What is Engineering?: A workshop for K-6 grade school counselors

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Introduction

Education research shows that K-12 educators and students generally have a poor understanding of what engineers look like and do (Cunningham et al., 2005; Cunningham and Knight, 2004). The U.S. Department of Labor forecasts that by the year 2012, the United States will need approximately 1.6 million individuals who are engineering educated and trained to fill the engineering employment demand (National Science Board, 2006). This indicates that it is important that educators and students begin to understand the profession of engineering and the role of engineers in order to meet the forecasted demands. In order to help students "…acquire the skills to investigate the world of work in relation to knowledge of self and to make informed career decisions" (ASCA National Model Career Development Standard A, 2003, p. 83), it is essential to provide career information about engineering to elementary students.

In a nation that was seeded by freedom and opportunity, the roots of the United States of America are grounded by hard work, innovation, and determination. Most often through identification with a worker, ages 5 to 10 is the stage of life when the concept of working becomes ingrained in the child's conception of his or her adult life (Havighurst, 1964). Immersed in a society that is dominated and driven by work, and vulnerable to social influences of prestige and gender bias, children as young as five years of age begin to postulate what career they will one day have (Gottfredson, 1981).

Young people tend to choose professions that are familiar (Parker & Jarolimek, 1997, p. 110), whether traditions in their family, or professions they have been exposed to them through education and experience. Young children can begin to gather information about careers and acquire the skills and competencies that will one day support success in the workplace (Duffy, 1989). Harkins states that since work readiness is developed over time, so it makes sense to begin with young children (Harkins, 2001). She articulates that the goals for early childhood career education should include: 1) acquiring information about various careers, 2) building self-awareness of personal interests and strengths, 3) developing positive attitudes and habits for work-readiness, 4) exploring equity issues and learning to challenge gender stereotypes, and 5) increasing competencies such as problem solving, teamwork, communication, and technology skills (Harkins, 2001).

In Kay Wahl's study on the development of elementary-aged children's career aspirations and expectations, she found that important decisions are being made by elementary-aged children about the types of careers they wish to have and expect to have, and that children may be unknowingly and unnecessarily restricting their career options, which supports previous investigations. Wahl proposed that "an appropriate goal for the career development efforts of school counselors working with elementary-aged children is to enhance students' knowledge of the array of career choices available to them and to encourage students from prematurely eliminating careers – particularly those they may deem inappropriate for their gender – that may eventually be a good match for their interests and talents (Wahl, 2005)."

The 2008-09 U.S. Bureau of Labor Statistics Report describes educational counselors as responsible for, among many things, operating career information centers and career education programs. The report describes that counselors "advocate for students and work with other individuals and organizations to promote the academic, ***career***, personal, and social development of children and youth. School counselors help students evaluate their abilities, interests, talents, and personalities to develop realistic academic and ***career goals*** (BLS, emphasis added)." The American School Counselor Association's National Standards in the academic, career, and personal/social domains are the foundation for this work. The ASCA National Model: A Framework for School Counseling Programs (ASCA, 2002), with its data-driven and results-based focus, serves as a guide for today's school counselor who is uniquely trained to implement this program. One of the ways in which elementary school counselors implement the counseling program is by providing, through school guidance curriculum, career awareness, exploration and planning (ASCA 2009).

Hoffman created a developmental curriculum for career guidance that seeks to satisfy the outlined goals and competencies of the National Guidelines for Career Development and the ASCA Model . It serves as the foundation for elementary school counselors to provide career guidance experiences that are developmentally appropriate for children in kindergarten through Grade 5 in Virginia's public schools. The following table (Table 1) is an extraction of content areas from Hoffman's curriculum that are specifically related to career awareness. Some of the key phrases are *roles*, and *kinds of work*.

Content Areas Related to Career Awareness Hoffman's Career Guidance Curriculum for Virginia Department of Education	
Grade 2	Becoming **familiar with the roles and contributions of workers** in school, home, and the community, and acquiring an understanding of the fact that people depend upon each other for services and products in school, home, and the community.
Grade 3	Recognizing the **relationship between school subjects and the kinds of work** that people do.
Grade 4	Recognizing that various **work roles are related to interests** and leisure activities and that various **work roles require abilities and skills**, personal qualities, and types of education or training.
Grade 5	Acquiring increased knowledge and understanding of the **relationship between one's favorite school subjects and various kinds of work**

Table 1 Content Areas Related to Career Awareness

Cunningham's educational research showed that K-12 teachers and students generally have a poor understanding of the *role* of engineers and the *kinds of work* that they do. The National Academy of Engineering's study, Changing the Conversation, found that the public "has a poor idea of what engineers actually on on a day-to-day basis; and there is a strong sense that engineering is not "for everyone," and perhaps especially not for girls (Changing the Conversation, p10)." If a counselor, teacher, or educator does not understand the career of engineering, would this not limit the level in which they engage in advocacy for their students? It is challenging to teach what you don't understand.

