assigned book and complete a "Narrative Quartering the Story" **RL.5.1, RL.5.2, W.5.1, W.5.2, W.5.9a,** 1 2 3 4	**2. READING - WRITING Homework** Complete four tasks on your "Conflict Tic-Tac-Toe". Write your responses in your Reader's Notebook **W.5.1, W.5.2 RL.5.1, RL.5.2, RL.5.10,** 1 2 3 4	**3. LITERARY ELEMENTS** Read your assigned book and complete a "Conflict" Quartering the Story" **RL.5.1, RL.5.2, W.5.1, W.5.2, W.5.9a,** 1 2 3 4
4. WRITING Write a review of the book you are reading. Use the template in the folder. **W.5.9a, RL.5.3** 1 2 3 4	Complete the L.I.T.T.O. Reflection **W.5.1**	**5. WORD STUDY** Find four new vocabulary words in your book. Use a dictionary to find the correct definitions and use the word in your own sentence on the vocabulary sheet. **RL.5.4** 1 2 3 4
6. CHARACTER TRAITS Create and "Inside-Out" chart for one of the characters in your book. Follow the directions provided. **W.5.9a,RL.5.2** 1 2 3 4	**7. WRITING** Complete the Venn Diagram comparing the main character in this story to the main character in one of your previous texts. **W.5.9a, RL.5.3** 1 2 3 4	**8. SEQUENCING** Create a timeline of the important events in the story. Include at least 6 events. **W.5.9a,RL.5.5** 1 2 3 4

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Figure 6

TIC-TAC-TOE READING RESPONSES Conflict & Identity

- **You must restate the question for your topic sentence and make use of transition phrases for each response.**
- **You must use evidence from the text to support each of your responses.**

1. Give an example of an event or dialogue that shows conflict between the character and their environment.	2. Copy down an example of descriptive language that helps you understand how the character is feeling.	3. Give an example of an event or dialogue that shows conflict between the character and somebody else.
4. What is your opinion of the main character? Why? Use evidence from the text.	5. If you could give the main character some advice that might help them solve a problem what would it be?	6. Give an example of an event or dialogue that shows conflict within the character.
7. Describe a problem that the main character has to solve. Be sure to include why it is important for the character to solve that problem.	8. Describe an event that changes the main character. How is the character changed?	9. Make a prediction about what you think will happen next in your story. Explain why and use evidence from the text.

4	**Exceeds Proficiency Standard** Student Performance demonstrates a thorough understanding of the ELA knowledge and skills expected at this grade level.
3	**Meets the Proficiency Standard** Student performance demonstrates an understanding of the ELA knowledge and skills expected at this grade level..
2	**Meets the Basic Standard** Student performance demonstrates a partial understanding of the ELA knowledge and skills expected at this grade level.
1	**Below Standard** Student performance does not demonstrate an understanding of the ELA knowledge and skills expected at this grade level.

At the beginning of the new L.I.T.T.O., the teacher reviews the matrix with the students and responds to any questions that the student may have about the content of the L.I.T.T.O. Most questions have to do with the specifics of where work can take place. "Can we work in the hallway?" "Would it be alright if we pushed these desks together?" There may also be questions about vocabulary, or task specific wording. Students might need help assembling a flap-book or folding paper for a triarama. They may need help finding a particular website or other computer application. After a few weeks, students are able to do these things for each other. Most often the questions that come up are related to time. "How much time will we have today?" or "Since we had Monday off will we get more time on Tuesday to work on this?" Following the introduction the students are free to determine how they will start the tasks and how they will proceed through the assignments. The teacher is free to meet with specific students at this time to select target tasks, or identify tasks that might be eliminated from the L.I.T.T.O. for specific students. This takes place during short one-to-one meetings where the students might choose which tasks are priorities and which ones will be extensions for them. This ability to modify the L.I.T.T.O. is particularly helpful for students who leave for the resource room, speech, music lessons, or AIS sessions. L.I.T.T.O is also available in the District Sakai Collaborative Learning Environment (similar to online course modules like Moodle or Blackboard) and on my website so that it may be readily accessed at home in case of absence.

Once the period has begun, the students are free to work where they choose, with whomever they choose, on any of the tasks that they have elected to begin their unit with. During this time the teacher is at liberty to circulate throughout the room to touch base with small groups or individual students once the work has commenced. The teacher may read with students, conference about writing, or help support students in their work as needed. If the expectation of effort and engagement and productivity is not being met, students may be asked to return to their own desks to ensure that the quality of the work is, in their judgment, their very best and that the classroom community is not being disrupted. Since work habits and collaboration are visibly assessed on a weekly basis, each student has a stake in demonstrating positive choices and effective learning behaviors. The expectations are clear in the weekly L.I.T.T.O. and Reader's Response rubrics (Figures 1 & 7). The rubric language guides expectations for behavior in discussions including collaboration and effort. The rubrics guide students in the process of setting goals in various behavioral and academic areas. Within each rubric cell the teacher may choose to highlight specific behaviors that require attention or may choose to comment on significant growth in one area or another. These rubrics go home with the students at the end of each L.I.T.T.O., which adds another dimension of accountability and also helps guide parents in their efforts to support student learning at home.

