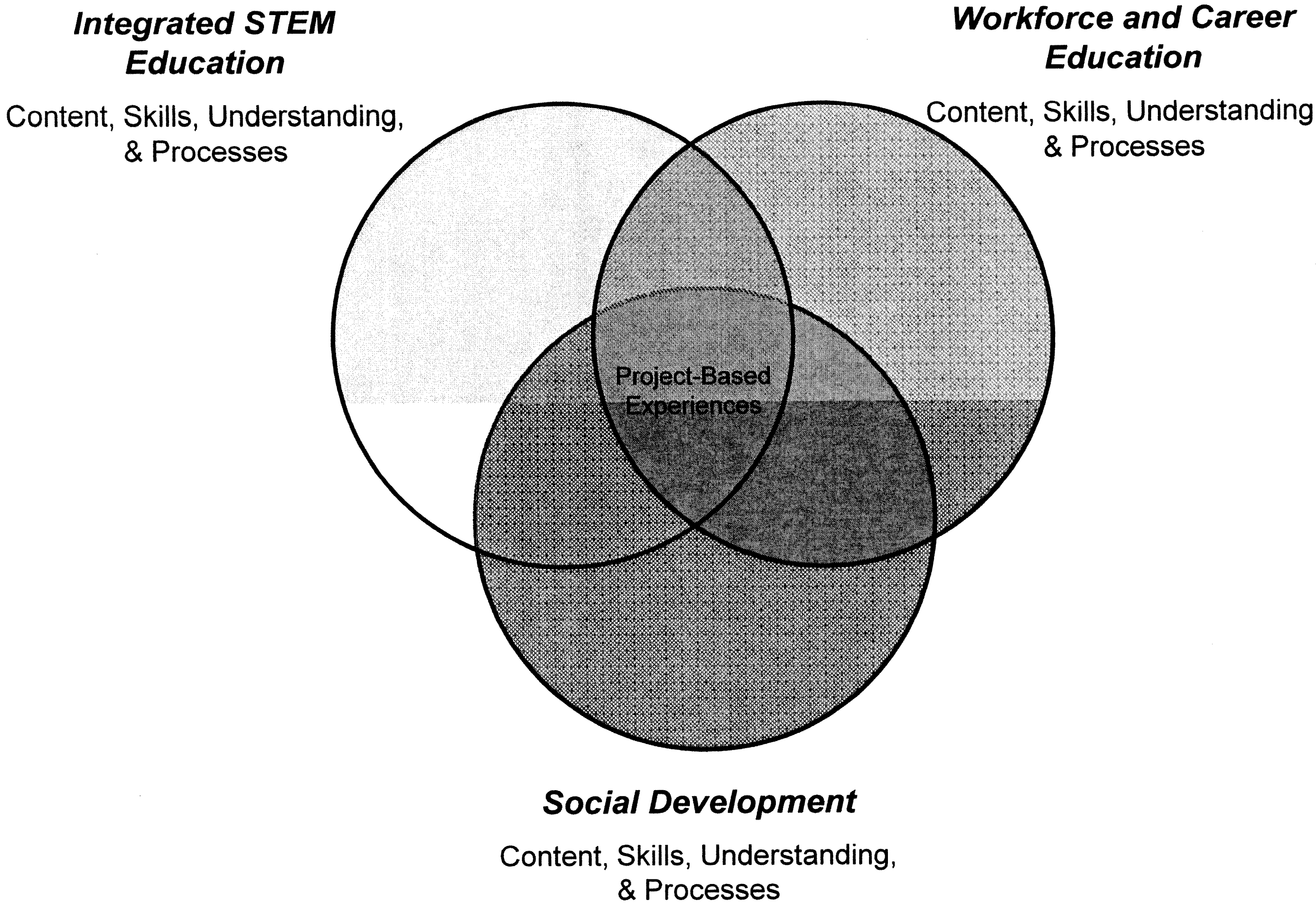
UNIT DEVELOPMENT

Concept Diagram for STEM Curriculum Design



Curriculum Design Considerations for Integrated Curriculum and Project-Based Learning

Big Ideas for Middle School Mathematics[1]

