Exploring the Dimensions of Problem-solving Ability on High-achieving Secondary Students: A Mixed Methods Study

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Abstract

This mixed-methods study investigated the relationship between self-concept and problem-solving style and how these two constructs compared and contrasted in regards to a participant's perception of his or her problem-solving ability. The 86 study participants were high-achieving rising 11th and 12th grade students attending a summer enrichment program for agriculture. This study used a concurrent triangulation mixed methods design. The quantitative aspect of the study employed two instruments, SDQ III to test perceived self-concept and the VIEW to determine the perceived problem-solving style. Concurrent with this data collection, 13 open-ended interviews were conducted to explored the description of the problem-solving process during a problem-solving event. The reason for collection of both quantitative and qualitative data was to bring together the strengths of both forms of research in order to merge the data to make comparisons and further the understanding of problem-solving ability of high-achieving youth.

The study discovered that self-concept and problem-solving style have a weak relationship for many of the constructs and a negative relationship between two of constructs. The qualitative component revealed that high-achieving youth had clear definitions of problem-solving, a rich and descriptive heuristic approach, a clear understanding of which resources provided key information, and a strong depiction of themselves as problem-solver. An emergent concept from the research was the participants' perceptions of the team-based structure and how the inclusion of multiple ability levels versus high ability levels affected the participants'

perceptions of solving a problem in a team situation. The mixing component of the study depicted the influence of self-concept on the problem-solving style.

This study was an initial exploration of the relationship between self-concept and problem-solving and compared the current results with previous research. It extended and connected the previous research areas of self-concept and problem-solving style. As an initial study, it led to recommendations for further research across education as well as additional exploration of the emergent relationships identified. Finally, the study denoted the importance of mixed-methods research due to the interconnectivity between self-concept and problem-solving style and the participant descriptions of themselves as problem-solvers.

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Chapter I

Introduction

This dissertation is a report of a mixed methods study based on the theories of social cognitive and social comparative theory specifically Big-Fish-Little-Pond Effect and Reflected Glory Effect. This first chapter presented the background for the study, the problem statement, the purpose, and the research questions. Chapter I culminated by noting the research methods, delimitations and limitations, and defining key terms of the study.

Background of the Study

Researchers in the fields of education and psychology investigate problem-solving style and self-concept as separate but significant entities that influence a student's problem-solving ability (Dermitzaki, Leondari, & Goudas, 2009, p. 65; Pinquart & Sorensen, 2001; Sanchez & Sanchez-Rhode, 2003). Self-concept is an individual's self-perception and in previous research has been shown to influence a person's academic and extra-curricular performance (Judge, Erez, & Bono, 1998; Marsh, Byrne, & Shavelson, 1988; Marsh, Gerlach, Trautwein, Ludtke, & Brettschneider, 2007). Problem-solving style is a way to recognize the interaction of a person with the problem-solving process and the variations of that interaction (Treffinger, Selby, & Isaksen, 2008). Problem-solving is one of the fundamentals in education that enables a person to creatively generate and critically evaluate ideas (Mayer, 1983, 1998). Creative thinking along with critical thinking, as in the case of problem-solving, is essential for the development of a well-rounded productive thinker (Marzano, 1992; Marzano, Norford, Paynter, Pickering, & Gaddy, 2001). This study explored the relationships between problem-solving style, self-concept. Additionally, this study investigated how individuals describe problem-solving ability regarding a set problem.

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Self-concept. Although there is a considerable body of literature on self-concept, there is no universally accepted definition for the term. For the purpose of this work, self-concept will be defined as "the perception of self" (Marsh, Trautwein, Ludtke, & Koller, 2008, p. 510). This follows the current practice of defining self-concept according to a theoretical model.