Figure 7

Name: _____ Date: _____

Reader's Response Rubric

Competency	4 - Exceeds	3- Meets	2- Partially Meets	1- See Teacher
Effort & Engagement -Academically Skilled -Productive Worker -Self-Directed Learner	**All** individual responses are complete and demonstrate exceptional effort and care.	**All** individual responses are complete and demonstrate effort and care.	**Some** individual responses are complete and demonstrate effort and care.	**Please work hard** to complete your tasks and demonstrate effort and care. -Work is **difficult to read or incomplete**
Information & Evidence -Information Manager -Effective Communicator -Self-Directed Learner	Entries are **exceptionally** clear & correct. -Tic-tac-toe questions have been thoroughly answered. -Responses integrate **multiple effective examples** of evidence from the text. Work **always** demonstrates **exceptional** reflective thought and connection to the text.	Entries are **consistently** clear & correct. -Tic-tac-toe questions have been thoroughly answered. -Responses integrate effective **examples** of evidence from the text. Work **consistently** demonstrates reflective thought and engagement with the text.	Entries are **inconsistently** clear & correct. -Tic-tac-toe questions have been **inconsistently** answered. -Responses inconsistently integrate effective **examples** of evidence from the text. Work **inconsistently** demonstrates reflective thought and engagement with the text.	Please work on making sure that your entries are clear and effective. -Tic-tac-toe questions must be answered – restate the question or task to begin your response. -Integrate effective **examples** of evidence from the text. Work **on demonstrating** reflective thought and engagement with the text.
Discussion & Sharing -Effective Communicator -Self-Directed Learner -Academically Skilled	-You are **consistently** prepared for discussions and sharing. -You participate actively in all sharing, discussion, and collaboration. -You respond to the ideas and work of others in a positive and thoughtful manner. -You express **detailed connections** between texts or text to self. -You demonstrate **exceptional** reflective practices and evidence of growth..	-You are **consistently** prepared for discussions and sharing. -You **consistently** participate in all sharing, discussion, and collaboration. -You respond to the ideas and work of others in a positive and thoughtful manner. -You may express connections between texts or text to self. -You **consistently** demonstrate reflective practices ad evidence of growth.	-You are **inconsistently** prepared for discussions and sharing. -You **infrequently** participate in sharing, discussion, and collaboration. -You **inconsistently** respond to the ideas and work of others in a positive and thoughtful manner. -You may **inconsistently** express connections between texts or text to self. -You **inconsistently** demonstrate reflective practices and evidence of growth.	You are unprepared for discussions and sharing and are often disengaged -You **infrequently** participate in sharing, discussion, and collaboration. -You **infrequently** respond to the ideas and work of others in a positive and thoughtful manner. -You may **infrequently** express connections between texts or text to self. -You **infrequently** demonstrate reflective practices or evidence of growth.
Independence & Self-Direction -Effective Communicator -Self-Directed Learner -Academically Skilled	Your entries and behaviors demonstrate **exceptional** self-direction in your ability to: -Restate the question -Make a claim – statement -Support your claim with effective evidence from the text with page number for each direct quote. -Utilize transitions -Express comprehension of the text and the tasks both in writing and discussion.	Your entries and behaviors demonstrate **consistent** self-direction in your ability to: -Restate the question -Make a claim – statement -Support your claim with effective evidence from the text with page number for each direct quote. -Utilize transitions -Express comprehension of the text and the tasks both in writing and discussion.	Your entries and behaviors demonstrate **inconsistent** self-direction in your ability to: -Restate the question -Make a claim – statement -Support your claim with effective evidence from the text with page number for each direct quote. -Utilize transitions -Express comprehension of the text and the tasks both in writing and discussion.	Your entries and behaviors **infrequently** demonstrate self-direction in your ability to: -Restate the question -Make a claim – statement -Support your claim with effective evidence from the text with page number for each direct quote. -Utilize transitions -Express comprehension of the text and the tasks both in writing and discussion.
Language Usage -Effective Communicator -Self-Directed Learner -Academically Skilled	-You use spelling, grammar, capitalization, and punctuation in a manner that assists considerably in communicating your ideas -You integrate new vocabulary in exceptionally effective and meaningful ways.	- You use spelling, grammar, capitalization, and punctuation in a manner that adequately aids in communicating your ideas. -You integrate new vocabulary in effective and meaningful ways.	-You use spelling, grammar, capitalization, and punctuation in a manner that may impede understanding of your ideas. -You may **occasionally** integrate new vocabulary in effective and meaningful ways.	You use spelling, grammar, capitalization, and punctuation in a manner that impedes understanding of your ideas. -work on integrating new vocabulary in effective and meaningful ways.

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Assessments, curriculum, instruction and student learning behaviors are vitally interdependent with the understanding that students may directly benefit from active reflection on their work and their interactions with others.

Modifications and Differentiation

Each one of the L.I.T.T.O. work matrices may be easily modified to account for different learning abilities. These modifications might include:

- Eliminating some of the tasks in conference with the student
- Ranking the tasks in order of difficulty or preference
- Changing the 1-4 rubric ratings to effort grades for special education students or English language learners
- Providing alternate texts at various levels
- Increased support from the classroom teacher of an academic interventionist (AIS provider, special education teacher)
- Allowing additional time
- Working in a small group with peer tutors
- Peer editing and revision assistance
- Exemplars

Modification and differentiation can take place in each of the L.I.T.T.O. tasks but the expectation is still that students will reflect on their own learning and work to develop academic habits that will enable them to perform to the very best of their abilities.

The L.I.T.T.O. rubric in Figure 1 shows how these expectations are communicated to students and parents as well as how they are assessed. This rubric is attached to each student's completed L.I.T.T.O., and accompanies the L.I.T.T.O. cover sheet with academic rubric scores to provide each student and family with a portrait of the child's learning behaviors and the effects that those behaviors have on their learning. This will also be followed by the student reflection (Appendix 4) after the work has been assessed by the teacher and reviewed by the student. These reflections are periodically shared with the whole class.