Not only are there numerous misconceptions of engineering as a discipline, but teachers tend to be very anxious to the barriers they identify between themselves and engineering. With no background to know how to converse with students about who designs technology and how they do it, educators can feel very strong barriers that limit their contribution to the development of future technical talent (Akerson and Hanuscin, 2007). Cunningham reflected on her experience teaching engineering to elementary educators:

> One of the biggest challenges to integrating engineering into elementary schools is teachers' anxiety about this new discipline. Perhaps the most important goal of professional development workshops for elementary teachers is affective—it focuses on reducing teachers' anxiety and building their self efficacy with respect to engineering.
>
> If most elementary teachers are afraid of teaching science, the notion of teaching engineering is often accompanied by terror. Much of the point of our professional development is to defuse their feeling of ineptitude through engagement. (Cunningham, 2008)

If children begin career development in elementary school, it is important for their teachers and counselors to be prepared to introduce all types of careers, especially those that will help us meet the demands of a rapidly changing world such as engineering and science (Augustine, 2007; BSCS, 2007).

Rationale

The Women of TI Fund (WTIF) is an organization that I volunteered for in 2008 in Dallas, Texas. The Women of TI Fund plans to close the gender gap in Science, Technology, Engineering and Math (STEM) professions. The Fund's mission is to increase the number of girls graduating from high school who are entering a university-level technical degree program. The strategy of the WTIF involves a three-pronged approach to target high school girls, educators and counselors. The Women of TI Fund programs include gender equity teaching strategies for educators, counselor workshops on STEM careers and physics camps for girls.[i]

As director of the counselor workshops, I was responsible for leading and coordinating the team that developed and facilitated the workshops. I led the team to create, organize, and facilitate a career workshop on engineering for all Plano ISD counselors (elementary through high school, ~150) in October of 2008. Given the strategy of the WTIF, they continue to offer counselor workshops on STEM careers. I have been in contact with my former colleagues and mentors in the WTIF, and they are very interested in my research and proposal for an improved counselor workshop. Tegwin Pulley, former Vice President of TI and current CEO of Tegwin Pulley Inc[ii], a consulting and management services firm, will hold the title of Executive Director and will work directly with WTIF leadership to solidify strategic plans, scaling partnerships and deployment for all WTIF programs. Tegwin is a mentor of mine and has invited me to share with her my proposal this June. My goal is to take a similar leadership role as I did in 2008 and facilitate the 2010 counselor workshops. There is potential for this to provide a research bed for future studies, as well as provide me with additional funding.

Design Site

The design site for this proposal is a professional development workshop for K-6 grade school counselors. I am assuming the counselors are either not familiar with or have misconceptions of career field of engineering (Changing the Conversation, p10), that they are responsible for engaging students in career exploration (ASCA, 2002), and that they are interested in engaging students in career exploration. Ideally, this would be a required 8 hour professional development workshop in a school district that supports STEM initiatives.

Overall Alignment of CAP

In order to effectively design a professional development directed towards K-6 counselors, I must first consider what I want them to know upon completion of the workshop, then determine acceptable evidence of these identified desired results, and finally plan the learning experiences and methods of instruction. Wiggins & McTighe identify this process as *Backwards Design*, as shown in Figure 1. This is the framework I will use to construct integrated content, assessment, and pedagogy segments for a professional development workshop for K-6 Counselors.

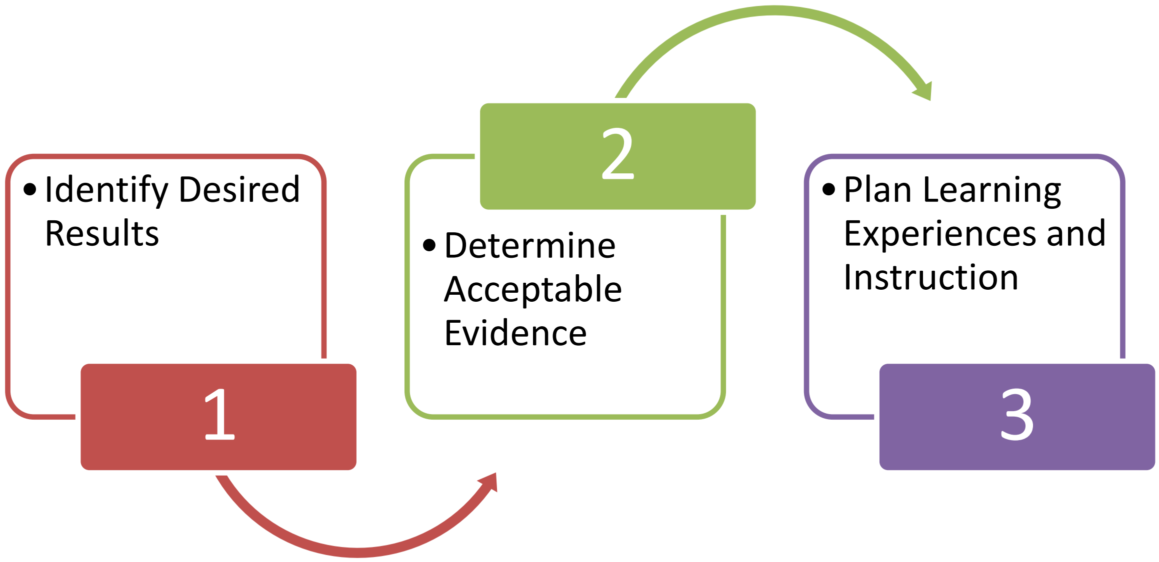


Figure 1 Wiggins & McTighe Stages of Backwards Design

The following sections will discuss the content of the professional development workshop for K-6 counselors tied to learning objectives, the methods for assessing evidence of the learning objectives, and the learning experiences and pedagogy methods prepared to provide for the desired learning.