This research is based in a multidimensional, hierarchical model, first proposed by Shavelson, Hubner, and Stanton in 1976 and revised by Shavelson and others in subsequent years, in which the factors of self-concept are characterized as being "relatively uncorrelated" (Marsh & Craven, 2006, p. 136). Multidimensionality implies that self-concept components can be interpreted as separate constructs even though they are interrelated. Self-concept is made up of multiple dimensions ranging from personality factors to academic achievement (Sanchez & Sanchez-Rhode, 2003). The construct is useful in that it can assist in predicting how someone will act. Simply stated, a person thinking they have the ability to perform and reacts to the action determines self-concept. Within this framework, several factors influence the development of an individual's self-concept.

Self-concept evolves as a response to developmentally related emergence of domain and situation specific self-evaluations (Byrne & Shavelson, 1996). Similar to various developmental tasks and cognitive abilities being associated with different levels of maturity, the ability to form self-perceptions is also associated with different levels of maturity (Harter, 1999). As self-concept develops, it is also impacted by its relation in its hierarchical structure.

Due to self-concept being hierarchical in nature, the lower the levels of this hierarchy, the more specific self-concept becomes and the more susceptible to change it becomes. This malleability makes self-concept a critical component of student evaluation and academic performance (Sanchez & Sanchez-Rhode, 2003). The relationship between the dimensions of

self-concept, gender, and achievement have been explored in abundance, however there are no decisive studies that provide a direct link between the dimensions of self-concept, gender, and performance (Sanchez & Sanchez-Rhode). Support for the multidimensionality of self-concept is supported by the works of Marsh and Craven (2006) wherein they argue that the individual constructs of self-concept, including verbal, math, academic, and problem-solving, are strongly correlated with their content areas. Therefore, math self-concept would be strongly related to the math content area. Other research has shown that the levels of self-concept determine the degrees of academic performance and that academic performance and self-concept influence each other mutually (Byrne & Shavelson, 1996; Marsh, et al., 1988). Thus, a unique aspect of self-concept is its influence on cognitive abilities such as academic performance.

Problem-solving style. In the creative problem-solving theoretical framework, individual differences play a critical role in how a person solves a problem (Treffinger & Isaksen, 2005). These individual differences are categorized as problem-solving style. Problem-solving style can be best defined as "consistent individual differences in the ways people prefer to plan and carry out generating and focusing, in order to gain clarity, produce ideas, or prepare for action" (Selby, Treffinger, Isaksen, & Lauer, 2004, p. 222). Problem-solving style provides the learner an opportunity to understand how their reactions and perceptions can influence their problem-solving ability and its impact on ingenuity (Selby, et al.). The varying problem-solving styles are considered to be important, beneficial aspects of society with no one style being the preferred style (Treffinger, et al., 2008). It should also be noted that no style is considered to be more creative than another; rather the preference in style impacts how a person prefers to solve a problem and the methods he or she may use in order to do so (Treffinger, et al.).

When examining problem-solving style and its impact on performance, individuals with a higher self-concept of problem-solving performed better in the academic setting (Baker, 2003). Within an academic setting, Lewis and Smith (2008) found that placing students of varying problem-solving styles in a group increased creativity, originality, collaboration, and performance scores over that of a group with all one type of problem solver.

High-achieving youth. In high-achieving populations, the literature has depicted non-cognitive outcomes such as self-concept as evaluation measures to examine the effects of specialized programs such as pull-out programs, summer programs, and residential programs (Cunningham & Rinn, 2007; Marsh & Hau, 2003; Rinn, 2006; Rinn, Jamieson, Gross, & McQueen, 2009). Rinn stated "a change in environment can influence a student's self-perception, leading educators and researchers to be concerned about the potential effects of such programs" (Rinn, p. 65). An increase in non-cognitive outcomes would validate the effectiveness of such programs, whereas a decrease in non-cognitive outcomes would raise concerns over the impact of such programs (Brounstein, Holahan, & Dreyden, 1991). Additionally, non-cognitive outcomes provided a means to evaluate the socio-emotional needs of the youth. High-achieving youth have complex socio-emotional needs with specificity to peer relationships due to the challenge that they present (Olszewski-Kubilius, 2010; Olszewski-Kubilius & Kulieke, 1989). Typically high-achieving youth have higher emotional and intellectual maturity that other youth of a similar age thus causing peer relationships to be hard to form and maintain (Webb, Meckstroth, & Tolan, 1994).