Evaluating Student Learning in L.I.T.T.O.

All good assessment provides information about learners and learning. As a student-centered approach, the purpose of L.I.T.T.O. is to guide students toward academic competency through the development of effective, independent learning capabilities. Assessments, curriculum, instruction and student learning behaviors are vitally interdependent with the understanding that students may directly benefit from active reflection on their work (metacognition) and their interactions with others (interpersonal/collaboration).

Authentic, relevant and ongoing assessment is embedded in L.I.T.T.O. with clear and consistent expectations for all students to guide them in their

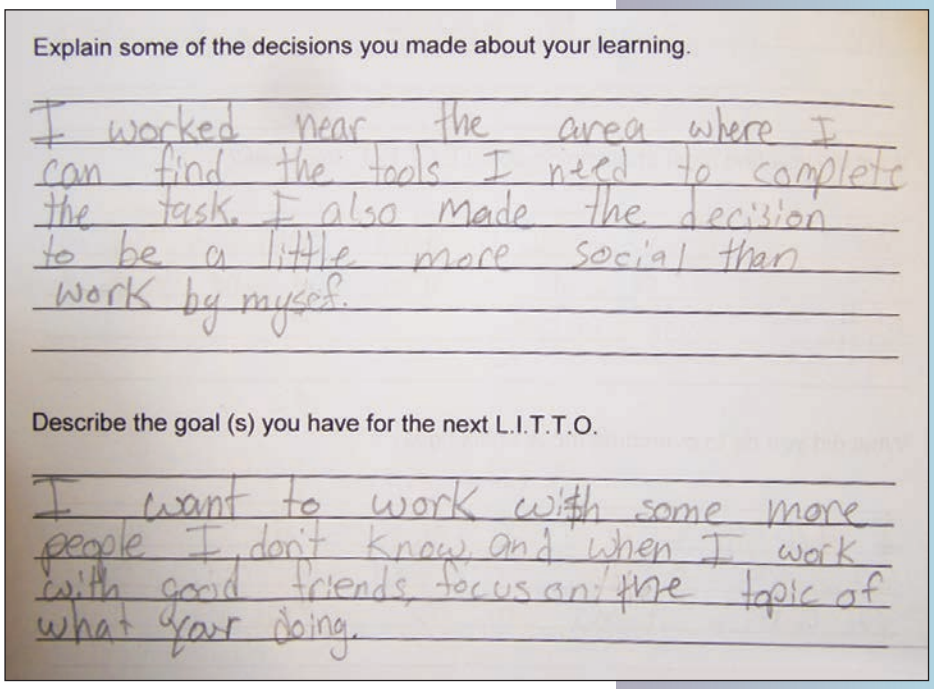
growth and to inform the teacher in the design of curriculum. As a result the assessment of student learning and development is multi-faceted and fundamentally differentiated focusing on growth and ownership.

Three types of assessments are embedded in L.I.T.T.O. for the purposes of gathering data: diagnostic, formative, and summative.

Diagnostic Assessment

Diagnostic assessments include the use of the Columbia Teacher's College Running records for fluency, independent reading level and comprehension benchmarks. These are administered three times each year. Additionally, the district mandates the use of the i-Ready diagnostic assessment for reading (also administered three times a year) a district benchmark, (mid-year) and the New York State English Language Arts tests. These assessments provide an overall portrait of each learner in a standardized setting.

In the classroom, writing samples are evaluated, along with entries in the reading response notebook and the writer's notebook. Observations of behaviors, peer interactions, and conferences provide a sense of how the student performs behaviorally as a learner in the classroom setting. These behaviors are central to student growth and development and are not only included in the rubrics, but openly discussed in the classroom.


Explain some of the decisions you made about your learning.

I worked near the area where I can find the tools I need to complete the task. I also made the decision to be a little more social than work by myself.

Describe the goal (s) you have for the next L.I.T.T.O.

I want to work with some more people I don't know and when I work with good friends, focus on the topic of what your doing.

Formative Assessment

Formative assessments in L.I.T.T.O. are intended to guide the learner and communicate the expectations for reflection, ownership, and individual growth. Assessment that guides the learner includes meetings, conferences, peer interactions and, ultimately, the gradual development of self-assessment capabilities. Expectations are clearly articulated throughout the classroom and within the various associated rubrics.

Charts, rubrics, and meetings identify precisely what students should be doing in specific realms of development

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to demonstrate growth on the continuum delineated in the Common Core Learning Standards, 21st Century Learning Framework, and the Ballston Spa School District Graduation Competencies (Dragone, Turner & Smith, 2009).

1. Academic performance and productivity

2. Interpersonal skills — communication and collaboration

3. Self-direction and independence

Student proficiency is monitored and evaluated to determine the level of competency, engagement and growth, informally, on a daily basis through observation, and formally on a weekly basis using the rubrics indicated above. The broader objective is to help students learn how to assess their own work and progress effectively toward independence and mastery through reflection and personal behavior modifications. Peer editing, conferencing and meetings are important elements of formative assessment that help the students internalize various models for discussion and collaboration that can contribute to interpersonal growth and self-assessment.

Formative assessment is ongoing and collaborative, forming the foundation for work in the classroom. Assessment is precisely connected to the integration of academic, personal, and interpersonal work. It expresses high expectations for all students in those three interconnected realms. Formative assessments focus on improving learning in a holistic and responsive manner.

Summative Assessment

Evaluative summative assessments occur at the end of an instructional unit or at a specific period in the academic year to assess mastery. Summative assessments for the purposes of gathering data or determining grades come in four basic forms. The smallest grouping is performance relative to classroom expectations and the size of the test population grows broader with each step.

