Making the Maker: A Pathway to STEM for Elementary School Students

FRANCIS QUEK
TEXAS A&M UNIVERSITY
Dual Goals of Learning: Process & Person

Process:

Learning Model

Scientific vs Everyday Knowledge → Employing Making as Means to an Ends → Technical Activity (Making Electronic & Physical Artifacts) → Storytelling Activity (Use of Artifacts)

- Social Learning Theories (E.g. Situated Learning)
- Constructivism/Constructionism/Learning by Doing
- Project-based Learning

Person:

Identity Formation Model

Making Activity → Sense of Technical Capability → Increased Self-Efficacy in STEM → Opportunity for Self-Identification in STEM

- Theories of Self, Self-Concept/Possible Selves, etc.
- Entity Theory Fixed vs Growth Mindset
- Communities of Practice
Interdisciplinary Research Team

Francis Quek (HCI, Embodied & Situated Learning, Electrical Engineering & Computer Science)

Sharon Chu (Child-Computer Interaction, Interaction Design)

Rebecca Schlegel (Social Psychology, Identity)

Lynn Burlbaw (Teacher Education, Curriculum Development)

Patricia Larke (Teacher Education, Culturally Responsive Teaching)
Making as Part of a New Economy

Promise for new industries and economies
Danger of a New Digital (STEM) Divide

Typical Maker: male, has advanced degree, and comes of higher SES
Integrating into Universal Education

Our Making-infused Classroom

Typical Classrooms

School Integration is Necessary
Neal Elementary School Project Site

- Representation: 72% Latino, 26% African American, 2% White or Asian
- 96% on reduced lunch programs
- Over 50% Bi-Lingual
Why Grades 3-5: Addressing Learning

Concrete modes of thinking

Conceptual Modes of Thinking

Critical Period of Transition
Why Grades 3-5: Addressing the Person

Identity formation takes place in early adolescence
Integrating Making with Science, Mathematics, and Language-Arts

**Integration of Knowledge and Ideas:**

**CCSS.ELA-LITERACY.RI.5.7**
Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

**CCSS.ELA-LITERACY.RI.5.8**
Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).

**CCSS.ELA-LITERACY.RI.5.9**
Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

**Matter and Energy: Properties of Light**

**TEK 4.5C:** The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to compare and contrast a variety of mixtures and solutions such as rocks in sand, sand in water, or sugar in water.

**Force, Motion, and Energy: Properties of Light**

**TEK 5.6C:** The student knows that energy occurs in many forms and can be observed in cycles, patterns, and systems. The student is expected to demonstrate that light travels in a straight line until it strikes an object or travels through one medium to another.

**Earth and Space: Rapid Changes**

**TEK 3.7B:** The student knows Earth consists of natural resources and its surface is constantly changing. The student is expected to investigate rapid changes in the Earth's surface such as volcanic eruptions, earthquakes, and landslides.
Making as the New Colored Pencil
Schedule of Maker-Curriculum in Classroom

- School Year divided into six 6-week units
- Each unit addresses a TEKS/Common Core Topic Area
- Our activity is integrated into one week per unit

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Curriculum-Based Maker Planning for One Making Unit

Involved Process Across the Team and Teachers
Human Body Model for 5th Grade

- Lungs LED
- Breathe Switch
- Eat Switch
- Oxygen Transfer Relay Switch
- Energy LED
Dioramas and Quiz Boards for Language-Arts

Quiz Boards

Story Dioramas
Multi-year Longitudinal Design

Initial Technology Development & Pilot Testing (Spring 2015)

Practice & Identity Formation are Long Term Effects
Summary Results and Findings

**Maker workshops leading to school study**

- the **utility of Making for storytelling** through instrumental/remote interaction,
- how to design Maker kits, and **analyze children’s behaviors** for mindset formation,
- the **importance of motor skills** when designing Maker kit components (e.g., connectors) for children

**First year of school study**

- affordances and challenges of introducing Making in the elementary school science curriculum,
- structure, component, and agency requirements in the curriculum-based Making as an activity system
- the operationalization of positive and negative affect in children during Making in the classroom
STEM Interest & Self-Efficacy

First semester of school study

- Statistically significant upward trajectories especially in students’ interest and self-efficacy in Making, and desire to have a STEM career when they grow up

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Empowering Elementary School Students in Science

Open house at Texas A&M by Elementary School Students

Bryan students engage with Texas A&M for hands-on learning

The students presented their projects Friday to A&M students and faculty from the Colleges of Education and Human Development, Architecture, Engineering, and Liberal Arts.

For Neal student Angel Salinas, his favorite part of this collaboration: “I get to work with circuits.”

It’s helping him and others develop skills in those STEM fields. The hope is to keep kids engaged in these subjects now so they keep working in them and further their education.
Dissemination Website released (http: MakingtheMaker.tamu.edu)