Within the social context, the literature depicted mixed results. Some research indicated significant positive non-cognitive outcomes for high-achieving youth as compared to non-high-achieving youth (Bain & Bell, 2004). However research has shown in opposite-sex

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relationships, non-high-achieving youth have higher self-concept than their high-achieving counterparts (Mayseless, 1993). Byrne and Shavelson (1996) found that social self-concept differentiated with age. Therefore, comparing primary-aged youth to secondary-aged youth would produce skewed results. In addition to social aspects being impacted by aged, these aspects are also impacted by gender (Marsh, 1988; Marsh & Craven, 2006). However, research results for both gender and age have varied from significance to no difference, thus maintaining the necessity for research continuation (Brounstein, et al., 1991; Cunningham & Rinn, 2007; Rinn, 2006; Rinn, et al., 2009). Rumberger and Palardy (2005) postulated that educational success is not only represented by academic achievement but also non-cognitive outcomes. Positive self-concept is viewed as an important construct influencing student achievement (Wright & Leroux, 1997).

Theoretical Framework

The basis of this study was a theoretical framework grounded broadly in the theory of social cognitive theory more specifically social comparisons theory and most specifically Big-Fish-Little-Pond Effect (BFLPE) and Reflected Glory Effect (RGE). Within the framing of this research, it is important to recognize social comparison theory and the influence of motivation over learning. In the context of social comparison theory, Bandura (1986, 1989b, 1991) viewed motivation as a "goal directed behavior" that is influenced by an individual's expectations toward the action outcome and their self-perception of the action i.e. a problem-solving task. Similarly, social comparison theory acknowledges the influence of the social context on an individual's personal beliefs (Bandura, Caprara, Barabaranelli, Pastorelli, & Regalia, 2001). This study investigated the impact on specific self-concept aspects and problem-solving style associated with BFLPE and RGE as compared to problem-solving ability. Social cognitive

theory provides the basis for connecting the cognitive and non-cognitive aspects within a social context.

Social cognitive theory. Social cognitive theory views goals and expectations as critical modes of learning. Bandura (1986, 1989b, 1991) depicted motivation as a goal directed behavior. This behavior is influenced by an individual's outcome expectations and his or her self-perception about their ability to perform those actions (Zimmerman, Bandura, & Martinez-Pons, 1992). Within the dichotomy of social cognitive theory, other attributes such as learning styles, like problem-solving style, influence motivation due to their impact on outcomes and expectations (Bandura, et al., 2001; Bussey & Bandura, 1999; Wood & Bandura, 1989).

Important motivational mechanisms are goal setting and self-evaluation (Bandura, et al., 2001). Motivational factors influence goal setting. How an individual perceives their progress and their ability to accomplish the task assists or prevents an individual from achieving their goal (Zimmerman, et al., 1992). Goal setting and motivational factors work in conjunction with each other and individuals act in a manner to achieve their goal. Social comparison theory influences these motivational factors.

Social comparison theory. Social Comparison theory is how individuals compare themselves to others. This theory was first presented by Festinger (1954) wherein he postulated that when standards are not indentified individual's appraise their abilities through comparison with others. In addition, individuals select individuals who are similar to themselves in order to conduct this comparison (Marsh, et al., 2008).

An important influence on social comparison theory is the developmental level of individuals. The ability to conduct intrinsic social comparison requires higher cognitive development and relative experience in making comparisons. As a result, social comparison

begins during the initials years of primary school. As individuals age and development progresses youth begin to use social comparison of task performance (Ruble, 1983). In adolescents, social comparison has a profound effect as youth compare their knowledge, skills, and abilities with others (Chan & Prendergast, 2007). Within the context of social comparison theory, BFLPE and reflected glory effect attempt to explain the basis of comparison used for making comparisons.