CONTENT

The first step in constructing an effective professional development is to identify the desired results. In order to help me create specific learning objectives, I clarify content priorities by using another framework created by Wiggins & McTighe. This framework challenges the curriculum designer to distinguish between "knowledge" and "understanding" and consider taxonomies of understanding. Figure 2 highlights the nested content priorities I've articulated in the three domains: worth being familiar with, important to know and do, and enduring understandings. The enduring understandings are the big ideas that will anchor the workshop, and also specify the transfer tasks at the heart of the subject (Wiggins & McTighe).

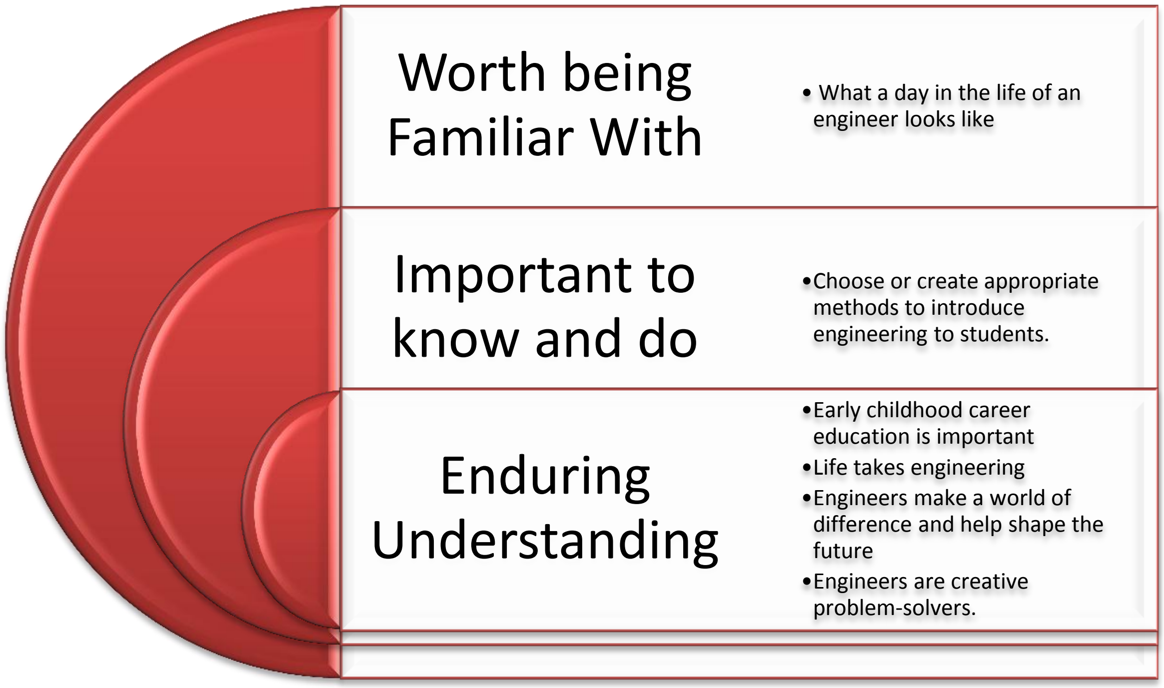


Figure 2 Clarifying Content Priorities (Wiggins & McTighe)

"Enduring Understanding"

The first anchor, or enduring understanding, in this workshop is: *early childhood career education is important*. This is grounded in Harkins research where she stated that since work readiness is developed over time, so it makes sense to begin with young children (Harkins, 2001). She articulates that the goals for early childhood career education should include: 1) acquiring information about various careers, 2) building self-awareness of personal interests and strengths, 3) developing positive attitudes and habits for work-readiness, 4) exploring equity issues and learning to challenge gender stereotypes, and 5) increasing competencies such as problem solving, teamwork, communication, and technology skills (Harkins, 2001).

The remaining three anchors of enduring understanding are grounded in the National Academy of Engineering's (NAE) study: Changing the Conversation. *Life takes engineering* is a theme identified that focuses on the field's essential role and life-changing work. The goal is for the counselors to become aware of and identify the vast work of engineers all around them, and realize that *life takes engineering*. *Engineers make a world of difference and help shape the future* is another message tested in the NAE study. From new farming equipment and safer drinking water to faster electric cars and faster microchips, engineers use their knowledge to improve people's lives in meaningful ways. In addition, engineers use the latest science, tools, and technology to bring ideas to life. *Engineers are creative and collaborative problem-solvers* that have a vision for how something should work and are dedicated to making it better, faster, or more efficient. (Changing the Conversation, p6-8)

Each of these four "big ideas" are the cornerstones of understanding. (Figure 3)