Classroom – student work including specific products, completed long-term projects and tasks and end-of-unit quizzes and tests of various design (for report cards and placement).

District – multiple choice and short response writing tasks assessed by classroom teachers.

Web-based – i-Ready and Harcourt Benchmarks administered online and scored by computer (limited item analysis).

State and national standardized exams – New York state tests, and PARCC (limited item analysis).

In order to be perceived as proficient, a student in the 21st century classroom must be able to demonstrate effectiveness in all of those diverse assessment environments. Since many of these assessment instruments are new and evolving to meet the Common Core standards it is not reasonable to expect that teaching to the test will provide successful instructional practice. This is particularly true where the development of 21st century skills is considered. For this reason, it is critical for students to develop confident reflective practices, broad literacy skills, time management and ownership so that they can demonstrate mastery in a range of environments.

How does L.I.T.T.O. fare?

I feel compelled to preface this by saying that my fifth-grade students are participating in this sort of learning for the first time. At the beginning of the year they are not accustomed to self-direction or practices that require a focus on metacognition. Additional time is given and the first "week" of L.I.T.T.O. is stretched out over two weeks in order for students to gain a working understanding of the processes and rubrics as well as a sense of time management.

Initially, students generally find it difficult to remain on task without direct supervision from the teacher. This allows for teachable moments that include meetings with the whole class to discuss academic behaviors and learning styles. As the students test the teacher's expectations and follow up, the quality of the student's work is often low and many tasks represent minimal effort or are incomplete. Students complain that they cannot finish the work in the time allowed, which provides an opportunity for individual and group discussions about strategic approaches to learning.

Some students demonstrate behaviors that interfere with their own work and with the climate of the classroom. This is addressed through individual conferences, attention to IEP requirements, and interactions with academic interventionists, special education teachers, and other school support staff. These dialogues are intended to set reasonable goals for the students to work toward in the development of the capabilities set forth in the L.I.T.T.O. program. The matrices and assessment expectations are readily modified for those purposes.

Students coming into fifth grade may have limited experience with effective collaboration. Teams must be carefully constructed and progress must be closely monitored. A very specific product with clear expectations helps guide the teams in their work and leads to the development of collaborative

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It is critical for students to develop confident reflective practices, broad literacy skills, time management and ownership so that they can demonstrate mastery in a range of environments.

Figure 8

2013-2014	Average Percent Completed – September			Average Percent Completed – January			Average Percent Completed – May		
Homework	60%			75%			90%		
Classwork	57%			70%			95%		
Grades – Classroom	# Level 3 or Above ELA Composite			# Level 3 or Above ELA Composite			# Level 3 or Above ELA Composite		
	3/21						12/21		
District Mid-Year ELA NY Ready Benchmark				< 90	<70	<50	>50		
				6/21	12/21	3/21	0/21		
i-Ready – Local Measure of Student Growth	# At or Above Grade Level	# < than 1 Grade Below Level	#> than 1 Grade Below Level	# At or Above Grade Level	# < than 1 Grade Below Level	#> than 1 Grade Below Level	# At or Above Grade Level	# < than 1 Grade Below Level	#> than 1 Grade Below Level
	1/21	1/21	8/21	14/21	4/21	3/21	16/21	5/21	0/21

evaluation. Initially, group work often requires constant modeling and it is helpful to have the students watch videos from Teacher Tube to see how students do this work. As the year goes by, cooperative processes become more and more central as the students' self-direction and reflection capabilities improve. Their reliance on the teacher for direction and validation decreases.

Nine of 21 students attended Academic Intervention Services for reading and four attended resource room for special education language arts instruction at the beginning of the 2013-14 school year. As the students' experience with the program progressed there were several indicators that these diverse students were successful. Beyond the improved classroom environment, independence, and engagement, the practices supported by various dimensions of the L.I.T.T.O. objective improved their ability to perform on a number of summative measures. (See Figure 8.)

Based on 2013-14 i-Ready Diagnostic scores for reading, these students experienced 200 percent progress toward growth as the average across all students from September to June, with an average scale score increase of 38 percent. There is evidence of increase in all areas assessed by a variety of assessments accompanied by a zero incidence of behavioral referrals. Intangibles include increased time on task, improved attitude, more effective collaborative work, increased self-direction, better quality work and more effective choices in learning. These results have encouraged me to continue my work on the development of L.I.T.T.O. by finding ways to better assess those factors using rating scales that would further increase engagement and self-reflection.

Supporting Materials

Over the six years that I have been working to develop the L.I.T.T.O. approach I have created some work templates that are used regularly in order for the students to be able to focus on features of the text, rather than the details of the task. These

materials include a variety of quartering the story templates, reading response tic-tac-toe, reading informational text templates and vocabulary forms. This consistency encourages confidence and independence. When a student is familiar with the expectations of the task then he is able to focus on answering the task by reading carefully and thinking about the reading. The attention is on the text, not the task. These pieces — quartering the story, tic-tac-toe, and word study — are included in all L.I.T.T.O. work to encourage students to make individual choices about their interactions with text.

L.I.T.T.O. generates the expectation that students will work to develop the habits of a master learner as an integral aspect of their academic work. Students in the L.I.T.T.O. classroom are expected to try different strategies for gathering, organizing, synthesizing and expressing knowledge, concepts and ideas to determine the most effective ways for them to approach various tasks and projects. It is an adaptable method that can be integrated into any classroom setting across all content areas.

L.I.T.T.O. is a means by which students may learn engagement in active learning based on the interrelationship between metacognition, interpersonal experiences, and academic practices.