Big-Fish-Little-Pond Effect. Big-Fish-Little-Pond Effect as proposed by Marsh suggests that when a high-achieving youth is removed from an environment of mixed achievement levels and placed in another environment with other high achievers their self-perception about their abilities will decrease (Marsh & Hau, 2003; Marsh, Trautwein, Ludtke, Baumert, & Koller, 2007). This is due to the self-evaluation with others who have equal or greater abilities with whom they will have to compete. Marsh (1990b) states that other mediating effects do exist that can influence a negative or positive self-perception. This effect has been explored in multiple studies (Jackson, Thomas, Marsh, & Smethurst, 2001; Marsh, 1988; Marsh, et al., 1988; Marsh & Craven, 2006; Marsh, Gerlach, et al.; Marsh & Hau; Marsh & Shavelson, 1985; Marsh, Trautwein, et al., 2007; Marsh, et al., 2008; Rinn, 2006; Welch, Brownell, & Sheridan, 1999). A result of BFLPE was the development of a secondary theory known as reflected glory effect.

Reflected glory effect. Reflected glory effect has its foundations in social psychology but in recent research has been used in education (Rinn, 2006). The premise of reflective glory is that when high-achieving individuals are placed in a group of high achievers they have an increase in their self-perceptions of their ability (Cialdini, et al., 1976). This increase in self-perception is associated with an individual's acceptance into this high-achieving successful

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group or program (Marsh, Kong, & Hau, 2000). Individuals in this theory use social comparison to facilitate this outcome and enhance their self-perception.

Problem Statement

A critical tenet in education is the development of youth as problem solvers in order to create individuals who have a problem-solving skill set as well as to enhance their ability level to solve the problems facing a global community (Friedman, 2007; Marzano, et al., 2001). Bandura (1991) postulated that key motivating factors that impact problem-solving are an individual's ability and self-perception of beliefs about their ability. Self-perception, a non-cognitive outcome, can influence how well a person does on a task. Marsh (2007) viewed perception of self as self-concept and considered it to be an important factor influencing student achievement. A review of the literature has shown that few studies focused on the non-cognitive outcomes of an educational program, this need is supported by the works of Andersen and Chen (2002) and Loeb and Jay (1987). Additionally, Marsh and Craven (2006), Sanchez and Sanchez-Rhode (2003), and Treffinger, Selby, Isaksen, and colleagues (Selby, et al., 2004; Treffinger & Isaksen, 2005; Treffinger & Nassab, 2000; Treffinger, et al., 2008) have expressed that there is a gap in the exploration of individual differences in creative problem-solving, specifically in terms of problem-solving style and the impact of a person's perceived ability in regards to a task. A result of the literature reviewed depicts the necessity of assessing the impact of individual differences in the areas of self-concept and problem-solving style as well as their influence on a task.

Purpose of this Study

The purpose of this mixed methods study was to investigate the relationship between perceived self-concept and perceived problem-solving style and how these two constructs

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compare and contrast in regards to a participant's perception of their problem-solving ability. Study participants were recruited from among the high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture. This study used a concurrent triangulation mixed methods design, in which different but complementary data was collected on similar aspects of problem-solving ability (Creswell & Clark, 2007). The quantitative aspect of the study employed two instruments. The first is the Self Description Questionnaire III (SDQ III), this instrument was used to test perceived self-concept using the multidimensional, hierarchical model of self-concept developed by Marsh (1987). Both the model and theory substantiated that problem-solving self-concept influences problem-solving ability either negatively or positively depending on the individual (Marsh, et al., 1988; Marsh, et al., 2008).

The second instrument, the VIEW: An Assessment of Problem-solving Style, was used to determine the perceived problem-solving style to provide insight into the type of problem solver the participant was. The VIEW was used to assess the problem-solving style of the participant group (Selby, Treffinger, Isaksen, & Lauer, 2002a). Current theory indicated that problem-solving type does not influence problem-solving ability, however little research has been done to substantiate this claim (Isaksen, 1995; Jonassen, 2000; Marsiske & Margrett, 2006).

