Table 1 - Paper Summary

Authors	Citations	Title	Type	Domain	Framework	Age	Goal	Conclusion
Barak & Zadok, 2009	41	Robotics projects and learning concepts in science, technology and problem solving	Study	Robotics	Project based learning, constructivism	Jr. High	Problem Solving	Students intuitively used heuristic search to find solutions to problem but could not articulate their strategies. Students qualitatively used systems knowledge to solve problem and they could have benefited from specific, in-context, math, science, and tech knowledge.
Baynes, 1994	11	Designerly play	Theoretical	Design	Paper provides several theoretical frameworks for the design process: Jean Piaget, John Gabriel (play), and David Cohen & Stephen A MacKeith (imagination).	0 to adult	Map out in detail the relationship between the play models of Gabriel and Cohen & MacKeith to aspects of design,	The ability to design is common and important to all children.

Brophy et al., 2008	124	Advancing Engineering Education in P-12 Classrooms	Review	Engineering	Constructivist (implicit)	PK-12	Review current state of engineering education programs and research.	Engineering education is important to increase the STEM pipeline and is also of value in and of itself. While there are many worthy programs and some research, much more needs to be done and many research questions remain.
Crismond, 2001	71	Learning and using science ideas when doing investigate-and-redesign tasks: A study of naive, novice, and expert designers doing constrained and scaffolded design work	Case study	Design	Cognitive Design Framework (Leonard, Dufresne, Gerace, and Mestre)	Mixed	Science	Experts used science concepts and general principles in a redesign task while novices did not.
Fleer, 1999	22	The science of technology: Young children working technologically	Case study	Design/Technology	Anning; Solomon & Hall	Ages 5-11	Characterize relationship between design ideas and actual products	Drawings and ideas exceeded young students capabilities so they mostly worked with 3D models. Design and evaluate occurred throughout the design process.
Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005	55	Design-based science and real-world problem-solving	Quantitative study	Design (Design Based Science – DBS)	Designerly Play (Baynes), problem solving and inquiry (constructivism)	Grade 9	Science knowledge and transfer	Transfer did occur using DBS

Hynes, Crismond, & Brizuela, 2010		AC 2010-447: Middle-School Teachers' Use And Development Of Engineering Subject Matter Knowledge	Quantitative study	Engineering	Constructivist	Middle school teachers	Use science content knowledge to when teaching engineering	Teachers did not necessarily use their math/science knowledge to teach engineering. Math teachers need to have engineering units with strong math content, similar for science.
Kendall & Wendell, 2012		AC 2012-4068: Understanding The Beliefs And Perceptions Of Teachers Who Choose To Implement Engineering-Based Science Instruction	Mixed methods	Engineering	Constructivist, constructionist, self-efficacy, teacher beliefs	Grade 4 elementary teachers	Implement engineering based science instruction	Self-selected teachers for an engineering based science unit had high self-efficacy for teaching science but lower for outcome expectancy beliefs. Teachers came in with a constructivist viewpoint. Teachers viewed the program positively.

Kolodner et al., 2003	364	Problem-based learning meets case-based reasoning in the middle-school science classroom: Putting Learning by Design (TM) into practice	Descriptive with some data	Design/Engineering	Problem based learning and Case Based Reasoning	Middle School	The goal is to help students be creative collaborative design with a strong knowledge of how to use science to aid in design.	A key focus is on how to create the collaboration. Uses a situated learning approach but also designed in transfer from the start. Student data was positive but there were challenges in terms of teachers.
Leonard & Derry, 2011	4	"What's the Science Behind It?" The Interaction of Engineering and Science Goals, Knowledge, and Practices in a Design-Based Science Activity	Qualitative	Engineering	Constructivist, social constructivist, constructionist, pragmatist, modeling, activity theory, sociocultural theory	Middle School	The goal is to help students be creative collaborative design with a strong knowledge of how to use science to aid in design.	Results showed that simple science models alone were not sufficient to enable the design task. Their conclusion is that thoughtful scaffolding is required to use engineering to teach science concepts. A pure scientific approach obscures the reality of actual system performance. A purely technological approach deprives studies of scientific concepts that will enable better solutions.

McRobbie, Stein, & Ginns, 2001	24	Exploring designerly thinking of students as novice designers	Case study	Design	Not specified	Preservice teachers	Help teachers understand the design processes actually followed by students.	Students and novice designers do not follow the ideal design models that have been developed. System of modeling design actions could be used in my research.
Mehalik, Doplet, & Schunn, 2008	72	Middle-school science through design-based learning versus scripted inquiry: Better overall science concept learning and equity gap reduction	Quantitative	Design/engineering	Constructivist (implied), systems design	Grade 8	Science concept learning	Students using the systems design approach showed significant gains compared to the scripted inquiry approach, especially low achieving African-American students.
Nourbakhsh, Hamner, Crowley, & Wilkinson, 2004	24	Formal measures of learning in a secondary school mobile robotics course	Mixed methods	Robotics	Constructionist	College seniors	Broad learning; establish methodology to evaluate robotics courses	Results showed both content, process, and interest gains. Girls had more difficulty with programming but confidence with technology increased more quickly than boys.