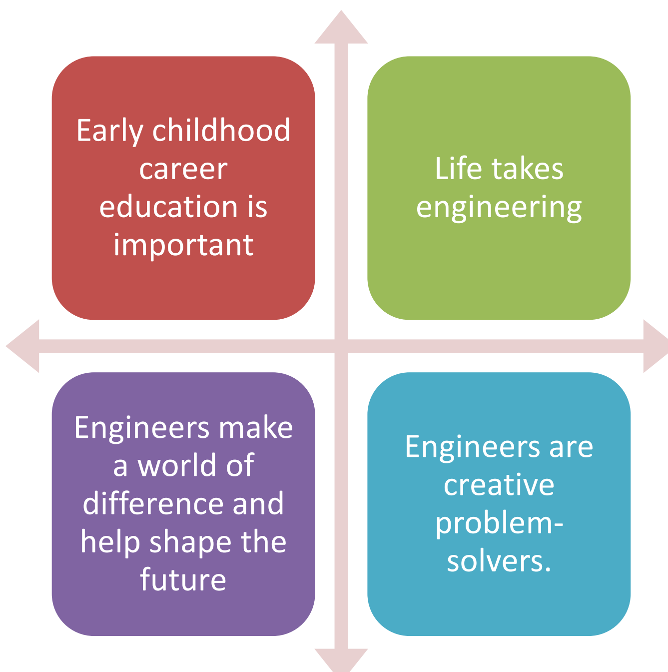


Figure 3 Enduring Understanding Cornerstones

"Important to know and do"

The application of the previously mentioned big ideas is what concludes the second tier of this priority framework: *Choose or create appropriate methods to introduce engineering to students.* It is unreasonable to assume we can provide sufficient content knowledge to the counselors nor expect them to become engineering teachers. We can however, provide them with resources and overviews of some of the programs available to them to *choose* as instruments of introduction or instruction of engineering. Some of these resources may include the Boston Museum of Science's Engineering is Elementary, and Project Lead the Way.

Some general principles for K-12 engineering education will be introduced as a guideline for *creating* or preparing engineering exploration activities, as defined by the National Academies report on Engineering in K-12 Education.

- Principle 1: K-12 engineering education should emphasize engineering design.
- Principle 2: K-12 engineering education should incorporate important and developmentally appropriate mathematics, science, and technology skills.
- Principle 3: K-12 engineering education should promote engineering habits of mind (systems thinking, creativity, optimism, collaboration, communication, and attention to ethical considerations)

"Worth being familiar with"

Based on the conclusion by the Changing the Conversation study that the "public has a poor idea of what engineers actually do on a day-to-day basis," it will valuable for the counselors to have a glimpse into *A day in the life of an engineer.*

Learning Objectives

The two key objectives for the counselors are:

1. Counselors should be able to discuss the importance of career exploration for K-6 children with their colleagues, and develop a lesson plan/proposal for career exploration in engineering for their students.
2. Counselors should be able to describe what engineering is to a K-6 student, based on the cornerstones (Figure 3): life takes engineering, engineers make a world of difference and help shape the future, and engineers are creative problem-solvers.

Using Wiggins and McTighe's Six Facets of Understanding(Figure 4), we will be able to integrate these learning objectives with effective assessments.

When we really understand, we…

- *Can **explain - cognitive***
- *Can **interpret - cognitive***
- Can ***apply - cognitive***
- Have ***perspective - affective***
- Can ***empathize - affective***
- Have ***self-knowledge - metacognitive***

Figure 4 Six Facets to Build Assessments for Understanding, Wiggins & McTighe, 2005 p163

Table 2 Facets for Understanding for Learning Objectives

	Facets for Understanding		Learning Objective 1	Learning Objective 2
1	Can explain	cognitive	Can explain why K-6 career exploration is important.	Can explain some disciplines of engineering
2	Can interpret	cognitive	Can interpret and describe careers for their students	Can interpret what engineering is to colleagues and students.
3	Can apply	cognitive	Can apply knowledge of careers and student development to create career exploration opportunities.	Can apply knowledge of engineering disciplines to recognize engineering around them.
4	Have perspective	affective	Have perspective to recognize opportunities for career exploration	Have perspective to see why engineers are important.
5	Can empathize	affective	Can empathize with students who are showing exemplar signs of interest or strength for particular careers	Can empathize to see why we need more engineers.
6	Have self-knowledge	metacognitive	Have self-knowledge to confidently talk to students (teachers/administration) about career exploration.	Have self-knowledge to confidently talk about engineering.

We can apply the six facets for understanding to Learning Objective 1(Table 2):

- Can explain why K-6 career exploration is important.
- Can interpret and describe careers for their students
- Can apply knowledge of careers and student development to create career exploration opportunities.
- Have perspective to recognize opportunities for career exploration
- Can empathize with students who are showing exemplar signs of interest or strength for particular careers
- Have self-knowledge to confidently talk to students (teachers/administration) about career exploration.

We can apply the six facets for understanding to Learning Objective 2 (Table 2):

- Can explain some disciplines of engineering
- Can interpret what engineering is to colleagues and students.
- Can apply knowledge of engineering disciplines to recognize engineering around them.
- Have perspective to see why engineers are important.
- Can empathize to see why we need more engineers.
- Have self-knowledge to confidently talk about engineering.

Structure

In order to build the momentum and provide a richer understanding, I believe it is important to structure the content so that it builds a coherent story for the counselors. I want them first to hear and learn the importance of career exploration for children in grades K-6. Then, I will introduce a section on "what is engineering?" After learning of various disciplines of engineering, and some stories of the significant impact of engineering on our culture and civilization, I want to talk about what engineers look like, and what they know. See Appendix 1 for a sample agenda, and Appendix 2 for a concept map of the content.