Figure 9

Quartering the Story – Conflict
Use the back of the sheet if necessary

Draw a picture illustrating what you think the central conflict in the story is. Write a caption describing it.	**Pick one type of conflict* that you have found in the story. Describe it and include evidence from the text.**
Write three sentences describing how the conflict was resolved in your story. (the resolution) Include evidence form the text to support your claim.	**The theme of a piece of fiction is its view about life and how people behave. What do you think the theme of this story is? What is the evidence that makes you think that?**

Students who are intellectually agile and thoughtfully responsive to our dynamic reality are students who possess the confidence and skill sets to approach tasks and challenges using different kinds of tools, and technology with dexterity. These students have developed the capacity to question, to analyze, to hypothesize, reflect, and to filter information from all sources for different purposes. These students are master learners with the thinking skills, personal and interpersonal behaviors to be successful in the culture of the 21st century.

continued on following page

Figure 10

TIC-TAC-TOE READING RESPONSES-
Evidence from the Text

1. Give your opinion of one of the main characters. Use at least one quote from the text to support your opinion.	2. Tell about the mood of the story and use at least one example from the text that illustrates that.	3. Describe the relationship between two of the characters. Use at least one quote from the text to prove your statements.
4. What do you think the theme of your story is? Use evidence from the text to support your choice.	5. Describe an event that changes the main character. Use at least one quote from the text to prove your point.	6. Tell about how the main character solves a problem or learns a lesson in the story. Use evidence from the text to support your point.
Describe a central problem that the main character has to solve. Use evidence from the text in your description.	8. Find places where the author uses dialogue to tell about a character. Use at least one quote from the text.	9. Find quotes that describe settings in the story. Explain how the author provides a good picture of where the story is taking place.

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Appendix 1

LITTO – Social Studies Content Area Text

Name: _____

Directions: Complete each of the activities in the boxes below in any order you want. You may work with people in your group, when appropriate. Make sure put your work in order and hand it in on Friday.

1. FLUENCY **RL.5.2** Read "Dangerous Crossing" text on pages 327 – 339 and complete a "Narrative Text" Quartering the Story. 1 2 3 4	**2. READING** **RI.5.2 - W.5.2** Create a poster that teachers the reader about the Boston Tea Party. Read "Tea Time" on pages 374-380) Use specific evidence from the text. 1 2 3 4	**3. READING -WRITING** **RL.5.5 - W.5.2** Read "Revolution and Rights" on pages 344-348. Complete a time-line showing the sequence of events before and after the American Revolution. Use specific evidence from the text. 1 2 3 4
4. READING **RI.5.1** Read "James Forten" on pages 420 – 431 text and complete an "Informational Text" Quartering the Story. 1 2 3 4	**5. WRITING** **W.5.2d** Create a "Found Poem" for two of the texts that you read for this LITTO. 1 2 3 4	**6. Comprehension** **RL.5.3** Complete a graphic organizer describing the relationship between two characters in "Can't You Make Them Behave, King George?"on pages 258-259 1 2 3 4
7. WRITING - OPINION **W.5.1** Compose a review of one of the texts that you read for this LITTO support your point of view with reasons and information. 1 2 3 4	**8. WRITING - OPINION** **W.5.1** Which of the texts that you read for this LITTO did you learn the most from? Compose a persuasive essay convincing the reader to choose that text over the others. Use the Scholastic Program on my website to learn how to do this. 1 2 3 4	**9. READING -** **RI.5.3 - RI.5.5** Compose a Compare and Contrast essay that compares any two texts from this LITTO. 1 2 3 4

Production and Distribution of Writing

CCSS.ELA-Literacy.W.5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

CCSS.ELA-Literacy.W.5.5 With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach. (Editing for conventions should demonstrate command of Language standards 1-3 up to and including grade 5 here.)

CCSS.ELA-Literacy.W.5.6 With some guidance and support from adults, use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of two pages in a single sitting.

Appendix 2

Geometry L.I.T.T.O.

You must complete ALL of the gray projects! Choose two others. Enjoy.

Brochure Create a brochure that describes 6 different kinds of polyhedra. Explain their similarities and differences. Persuade the reader that the polyhedra is important in the real world and tell about where they can be seen in the surrounding environment. 1 2 3 4	**Poster** Create a poster describing the different types of quadrilaterals and triangles. Explain what makes them quadrilaterals or triangles. Persuade the reader that one of them is more important than the other. Then tell about where they can be seen in the surrounding environment. 1 2 3 4	**Multi-Media** Create a multi-media presentation describing the major types of angles. Explain what makes them all angles. Persuade the reader that the angle is visible in the real world and identify some places where they can be seen in the surrounding environment. 1 2 3 4
Geometry Flap Book Directions and materials in the center. 1 2 3 4	**MATH LAND PROJECT!** Directions are attached. Work with your team. 1 2 3 4	**Newspaper Article** Create a newspaper article that tells about your "Math Land". • Must include visual images • Describe all of the geometric shapes, lines and figures that were used in its design. • Describe the extra features you included. 1 2 3 4
Reading Read one of the Geometry books in the basket. Complete a "Quartering the Story". 1 2 3 4	**Tessellations!** Create your tessellation in Art class. Use the digital camera to take a picture of it. Upload your picture into Sakai. 1 2 3 4	**Geometry Cootie-Catcher** Make your own Geometry Cootie Catcher to help you learn the vocabulary of geometry. Look at the example in the center. 1 2 3 4

Name: _____ Date: _____

Appendix 3

READING INFORMATIONAL TEXT

Name: _____ Date: _____

Before you read the text, complete these statements. Write complete sentences using your best spelling and grammar.