- Proportionality, Similar Figures, Scalar Thinking
- Polygons and Angles, Measurement of Angles
- Algebraic Thinking: Patterns, Functions and Relations
- Sampling and Probability: Quantitative Literacy Skills

Big Ideas for Middle School Science[2]

- The Physical World
- The Living World
- Science and Technology as a Human Endeavor
- The Designed World

1. Annenberg Media, www.learner.org , ***The Missing Link*** - video and workshop
2. Excerpted from AAAS Benchmarks for Science Literacy, www.project2061.org/
3. Excerpted from Partnership for 21st Century Skills Route 21, http://www.21stcenturyskills.org/route21/
4. Taken from a Jan Morrison monograph on STEM school design, http://www.tiesteach.org/monographs.htm
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21st Century Skills[3]

Flexibility & Adaptability

- Adapting to varied roles and responsibilities
- Working effectively in a climate of ambiguity and changing priorities

Initiative & Self-Direction

- Monitoring one's own understanding and learning needs
- Going beyond basic mastery of skills and/or curriculum to explore and expand one's own learning and opportunities to gain expertise
- Demonstrating initiative to advance skill levels towards a professional level
- Defining, prioritizing and completing tasks without direct oversight
- Utilizing time efficiently and managing workload
- Demonstrating commitment to learning as a lifelong process

Social & Cross-Cultural Skills

- Working appropriately and productively with others
- Leveraging the collective intelligence of groups when appropriate
- Bridging cultural differences and using differing perspectives to increase innovation and the quality of work

Productivity & Accountability

- Setting and meeting high standards and goals for delivering quality work on time
- Demonstrating diligence and a positive work ethic (e.g., being punctual and reliable)

Leadership & Responsibility

- Using interpersonal and problem-solving skills to influence and guide others toward a goal
- Leveraging strengths of others to accomplish a common goal
- Demonstrating integrity and ethical behavior
- Acting responsibly with the interests of the larger community in mind

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Creativity & Innovation

- Demonstrating originality and inventiveness in work
- Developing, implementing and communicating new ideas to others
- Being open and responsive to new and diverse perspectives
- Acting on creative ideas to make a tangible and useful contribution to the domain in which the innovation occurs

Critical Thinking & Problem Solving

- Exercising sound reasoning in understanding
- Making complex choices and decisions
- Understanding the interconnections among systems
- Identifying and asking significant questions that clarify various points of view and lead to better solutions
- Framing, analyzing and synthesizing information in order to solve problems and answer questions

Communication & Collaboration

- Articulating thoughts and ideas clearly and effectively through speaking and writing
- Demonstrating ability to work effectively with diverse teams
- Exercising flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal
- Assuming shared responsibility for collaborative work

Information Literacy

- Accessing information efficiently and effectively, evaluating information critically and competently and using information accurately and creatively for the issue or problem at hand
- Possessing a fundamental understanding of the ethical/legal issues surrounding the access and use of information

Media Literacy

- Understanding how media messages are constructed, for what purposes and using which tools, characteristics and conventions.
- Examining how individuals interpret messages differently, how values and points of view are included or excluded and how media can influence beliefs and behaviors.
  Possessing a fundamental understanding of the ethical/legal issues surrounding the access and use of information

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Information, Communications & Technology Literacy

- Using digital technology, communication tools and/or networks appropriately to access, manage, integrate, evaluate, and create information in order to function in a knowledge economy
- Using technology as a tool to research, organize, evaluate and communicate information, and the possession of a fundamental understanding of the ethical/legal issues surrounding the access and use of information

STEM Skills[4]

- *Problem-solvers* - able to frame problems as puzzles and then able to apply understanding and learning to these novel situations (argument and evidence)
- *Innovators* - "power to pursue independent and original investigation" (Gilman, 1898) using the design process
- *Inventors* - recognize the needs of the world and creatively design and implement solutions
- *Self-reliant* - able to set own agendas, develop and gain self-confidence and work within time specified time frames
- *Logical thinkers* - using the logic offered by calculus and found in 60% of all professions world-wide; able to make the kinds of connections to affect an understanding of natural phenomena
- *Technologically literate* - understand the nature of the technology, master the skills needed and apply it appropriately (Knowledge, Ways of Thinking and Acting, and Capabilities as specified by ITEA in "Technically Speaking")
- *Participants* in the STEM lexicon that supports the bridge between STEM education in school and the workplace
- *Able* to relate their own culture and history to their education