1. Early childhood career education is important
    - Why is career exploration in K-6 important?
    - What does this look like?
    - What are some examples of how to provide opportunities?
2. Life takes engineering
    - What is engineering? (Posit questions to determine current mental models of engineering, dispel myths and misconceptions – based on Changing the Conversation research)
    - Where is engineering? (become aware of and identify the vast work of engineers all around them)

3. Engineers make a world of difference and help shape the future
    - What do engineers do? A glimpse into the many disciplines of engineering
    - What is a day in the life of an engineer like?
4. Engineers are creative problem-solvers.
    - How do engineers think? Example of the Engineering Design Process (Boston Museum of Science Model[iii])
    - What does a future engineer look like?
    - How do you help a student become interested in engineering and adequately prepare for this career beginning in grade school?

Bottlenecks

In designing the content, it is first necessary to identify the points in the course where a significant portion of the students learning may be interrupted, also referred to as the bottlenecks of the course (Pace & Middendorf). The National Research Council's report on *How People Learn* found that one of the key principles is that people learn by using what they know to construct new understandings (pp14-16, 68-70). Therefore drawing out and working with existing understandings is important for learners of all ages. The counselor's existing knowledge about early career exploration and engineering must be identified and addressed, as I believe this will be the greatest bottleneck. In addition, prior knowledge also includes knowledge that learners acquire because of their social roles, such as those connected with race, class, gender, and their culture and ethnic affiliations (HPL, 72).

A few examples of existing knowledge or understanding that may potentially hinder learning transfer:

- "Why do young kids need to think about their career? They have the rest of their life to do that."

- "Career exploration is not important when you consider everything else I have to do on a daily basis."
- "Engineering is boring and for the nerdy types."
- "Engineering is best for boys strong in math and science."
- "Engineering isn't that important."

The counselors will have strong misconceptions or understandings about early career exploration and engineering, though perhaps different from these listed. Therefore, it is necessary to develop the pedagogy and assessment in a way that makes student's thinking visible in order to help them reconceptualize faulty conceptions. This will provide for greater learning transfer and cognition.

ASSESSMENT

Assessment is key in developing quality programs. Not only is assessment valuable in the process of evaluating the program, but it is important to assess if the participants are learning what we've designed for them to learn. This includes both formative and summative measures. Wiggins & McTighe (2005) state that "our theory of understanding contends that contextualized application is the appropriate means of evoking and assessing enduring understandings," therefore their theory will influence the assessment choices for this program. Using the assessment triangle framework established by James Pellegrino (Figure 5), effective assessments can be aligned with our learning objectives. The two main learning objectives for this program can be broken down into four claims that need to be assessed. Table 3 and Table 4 articulate the assessment method for each claim, and include each of the three corners of Pellegrino's Triangle: observation, interpretation, and cognition. "The corners of the triangle (Figure 5) represent the three key elements underlying any assessment: a model of student *cognition* and learning in the domain, a set of beliefs about the kinds of *observations* that will provide evidence of students' competencies, and an *interpretation* process for making sense of the evidence (Pellegrino)."

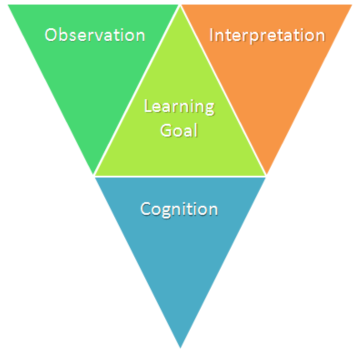


Figure 5 Pellegrino's Assessment Triangle

Table 3 Learning Objective 1 Assessment Table

Learning Objective		Claim		Type of Assessment	Task/Observation	Evidence/Interpretation	Cognitive Theory
1	Counselors should be able to discuss the importance of career exploration for K-6 children with their colleagues, and develop a lesson plan/proposal for career exploration for their students that includes engineering.	1a	Counselors will be able to discuss the importance of career exploration for K-6 children with their colleagues.	Observation/Dialogue	The counselors will be grouped at each table with the colleagues from their particular schools (usually 4-5 counselors). They will be asked to do a Think-Pair-Share with a colleague at their table about the importance of career exploration for K-6 children. They will then discuss with the rest of their colleagues at the table.	Facilitators will observe the dialogues of the teachers, and offer support and scaffolding where necessary. Acceptable evidence will include teachers actively participating in the TPS and group discussion.	Conversation Theory (Pask)
		1b	Counselors will develop a lesson plan/proposal for career exploration in engineering for their students.	Performance Project	The counselors will be grouped at each table with the colleagues from their particular schools (usually 4-5 counselors) and they will be challenged to create a lesson plan/proposal for career exploration in engineering that they can immediately take back and propose for implementation.	Facilitators will provide assistance in the process, and counselors will submit a copy of their lesson plan/proposal for further review and follow-up with feedback.	Situated Learning Theory (J. Lave)

Claim 1a: Counselors will be able to discuss the importance of career exploration for K-6 children with their colleagues.

The type of assessment to be used for Claim 1a is a formative measure, observation of participant dialogue. The counselors will be grouped at each table with the colleagues from their particular schools (usually 4-5 counselors). They will be asked to do a Think-Pair-Share (TPS)[1] with a colleague at their table about the importance of career exploration for K-6 children. They will then discuss with the rest of their colleagues at the table. Facilitators will observe the dialogues of the teachers, and offer support and scaffolding where necessary. Acceptable evidence will include teachers actively participating in the TPS and group discussion. This assessment activates a learning theory proposed by Gordon Pask (1975), the conversation theory where learning occurs through conversations about a subject matter which serve to make knowledge explicit.

Claim 1b: Counselors will develop a lesson plan/proposal for career exploration in engineering for their students.