Title: _____

I predict that this text will give me information me about ...

What makes you think that?

After Reading the text, complete these statements. Write complete sentences using your best spelling and grammar. Use evidence from the text when possible.

The main idea of the text is

Two facts from the text that I want to remember are

Something that the author did to make the text interesting is

Something that I would like to ask the author is

One new or interesting word I found in reading the text is

The meaning of the word is

I know this because I used: context clues dictionary non-text items

Some of the graphic aids and illustration aids that the author included in this text were...

Of these, the feature that helped me learn the most about the topic was...
because...

Draw a picture to help you remember what you learned from the text. It may be a sketch, a diagram, a map or any other visual representation.

Caption: Write complete sentences using your best spelling and grammar.

Appendix 4

LITTO REFLECTION

Name: _____ Date: _____

Describe the theme of the L.I.T.T.O. you worked on this week.

_____

_____

_____

_____

What did you find most challenging about L.I.T.T.O. this week?
Why?_____

_____

_____

_____

What did you do to overcome those
challenges?_____

_____

_____

_____

Describe some of the interpersonal (collaborative) skills that you used:

_____

_____

_____

_____

Describe some of the academic skills that you used.

_____

_____

_____

_____

Explain some of the decisions you made about your learning.

_____

_____

_____

_____

_____

Describe the goal (s) you have for the next L.I.T.T.O.

_____

_____

_____

_____

_____

Glossary

Acronyms and Terms

Accompagnato
Musical terminology meaning accompanied, with accompaniment.

Cadenza
Musical terminology meaning a virtuosic solo section used to display a performer's technique.

Cesura
Musical terminology meaning a break or stop.

Con bravura
Musical terminology meaning with boldness, boldly.

Gamification
The concept of applying game-design thinking and game elements (e.g., point scoring, competition with others, rules of play) to nongame applications.

Giocoso
Musical terminilogy meaning gaily, playfully.

Hemiola
A rhythmic alternation of two musical notes in the place of three, or of three notes in place of two.

Integrated Co-Teaching
Formerly called Collaborative Integrated Teaching, ICT provides students the opportunity to be educated alongside their nondisabled peers with the full or part-time support of a special education teacher to assist in adapting and modifying instruction.

Inquiry-based learning
Inquiry-based learning is a complex process where students formulate questions, investigate to find answers, build new understandings, meanings and knowledge, and then communicate their learnings to others.

Metacognition
The reflection on one's learning behaviors and processes.

MIDI
Musical Instrument Digital Interface is a technical standard that describes a protocol, digital interface and connectors and allows a wide variety of electronic musical instruments, computers and other related devices to connect and communicate with one another.

Mixed meter
Multiple meters or time signatures during one piece of music.

Mulitmodal learning
A learning environment which allows instructional elements to be presented in more than one sensory mode (visual, aural, written, etc.).

Newsela
Newsela delivers daily news articles at five reading levels from grades 3 through 12. The site allows an entire class to read the same content, but at a level that's just right for each student.

Sight-read
Performing a piece of music that the performer has not seen before.

Triarama
A three-dimensional paper craft display. Also know as a pyramid diorama.

Tutti
Muscal terminology meaning all, together.

WISE
Web-based Inquiry Science Environment (WISE) is a free online science learning environment for students in grades 4-12

Resources

Additional Resources on Critical Thinking and Problem-Solving for the 21st Century Learner

Union Resources

NYSUT's Common Core Anchor Lessons
http://www.nysut.org/resources/special-resources-sites/common-core/lesson-plans
These Common Core anchor lessons were produced under the direction of NYSUT's Subject Area Committee members. The lessons and accompanying video clips are intended to be used as templates for Common Core lessons and as a reference point for discussions concerning implementation of the Common Core Learning Standards. The videos capture key points of the development process including where the lesson creators began, the struggles they encountered, and the ultimate successes they enjoyed. They provide authentic feedback on what worked and what did not.

American Federation of Teachers
http://www.sharemylesson.com/
Provides member generated teaching resources and lesson plans free of charge. Resources span all subject areas and grade levels.

AFT also hosts resources on 21st century learning at: ***http://www.sharemylesson.com/TaxonomySearchResults.aspx?area=resources&keywords=21st+century+learning***

National Education Association
http://www.nea.org/home/37004.htm?q=critical%20thinking
Provides educational resources for critical thinking and 21st century learning including: the four C's, inquiry-based learning, brain development, and rigorous and reflective thinking.

NEA also published, An Educator's Guide to the "Four Cs": Preparing 21st Century Students for a Global Society ***http://www.nea.org/tools/52217.htm***

Organizations

Partnership for 21st Century Learning
http://www.p21.org/
The Partnership's (P21) mission is "to serve as a catalyst to position 21st century readiness at the center of US K12 education by building collaborative partnerships among education, business, community and government leaders." P21 developed frameworks and other resources on 21st Century learning for teachers, schools and school districts.

Coalition of Essential Schools
http://www.essentialschools.org
The Coalition of Essential Schools (CES) is a grassroots national network of public and private schools that promotes critical thinking and problem solving across the curriculum. Its resource page includes publications on classroom and organizational practice, including the Horace Journal for educators. CES resources support practices related to critical thinking including: habits of mind, performance assessment, essential questions, differentiated instruction and student-centered teaching and learning.