Nugent, Barker, Grandgenett, & Adamchuk, 2010	17	Impact of robotics and geospatial technology interventions on youth STEM learning and attitudes	Quantitative	Robotics and GIS	Experiential learning	Middle School	Science content and motivation/interest	Researchers compared a control, a short term, and long term group for STEM learning and attitudes (self-efficacy). The long term (one week camp) showed increases all around. The short-term group showed increases in STEM interest/attitudes but not in STEM learning.
Outterside, 1993	10	The emergence of design ability: The early years	Case study	Design	Design modeling (Baynes), multiple intelligence theory, constructivism (implicit)	Ages 2-4	Understand very young children's design processes especially the interactions between perceiving, imagining, and modeling.	Children come to school with lots of experience and processes in place for design. Awareness of the processes and interactions between imaging and modeling is often implicit and should be made explicit in school.
Penner, Giles, Lehrer, & Schauble, 1997	122	Building functional models: Designing an elbow	Quantitative	Design	Modeling, constructivist (implied)	Grades 1-2	Model construction and model revision	Modeling can be taught and developed even for grade 1 and grade 2 children.
Perova, Johnson, & Rogers, 2008		Using Lego Based Engineering Activities To Improve Understanding Concepts Of Speed, Velocity, And Acceleration	Mixed methods	Robotics	Multiple intelligence theory and constructivism	First year college and secondary	Science concepts	Data showed positive results in terms of achievement and attitude. Demonstrations and especially hands-on were the most popular with students.

Puntambekar & Kolodner, 2005	24	Distributed Scaffolding: Helping Students Learn Science from Design		Design	Bruner, social constructivist	Middle school	Find methods to help middle school teachers teach science using design. Teach students science concepts and processes.	Students need distributed scaffolding to fully use science process and content in the context of design based science activities.

Roth, 1996	127	Art and Artifact of Children's Designing: A Situated Cognition Perspective	Qualitative (ethnographic)	Design	Situated cognition	Grades 4 and 5	What is the nature of design artifacts from a situated cognition perspective? How can teaching be improved from such an analysis?	Artifacts are not ontologically stable. - Students will use whatever materials and processes they discover which may not match the teacher's intentions, Movements spread throughout classrooms so much that it is difficult to figure out individual performance, even though artifacts are named by students to belong to individuals or teams.

Schunn, 2009	11	How Kids Learn Engineering: The Cognitive Science Perspective	Review	Engineering	Constructivist (implied)	K-16	Increase STEM< pipeline, teach engineering as valuable in and of itself, teach science concepts	Gives practical tips and methods for teaching engineering
Sullivan, 2008	35	Robotics and science literacy: Thinking skills, science process skills and systems understanding	Mixed methods	Robotics	Constructivist (implied), mediated learning, inquiry	Middle School	Thinking skills, science process skills, systems understanding	Robotics instruction, with proper pedagogy, can increase content knowledge, thinking skills, and science process skills, and systems understanding,
Wagner, 1999	25	Robotics and Children Science Achievement and Problem Solving	Quantitat ive, review	Robotics	Constructionism	Grades 4,5,6 primarily	Compared robotic, battery mechanism, and traditional treatments for science achievement and problem solving.	Robotics better for programming/proble m solving but both battery manipulative and robotics better than traditional treatment.
Welch, 1999	45	Analyzing the Tacit Strategies of Novice Designers	Case study	Design	Extant design process models	Grade 7	Understanding actual design strategies of novice designers	Novice designers do not follow a model/expected design strategy but used a serial approach (not considering multiple possible designs first and evaluating them). Evaluation occurred much more than the models predicted.

K. B. Wendell & Lee, 2010	6	Elementary students' learning of materials science practices through instruction based on engineering design tasks	Case study	Engineering	Situated learning, social constructionist	Grade 3	Science Content specifically materials science/engineering	Engineering based activity increased content understanding especially through the use of engineering workbooks.
K. Wendell et al., 2010		AC 2010-863: Poster, Incorporating Engineering Design Into Elementary School Science Curricula	Descriptive, quantitative	Engineering	Situated cognition, distributed cognition, social constructivism	Elementary	Science Content	Pre and post testing showed that students learned science as well as or better than those with traditional methods but also learned engineering design in the process. Discourse, oral and/or written is important.
M. K. B. Wendell & Portsmore, 2011		AC 2011-904: The Impact Of Engineering-Based Science Instruction On Science Content Understanding	Quantitative	Engineering	Learning by Design, situated and distributed cognition	Elementary	Science Content	Students showed science content gains even when controlled for teacher. Attitudes were positive towards science in engineering based and traditional classes.
Williams, Ma, Lai, Prejean, & Ford, 2007	26	Acquisition of Physics Content Knowledge and Scientific Inquiry Skills in a Robotics Summer Camp	Mixed methods	Robotics	Constructionism	Middle school	Science content knowledge and inquiry skills	Study showed content gains but not inquiry skills. However, it was only a 2-week camp.