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STEM Schools[5]

- Design process drives the STEM instruction throughout the school
- Designing is cognitive modeling in which a person gains insight into a problem, determines alternative pathways, and assesses the likelihood of success between solution sets
- Designing is an intentional activity which can bring about change
- Designing is intuitive and deductive, it is more than knowing how to use resources, or how to practice skill sets "through designing humans structure continuous experiences into a series of overlapping episodes... by focusing on designing and interpretive activity... construct meaning and knowledge."
- Tinkering with notions and materials central in all school areas, curricular and co-curricular
- Curriculum materials in support of the instruction not to supplant it
- All curriculum materials STEM in nature (trans-disciplinary)
- Emphasis on technology and engineering in science and mathematics courses
- Use of NSF generated mathematics and science materials with design embedded
- Broad range of STEM courses available to students throughout their ... school career
- Innovation and invention highly prized in all student engagement
- A culture of questioning, creativity and possibility pervading the school
- Rigor is defined using benchmarking of design process with student outcomes
- Testing of students formative and most often performance based
- Teachers having a "thorough understanding of the subject domain and the epistemology that guides the discipline (How People Learn, p. 188)
- All professional development for teachers yearlong would use classroom materials, integrate STEM across the curriculum and be constructivist in nature (Horizon Research NSF, 2006)
- Compliant in state testing and standards as the floor not the ceiling
- Administrative decisions data driven within the mission of the STEM

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What are the STEM School Design Principles?

#1 STEM embraces a comprehensive education philosophy, based on student inquiry and experience.[1]

#2 STEM schools thrive in a connected P-16 education continuum, where students cultivate a passion for mathematics and science in the early grades and earn college credit and work experiences in the later grades.[2]

#3 STEM schools educate the "whole" child, incorporating the arts, languages and humanities into student curricula.

#4 STEM schools reflect an interdisciplinary approach, offering students the opportunity to make sense of the world around them, rather than learn isolated bits and pieces of subjects in separate forums.[3]

#5 STEM schools engage students in the "technological design process," using technology to meet the challenges of life.

#6 STEM schools are collaborative and innovative, built on strong partnerships among K-12 education,higher education and business. They might be co-located on a college campus or a corporate center.

#7 STEM schools employ a specific set of design principles that distinguish them from other schools.

Reference Notes 1,2,3: Taken from the work of **Janice Morrison, TIES (Teaching Institute for Excellence in STEM)**
TIES seeks to provide an array of school support services that focus on teaching and learning for students in STEM disciplines. TIES recognizes the importance of school design and professional development for all teachers in an effort to improve the character of science, technology, engineering and mathematics teaching for students regardless of grade level.