Project Zero Harvard University
http://www.pz.gse.harvard.edu/index.php
The project has conducted a large body of research and published many books related to teaching in the arts, critical thinking, the nature of intelligence, understanding, thinking, creativity, cross-disciplinary and cross-cultural thinking. Project Zero sponsors summer institutes for educators; see more info at: *http://www.pz.gse.harvard.edu/project_zero_summer_institutes.php.*

The Critical Thinking Community
http://www.criticalthinking.org/pages/k-12-instruction/432
The Center for Critical Thinking holds an annual conference, conducts research, and disseminates information about critical thinking. In addition you can find books and other useful publications on its website. The Community also sponsors the critical thinking fellows program.

Authentic Education
http://www.authenticeducation.org
Founded by Grant Wiggins, co-author of Understanding by Design, Authentic Education is an organization dedicated to promoting professional development for schools and workshops or online courses for individuals. Books and DVDs on authentic learning and assessment can be found for purchase on its website. Authentic Learning also posts an electronic e-journal under the heading "Big Ideas."

continued on following page

NYSUT Education Learning Trust Courses

COLLABORATIVE INQUIRY FOR STUDENTS: PREPARING MINDS FOR THE FUTURE™

EDU 661108 Empire State College

This course provides educators with research-based strategies for designing and implementing collaborative inquiry for students. Participants will explore and experience the collaborative inquiry models of problem-based learning, hypothesis-based learning, project-based learning, Appreciative Inquiry, and performance-based learning. 3 graduate credits. Meets Teaching Standards I, II, III, VII

COOPERATIVE LEARNING FOR STUDENTS WITH SPECIALS NEEDS

SED 661 College of Saint Rose

This course focuses on promoting student achievement and development in a collaborative learning community. Communication skills for effective teaching in an inclusive or special education setting are described, modeled and then practiced by participants. 3 Graduate Credits. Meets Teaching Standards I, IV

THE 21ST CENTURY CLASSROOM: HOW PROBLEM-BASED LEARNING WITH TECHNOLOGY CAN TRANSFORM STUDENT LEARNING IN THE DIGITAL AGE

EDU 661109 SUNY Empire State College – Also Available Online

This practical course is designed to enable K-12 educators to synthesize newly framed requirements for highly effective teaching (APPR), the 21st Century Skills, the Common Core Standards, existing research on best instructional practices, technology use and assessment into a high performing classroom that can transform their students' learning and ready students for college and career success in a global, digital world. The course shows educators the practical "how-to" to create innovative but easy-to-implement, standards-aligned, project-based learning units that integrate intuitive digital tools into daily differentiated instruction. 3 graduate credits. Meets Teaching Standards I, III, IV

DEVELOPING INNOVATORS AND INNOVATION SKILLS

EDU 661113 SUNY Empire State College

This course focuses on developing innovation capabilities in students by exploring the discovery skills of associating, questioning, observing, networking, and experimenting. Participants learn how to create a culture of innovation and provide learning opportunities that promote perseverance, encourage curiosity, and ignite intrinsic motivation. Participants explore resources, strategies, and ideas for designing content-based lessons that incorporate discovery skills and foster the behaviors students need to be innovation-ready. 3 graduate credits. Meets Teaching Standards I, II, III, IV, V

CONSTRUCTIVIST TEACHING AND LEARNING

This seminar will address one of the priorities of the NYS Teaching Standards. Teachers must consider how each student learns. Understanding how to address this in the classroom means that teachers must implement a variety of instructional strategies. Participants will explore how students learn when they "build" the learning for themselves. When students are asked to classify, analyze, predict and create, they begin to think critically and ask questions in order to understand the complex material presented to them in school and in the world. Meets Teaching Standards II, III, IV, V

Call for Article Proposals for Educator's Voice, Vol. IX

English Language Learners: A Mosaic of Languages and Cultures

English Language Learners (ELLs) are the fastest growing student population in the U.S. Over the past decade ELL enrollment has grown by 20 percent in New York state. This issue will highlight the diverse world of English Language Learners as they navigate languages and cultures. We will showcase how educators teach and support ELLs in different models of instruction.

Examples of topic areas include:

- Strategies for supporting ELLs in the mainstream classroom
- Scaffolding learning in the content areas
- Applying the Bilingual Common Core Initiative in the classroom
- Understanding the relationship between language development and disabilities
- Engaging the newcomers in the classroom community
- Differentiated instruction for long-term ELLs
- Instructional models for students with interrupted formal education (SIFE)

English Language Learners: A Mosaic of Languages and Cultures

EDITORIAL GUIDELINES

Grade and Content Area: Author(s) can describe practices in any grades (P-12) and affiliated with any content area. For example, a fourth-grade teacher and special education teacher may address their approaches as a teaching team; a high school social studies teacher may co-author a manuscript with the school psychologist, a kindergarten teacher in partnership with a university professor may discuss their approaches.

Audience: Teachers, school-related professionals, pupil personnel services providers, union leaders, parents, administrators, higher education faculty, researchers, legislators, and policymakers.

Deadline for Proposals: June 12, 2015.

Rights: Acceptance of a proposal is not a guarantee of publication. Publication decisions are made by the Editorial Board. NYSUT retains the right to edit articles. The author will have the right to review changes and if not acceptable to both parties, the article will not be included in *Educator's Voice*. NYSUT may also retain the article for use on the NYSUT website (*www.nysut.org*) or for future publication in *NYSUT United*.

Article Length: The required article length is flexible. Please submit approximately 2,000 – 3,000 words (or 7-9 double-spaced pages plus references).

Writing Style: Authors are encouraged to write in a direct style designed to be helpful to both practitioners and to others committed to strengthening education. Education terms (i.e., jargon, acronyms) should be defined for a broad audience. For articles with multiple authors, use one voice consistently.