Concurrent with this data collection, qualitative open-ended interviews explored the participants' description of their problem-solving process during a problem-solving event. Mixing of the quantitative and qualitative occurred during the merging phase of the study where themes from the interviews used to compare and contrast between the constructs of problem-solving style and self-concept. The reason for collection of both quantitative and qualitative data was to bring together the strengths of both forms of research in order to merge the data to make

comparisons and further the understanding of problem-solving ability of high-achieving youth in the agricultural concentration.

Research Questions

This study seeks to examine the following questions:

<u>Research Question 1</u>: What are the relationships between problem-solving style and perceived self-concept for this group of participants?

<u>Research Question 2</u>: How do participants describe their problem-solving ability for a given problem-solving task?

<u>Research Question 3:</u> How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

Professional Significance

Within the literature, there is a need for more research that addresses the correlation between self-concept and problem-solving ability in high-achieving high school students. Self-concept is studied in many fields and is referred to within the field of education. Positive self-concept is desirable and important to student achievement (T. L. Lewis & Smith, 2008; Wright & Leroux, 1997) however few studies have focused on the social and emotional impact of education programs (Geffen, 1999; Loeb & Jay, 1987). Non-cognitive outcomes such as changes in self-concept are not often studied by educational researchers (Nagda, Gregerman, Jonides, Von Hippel, & Lerner, 1998). Coleman (1995) supports the need for more studies addressing the impact of social context and the significance of non-cognitive outcomes in assessing the appropriateness of specialized environments.

Problem-solving is important to cognitive development of an individual and problem-solving style provides a means categorizing types of problem solvers This categorization both facilitates the investigation of problem-solving processes and enables individuals to use this knowledge to further their understanding about their own problem-solving abilities (Treffinger & Isaksen, 2005). Current focus has been on relating problem-solving style with problem-solving ability, however there are no conclusive studies that provide a direct link between problem-solving style and problem-solving ability (Ates & Cataloglu, 2007; Dermitzaki, et al., 2009). Educators and researchers alike consider problem-solving ability to be a key factor in the development of youth and exploration of this ability as well as its connectivity to other constructs broadens the understanding of a concept that is challenging to capture due to its complexity (Blanchard-Fields, 2007; Jonassen, 2000; Mary S. Riley & Greeno, 1988).

Due to the nature of this study, the study will use a mixed methods approach, one that uses both quantitative and qualitative measures, in order to explore both the inductive and deductive aspects of the research being conducted (Creswell & Clark, 2007). Mixed methods allows for "a more complete and nuanced basis for understanding" of the research being conducted (Siefert, Goodman, King, & Baxter Magolda, 2009, p. 2). The qualitative aspect of this study will permit the researcher to develop an understanding of problem-solving within the context of high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture. The quantitative aspect identified the relationships between the constructs being examined and the central phenomenon of problem-solving. The use of a mixed method approach enabled this study to have a better and more well rounded understanding of problem-solving.

Overview of Methodology

This study used a mixed method design in which quantitative and qualitative measures are equally important and complementary of one another. This mixed method approach used correlation research for the quantitative section, case study research for the qualitative component, and triangulation as the mixing component of this study. The use of these aspects within one research design investigated the relationship between self-concept and problem-solving style and the influence on perceived problem-solving ability in high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture. This study focused specifically on the self-concept constructs of mathematics, verbal, general academic, problem-solving, same-sex peer, and opposite sex peer and the problem-solving style constructs of ways of deciding, manner of processing, and orientation-to-change.

The research participants completed the SDQ III and the VIEW at the beginning of the summer residential program. During the remainder of the program, interview participants completed two 30 to 60 minute interviews to explore problem-solving ability. A definitive number of interview participants were unknown due to the researcher needing to conduct interviews to saturation. However, researcher interviewed a minimum of 10 percent of the study population. Descriptive statistics such as means and standard deviation were computed for each self-concept and problem-solving style construct. Select inferential statistics i.e. Pearson's r correlation were used to answer the quantitative research question. For the qualitative data analysis, recordings were transcribed and coded to identify key terms or phrases as related to problem-solving ability and the theoretical framework presented. The merging phase of this study occurred through comparing and contrasting the qualitative themes to the results for the non-cognitive measures.