Burneson Middle School

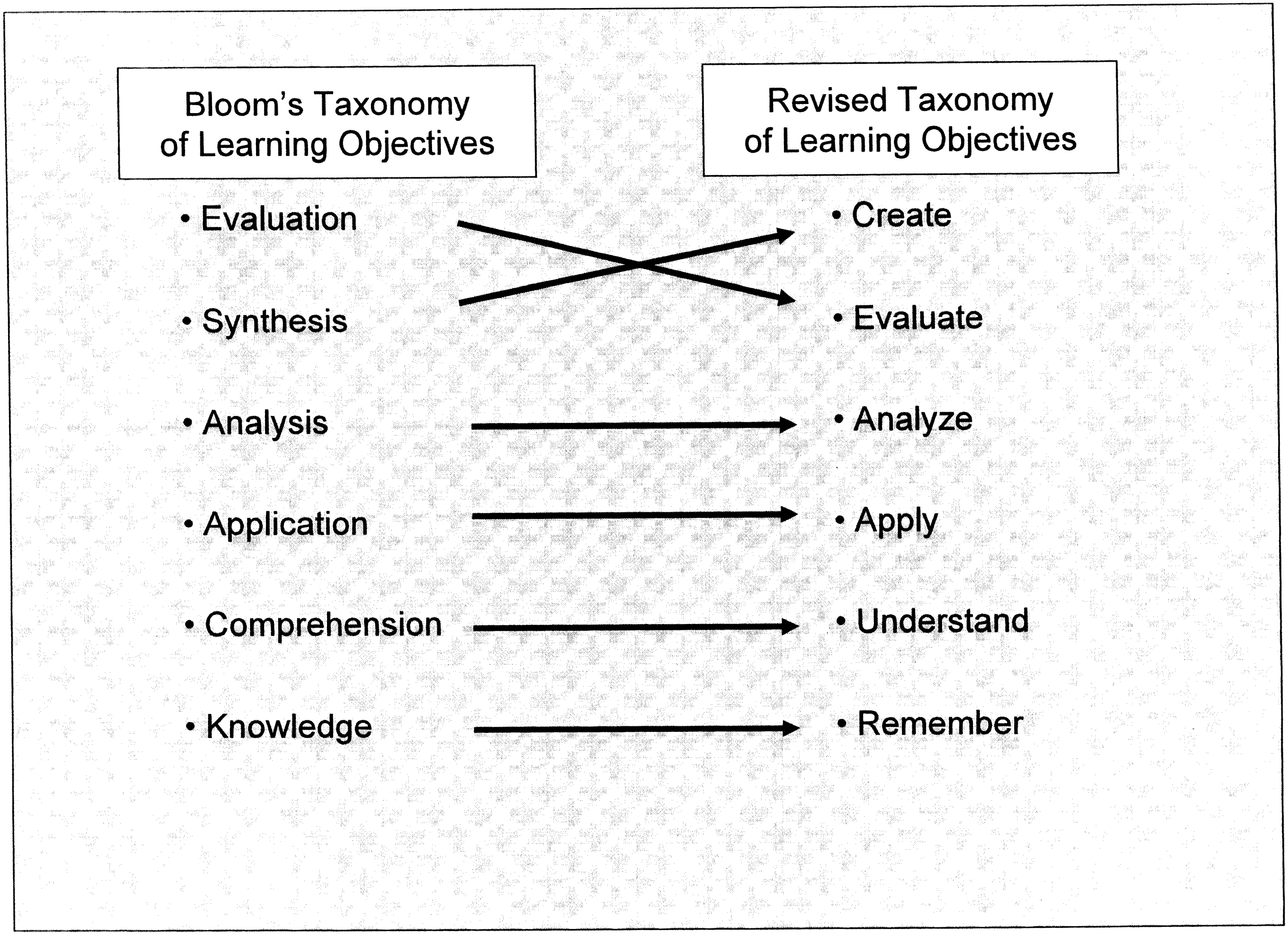
Teamwork Assessment

Name: ____________________ Teacher: Viebranz Sample

Date: ____________________ Title of Work: ____________

Skills	Criteria				Points
	1	2	3	4	
Helping The teacher observed the students offering assistance to each other.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Listening The teacher observed students working from each other's ideas.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Participating: The teacher observed each student contributing to the project.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Persuading: The teacher observed the students exchanging, defending, and rethinking ideas.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Questioning: The teacher observed the students interacting, discussing, and posing questions to all members of the team.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Respecting: The teacher observed the students encouraging and supporting the ideas and efforts of others.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
Sharing: The teacher observed the students offering ideas and reporting their findings to each other.	*None* of the Time	*Some* of the Time	*Most* of the Time	*All* of the Time	___
				Total Points	___

Teacher Comments:


Bloom's Taxonomy of Learning Objectives
Revised Taxonomy of Learning Objectives
• Evaluation
• Synthesis
• Analysis
• Application
• Comprehension
• Knowledge
• Create
• Evaluate
• Analyze
• Apply
• Understand
• Remember

How Does Engineering Compare with Science?

Scientific Inquiry	Engineering Design
Formulate a **question**.	Define a **problem**.
Research how others have answered it.	Research how others have solved it.
Brainstorm hypotheses and choose one.	Brainstorm solutions and select one.
Conduct an experiment.	Create and test a prototype.
Modify hypothesis based on results.	Redesign solution based on tests.
Draw conclusion, write paper.	Finalize design, make drawings.
Submit paper for peer review.	Present optimal solution to client.
Ask new question	Define new problem.