Manuscript: Authors must follow American Psychological Association (APA) 6th edition style with in-text citations and references at the end of the article. Do not use footnotes. Please paginate the manuscript and include the lead author's name in the header.

Graphics may be submitted as JPEGs, TIFFs or PDFs, but must be high-resolution and provided separately from the manuscript (not embedded in the document). Please do not submit copyrighted material unless you obtain and provide permission from the publisher.

Call for Article Proposals for Educator's Voice, Vol. IX

English Language Learners: A Mosaic of Languages and Cultures

Proposal Guidelines

Please reference each of the following in your proposal and return to NYSUT by the June 12, 2015 deadline. You may also try our optional online submission form at: *http://www.nysut.org/resources/special-resources-sites/educators-voice/call-for-proposals.*

- The context for the reader; describe the setting and student population (e.g., class approaches, whole school approaches).
- Description of your approaches; include specifics of the practice, strategy used in your classroom(s). Include relevant artifacts if available.
- The research base that supports the practice, including relevant citations and their connection to your classroom practice; links to Common Core or other standards.
- Evidence of success that indicates the practice achieved its goal(s). Describe student and evaluation criteria, or metrics.
- How you involved parents and caregivers as partners in your work.
- How does your practice address the needs of diverse populations? (E.g., students with disabilities, students who are English language learners, other students with unique learning needs.)

English Language Learners: A Mosaic of Languages and Cultures

You can download this document from our website:
http://www.nysut.org/resources/special-resources-sites/educators-voice/call-for-proposals

Name of Author(s) _____

If multiple authors, please list all names, and identify one author as primary contact person _____

_____

Article working title _____

_____

Please check all the categories of affiliation with NYSUT that apply to the primary author/contact person:

- ❑ 1. I am an active teacher member of the following local _____
- ❑ 2. I am an active SRP member of the following local _____
- ❑ 3. I am an active higher education member of the following local/chapter _____
- ❑ 4. I am an instructor of the following NYSUT Education & Learning Trust course _____

_____

- ❑ 5. I am a member of the following NYSUT Subject Area Committee _____

_____

- ❑ 6. I am a retired teacher and member of the following retiree council _____

Please provide a statement/outline describing how you plan to address each specific "Proposal Guideline" and any additional information that you intend to incorporate in your manuscript. Also, please provide:

Current position of author(s), including district, grade(s) and content area: _____

_____

Primary author's name, address and phone number: _____

_____

Alternate phone number: _____

Primary author's email address: _____

Summer contact information, if different: _____

Information can be submitted electronically by June 12, 2015, to:

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Or mail to:

NYSUT Research & Educational Services
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800 Troy-Schenectady Road
Latham, NY 12110

Deadlines for Volume VIIII:

June 12, 2015	Proposal submission deadline
July 10, 2015	NYSUT responds to proposal
Sept. 1, 2015	Completed article submission
April 2016	Publication

Notes:

Notes:

NYSUT Education & Learning Trust

The Education & Learning Trust is NYSUT's primary way of delivering professional development to its members. ELT offers courses for undergraduate, graduate and in-service credit, partnership programs that lead to master's degrees and teaching certificates, and seminars as well as professional development programs for teachers and school-related professionals.

NYSUT Education & Learning Trust offers the following professional development on the topic of Critical Thinking and Problem Solving for the 21st Century Learner:

Site-based and/or online courses:

- **Collaborative Inquiry for Students: Preparing Minds for the Future™**

This course provides educators with research-based strategies for designing and implementing collaborative inquiry for students. Participants will explore and experience the collaborative inquiry models of problem-based learning, hypothesis-based learning, project-based learning, Appreciative Inquiry and performance-based learning. *Meets NYS Teaching Standards I, II, III, VII*

- **Cooperative Learning for Students with Special Needs**

This course focuses on promoting student achievement and development in a collaborative learning community. Communication skills for effective teaching in an inclusive or special education setting are described, modeled and then practiced by participants. *Meets NYS Teaching Standards I, IV*

- **The 21st Century Classroom: How Problem-Based Learning with Technology Can Transform Learning in the Digital Age**

This practical course is designed to enable K-12 educators to synthesize newly framed requirements for highly effective teaching (APPR), the 21st Century Skills, the Common Core Standards, existing research on best instructional practices, technology use and assessment into a high-performing classroom that can transform their students' learning and ready students for college and career success in a global, digital world. The course shows educators the practical "how-to" create innovative but easy-to-implement, standards-aligned, project-based learning units that integrate intuitive digital tools into daily differentiated instruction. *Meets NYS Teaching Standards I, III, IV*

- **Developing Innovators and Innovation Skills**

This course focuses on developing innovation capabilities in students by exploring the discovery skills of associating, questioning, observing, networking and experimenting. Participants learn how to create a culture of innovation and provide learning opportunities that promote perseverance, encourage curiosity and ignite intrinsic motivation. Participants explore resources, strategies and ideas for designing content-based lessons that incorporate discovery skills and foster the behaviors students need to be innovation-ready. *Meets NYS Teaching Standards I, II, III, IV, V*

Seminar:

- **Constructivist Teaching and Learning**

This seminar will address one of the priorities of the NYS Teaching Standards. Teachers must consider how each student learns. Understanding how to address this in the classroom means that teachers must implement a variety of instructional strategies. Participants will explore how students learn when they "build" the learning for themselves. When students are asked to classify, analyze, predict and create, they begin to think critically and ask questions in order to understand the complex material presented to them in school and in the world. *Meets NYS Teaching Standards II, III, IV, V*

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