The type of assessment to be used for Claim 1a is a summative measure, a performance task. This is an authentic project that is relevant to the participant, can be highly personalized, and allows the participants to address their specific audience (Wiggins & McTighe, 2005). The counselors will be grouped at each table with the colleagues from their particular schools (usually 4-5 counselors) and they will be challenged to create a lesson plan/proposal for career exploration in engineering that they can immediately take back and propose for implementation. They will be presented with a model for creating a lesson plan (Appendix 3**Error! Reference source not found.Error! Reference source not found.**), and a rubric (to be designed) for evaluation. Facilitators will provide assistance in the process, and counselors will submit a copy of their lesson plan/proposal for further review and follow-up with feedback.

This assessment activates a learning theory proposed by J. Lave, the situated learning theory. Knowledge needs to be presented in an authentic context; "situated" by settings and applications that would normally involve that knowledge. Situated learning theory requires social interaction

[1] Think-Pair-share is a short collaborative learning structure first introduced by Lyman (1981). The facilitator first poses a challenging question where the participants are asked to take a few minutes to think about their response. Then each participant pairs with a classmate to share and discuss their ideas and answers to the proposed question. This method is valuable because it allows each participant to construct their own knowledge and have the opportunity to discuss their ideas.

and collaboration for learning to take place. As summarized on Greg Kearsley's Theories Into Practice Database:

> Social interaction is a critical component of situated learning -- learners become involved in a "community of practice" which embodies certain beliefs and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its center, they become more active and engaged within the culture and hence assume the role of expert (Kearsley, 2010).

Table 4 Learning Objective 2 Assessment Table

Learning Objective		Claim		Type of Assessment	Task/Observation	Evidence/Interpretation	Cognitive Theory
2	Counselors should be able to describe what engineering is to a K-6 student, based on the cornerstones (Figure 3): life takes engineering, engineers make a world of difference and help shape the future, and engineers are creative problem-solvers.	2a	Based on the cornerstones (Figure 3), counselors should be able to describe to a K-6 student what engineering is and what it means to them.	Observation/Dialogue	Counselors will do a TPS and role play as a student as the other shares what engineering is based on the cornerstones. Counselors will be challenged to share a story they've learned about engineering.	Acceptable evidence will include counselors confidently talking about engineering.	Social Learning Theory (Bandura)
		2b	Counselors should be able to describe what engineering means to them and why.	Academic Prompts (Pre/Post)	Counselors will answer an open-ended question before and after the workshop: What engineering means to me and why?	A short response that charges the counselors to think critically about engineering, and prepare a specific academic response they can use to share engineering with their students.	Transformative Theory (J. Mezirow)

Claim 2a: counselors should be able to describe to a K-6 student what is engineering.

As addressed in the literature review, teachers tend to be very anxious to the barriers they identify between themselves and engineering. With no background to know how to converse with students about who designs technology and how they do it, educators can feel very strong barriers that limit their contribution to the development of future technical talent (Akerson and Hanuscin, 2007).

The type of assessment to be used for Claim 2a is a formative measure, observation of participant dialogue. Counselors will do a TPS and role play as a student as the other shares what engineering is based on the cornerstones (Figure 3). Counselors will be challenged to share a story they've learned about engineering. A few volunteers will be invited to share their definition of engineering for the entire group. Acceptable evidence will include counselors confidently talking about engineering. If possible, it would be ideal to have the teachers practice with students, but there may be constraints in facilitating this scenario.

This assessment activates a learning theory proposed by Bandura, the Social Learning Theory. Bandura (1977) states: "Learning would be exceedingly laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action." Through working together to establish their definitions of engineering, they will be able to construct a richer knowledge and more enduring understanding of engineering.

Claim 2b: Counselors should be able to describe what engineering means to them and why.

The type of assessment to be used for Claim 2a is a summative measure, an academic prompt taken pre and post workshop. According to Wiggins & McTighe (2005), an academic prompt is an "open ended question or problem that require the student to think critically, not just to recall knowledge, and to prepare a specific academic response which may involve analysis, synthesis, and evaluation." Counselors will answer an open-ended question before and after the workshop: *What does engineering means to me and why?* The prompt for a short response challenges the counselors to think critically about engineering, and prepare a specific academic response they can use to share engineering with their students.

This assessment activates a learning theory proposed by Mezirow, the transformative theory. The Transformational Learning Theory originally developed by Jack Mezirow is described as being "constructivist, an orientation which holds that the way learners interpret and reinterpret their sense experience is, central to making meaning and hence learning" (Mezirow, 1991). Meaning structures, a major component of the theory, are understood and developed through reflection.

PEDAGOGY

The instructor will act as a facilitator throughout the program, engaging students in active discussion that invites inquiry, and leads to *enduring* understanding. There will be minimal direct instruction, with the primary method of discovery being through inquiry based & experiential learning. Malcolm Knowles articulated the difference between the strategies of instruction for children and adults. His theory for adult learning is called andragogy. Andragogy makes the following assumptions about the design of learning: (1) Adults need to know why they need to learn something (2) Adults need to learn experientially, (3) Adults approach learning as problem-solving, and (4) Adults learn best when the topic is of immediate value (Kearsley, 2010b). These four assumptions are the guiding principles for the design of this program.

Learner Expectations

The participants, or learners, will be expected to have active and thoughtful engagement in class discussions. Participants are asked to be respectful of others by turning off their cell phones and limiting interruptions to the class by taking full advantage of breaks.

There will be two items submitted for review and feedback:

1) Counselors will develop a lesson plan/proposal with their colleagues for career exploration in engineering for their students.
2) Counselors will complete a thoughtful and reflective response to the following: *What does engineering means to me and why?*

Teacher Expectations

As facilitator, the goal is to create a safe and engaging environment for learning. Their responsibility is to take into account where students are coming from, push on prior conceptions, and provide opportunities for students to achieve course learning objectives through authentic and rich learning experiences.

Alignment

Table 5 highlights three key alignments between the types of assessments, the cognitive learning theories, and the pedagogical theories. The following sections will further explain these alignments.

Table 5 Alignment of Assessment, Cognition & Pedagogy

Alignment	Types of Assessment	Cognitive Theories	Pedagogy Theory
1	Performance Project	Situated Learning Theory (J. Lave)	Kolb - Experiential Learning Theory
2	Observation/Dialogue	Conversation Theory (Pask), Social Learning Theory (Bandura)	Welty - Discussion Method of Teaching
3	Academic Prompts (Pre/Post)	Transformative Theory (J. Mezirow)	Keller - Principles of Motivation

Alignment 1

For learning to take place, situated learning theory requires social interaction and collaboration, using knowledge that is presented by the facilitator in an authentic context. This provides for interactive inquiry based learning, which is based on the early constructivist theorists such as Bruner, Dewey and Piaget. Dimitrios Thanasoulas writes, “It is the learner who interacts with his or her environment and thus gains an understanding of its features and characteristics. The learner constructs his own conceptualizations and finds his own solutions to problems, mastering autonomy and independence. ” Autonomy and independence are characteristics of the Deci & Ryan’s self-determination theory which when encouraged by a teacher can result in intrinsically motivated learning (Deci & Ryan, 1994). Experiential learning theory defines learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience (Kolb, 1984)." The process and experience of developing a lesson plan/proposal for career exploration in engineering, will enable the counselors to not only meet the objective, but gain an enduring understanding of engineering & career exploration.

Alignment 2

Using Welty's Discussion Method of Teaching, the class can be facilitated in a way that supports Pask's conversation theory and Bandura's social learning theory. Welty proposes that after the content has been established, develop an outline of questions to pose to students while using the board to make notes organizing the discussion (Welty, 1989). (Additionally, He suggests a classroom setting of small tables arranged in a u-shape, with room for the instructor to roam around the room.) This aligns with the assumptions of adult learning, and with the observation/dialogue assessment method of two of my claims (Claim 1a & 2a).

Alignment 3

Keller (1979) identified four conditions for learning based on a review and synthesis of motivational literature:

> In brief, we can say that in order to have motivated students, their curiosity must be aroused and sustained; the instruction must be perceived to be relevant to personal values or instrumental to accomplishing desired goals; they must have the personal conviction they will be able to succeed; and the consequences of the learning experience must be consistent with the personal incentives of the learner.

These conditions closely align with Knowles (1989) assumptions of adult learning, or andragogy. However, the key is *motivation.* The process of the instructor scaffolding the motivation of the participants will enable them engage the transformative learning theory to use their *enduring* understandings and reflectively write an authentic response to the academic prompt, *What does engineering means to me and why?*

SUMMARY

This proposal for a professional development workshop for K-6 grade school counselors, targeted at the WTIF organization in Dallas, Texas, will enable participants to gain the following fundamental and enduring understandings:

- Early childhood career education is important
- Life takes engineering
- Engineers make a world of difference and help shape the future
- Engineers are creative problem-solvers.

The two key objectives for the counselor participants are:

1. Counselors should be able to discuss the importance of career exploration for K-6 children with their colleagues, and develop a lesson plan/proposal for career exploration in engineering for their students.
2. Counselors should be able to describe what engineering is to a K-6 student, based on the cornerstones (Figure 3): life takes engineering, engineers make a world of difference and help shape the future, and engineers are creative problem-solvers.

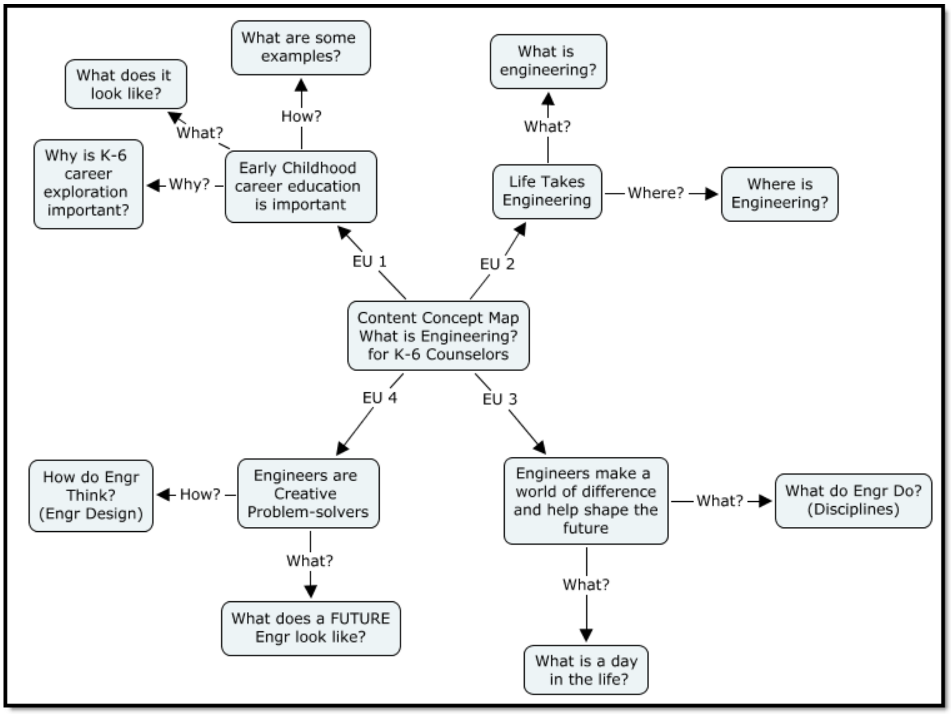
If children begin career development in elementary school, it is important for their teachers and counselors to be prepared to introduce all types of careers, especially those that will help us meet the demands of a rapidly changing world such as engineering and science (Augustine, 2007; BSCS, 2007).

APPENDIX

Appendix 1 Sample Agenda

Minutes	Agenda
5	Welcome
20	Design Squad Paper Table Challenge
15	Introduction (Agenda, Facilitators, etc)
60	Early childhood career education is important
	TPS: Evaluate claim 1a
	Group Discussion
10	BREAK
60	Life takes engineering
	TPS: Evaluate claim 2a
	Group Discussion
10	BREAK
120	Engineers make a world of difference and help shape the future
	Panel of Engineers
	Case Studies of Engineering Disciplines in Small Groups
10	BREAK
60	Engineers are creative problem-solvers.
	Engineering Design Process, Paper Tables Revisited
	Reflection: Evaluate Claim 2b
5	BREAK
60	Lesson Planning
15	Conclusion

Appendix 2 Content Concept Map



Appendix 3 Lesson Planning Model (MS Template)

Type the name of the lesson here

Grade Level: ________ **Subject:** ____________________ **Prepared By:** ______________________

Overview & Purpose	**Education Standards Addressed**
What will be learned and why it is useful.	What state/county education standards that this lesson satisfies.

	Teacher Guide	**Student Guide**	
Objectives (Specify skills/information that will be learned.)			**Materials Needed** • Paper • Pencil • Others
Information (Give and/or demonstrate necessary information)			
Verification (Steps to check for student understanding)			**Other Resources** (e.g. Web, books, etc.)
Activity (Describe the independent activity to reinforce this lesson)			
Summary			**Additional Notes**

PAPER TABLE

DESIGN SQUAD
PBS.
as built on TV
pbs.org/designsquad

YOUR CHALLENGE

Design and build a table out of newspaper tubes. Make it at least eight inches tall and strong enough to hold a heavy book.

BRAINSTORM & DESIGN

Look at your materials and think about the questions below. Then sketch your ideas on a piece of paper or in your design notebook.

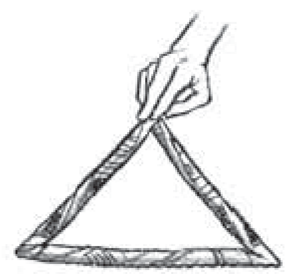
1. How can you make a strong tube out of a piece of newspaper? (This challenge uses tubes because it takes more force to crumple paper when it's shaped as a tube.)
2. How can you arrange the tubes to make a strong, stable table?
3. How can you support the table legs to keep them from tilting or twisting?
4. How level and big does the table's top need to be to support a heavy book?

MATERIALS (per person)

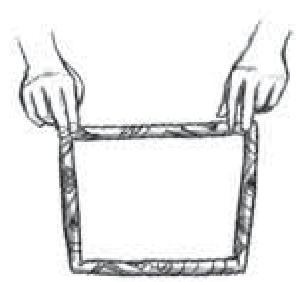
- 1 piece of cardboard or chipboard (approximately 8 ½ x 11 inches)
- heavy book (e.g., a textbook or telephone book)
- masking tape
- 8 sheets of newspaper

BUILD, TEST, EVALUATE & REDESIGN

Use the materials to build your table. Then test it by carefully setting a heavy book on it. When you test, your design may not work as planned. If things don't work out, it's an opportunity—not a mistake! When engineers solve a problem, they try different ideas, learn from mistakes, and try again. Study the problems and then redesign. For example, if:



- the tubes start to unroll—*Re-roll them so they are tighter. A tube shape lets the load (i.e., the book) push on every part of the paper, not just one section of it. Whether they're building tables, buildings, or bridges,* **load distribution** *is a feature engineers think carefully about.*
- the legs tilt or twist—*Find a way to stabilize and support them. Also check if the table is lopsided, too high, or has legs that are damaged or not well braced.*
- a tube buckles when you add weight—*Support or reinforce the weak area, use a wider or thicker-walled tube, or replace the tube if it's badly damaged. Changing the shape of a material affects its strength. Shapes that spread a load well are strong. Dents, creases, and wrinkles that put stress on some areas more than others make a material weaker.*
- the table collapses—*Make its base as sturdy as possible. Also, a table with a lot of triangular supports tends to be quite strong. A* **truss** *is a large, strong support beam. It is built from short boards or metal rods that are arranged as a series of triangles. Engineers often use trusses in bridges, buildings, and towers.*



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