Delimitations and Limitations

This study intended to compare only selected aspects of self-concept (mathematics, verbal, problem-solving, general academics, same-sex peer, and opposite-sex peer). It did not intend to address other self-concept domains. This study confined its self to a single population. The population group consisted of high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture.

When a comparison of different types of services for students was conducted, several conceptual and practical difficulties that may have been encountered. This was best noted by Cornell, Delcourt, Goldberg and Bland (1992) wherein they stated that this variability can occur from uncontrollable factors such as administrative policies, admission, curriculum and quality of instruction, and parental support. Thus, caution must be exercised when one attempts to generalize this study beyond the actual population represented in the study. As in the case of the qualitative portion of this study, this represents rich descriptions found within a particular population that cannot and should not be generalized. Participation in this research was voluntary. The actually study samples consisted of respondents. The potential impact of non-participants on study results could not be determined.

Definition of Terms

The following definitions are provided to clarify meanings of importance that will be used throughout this study:

1.   General academic self-concept: The perception of self a related to most school subjects measured by the general academic scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1 means "definitely false" and 8 means

"definitely true" (Marsh, 1990a, p. 1). For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

2. High-achieving students: Operationally defined as students who have been identified as gifted or who have gained acceptance into a selective, academically rigorous program that bases admission on past performance.

3. Manner of processing: One of three independent dimensions of the VIEW instrument that represents an individual preference in thinking about a problem as measured by the manner of processing Scale of the VIEW (Treffinger, et al., 2008). This construct has a subset range of 1 to 7 with seven representing the highest scale. Within the VIEW, manner of processing is comprised of eight questions, with a maximum score of 56 and a minimum score of eight.

4. Mathematics self-concept: The perception of mathematical skill and reasoning ability as measured by the mathematics scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1 means "definitely false" and 8 means "definitely true" (Marsh, 1990a, p. 1) For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

5. Non-cognitive: As defined by James Heckman are items associated with "motivation, socioemotional regulation, time preference, personality factors, and the ability to work with others" (Heckman, 2008, p. 296)

6. Opposite-sex peer self-concept: The perception of interactions and relationships that occur with members of the opposite sex as measured by the opposite-sex peer scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1

means "definitely false" and 8 means "definitely true" (Marsh, 1990a, p. 1). For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

7. Orientation-to-change: One of three independent dimensions of the VIEW instrument that represents the cognitive facets of problem-solving as measured by the orientation-to-change scale of the VIEW (Treffinger, et al., 2008). This construct has a subset range of 1 to 7 with seven representing the highest scale. Within the VIEW, the orientation-to-change is comprised of 18 questions, with a maximum score of 126 and a minimum score of 18.

8. Problem-solving ability: "the development and acquisition of our abilities to think and solve problems"(Chi & Glaser, 1985, p. 228).

9. Problem-solving self-concept: Is the perception of self as related to problem-solving and creative thinking as measured by the problem-solving scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1 means "definitely false" and 8 means "definitely true" (Marsh, 1990a, p. 1). For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

10. Problem-solving task: The item that stimulates the problem-solving process in an individual or group.

11. Same-sex peer self-concept: The perception of interactions and relationships that occur with members of the same sex as measured by the same-sex peer scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1 means "definitely false" and 8 means "definitely true" (Marsh, 1990a, p. 1). For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

12. Self-concept: An individual's self-perception that develops through experience and interaction with their surroundings (Marsh, 1990b; Marsh, et al., 1988; Marsh & Craven, 2006; Marsh & Hau, 2003). Self-concept includes knowledge, attitudes, and feelings about skill, abilities, and social acceptance (Byrne & Shavelson, 1996).

13. Self-description questionnaire III (SDQ III): The third of a series of SDQ instruments designed by Herbert Marsh to test the multi-facets of the hierarchical, multidivisional model of self-concept postulated by Shavelson (Marsh, 1987, 1990a). This instrument was developed specifically for use with late adolescents to adult ages. This instrument has been comprehensively evaluated and is considered to be an exceptional tool for measuring self-concept and appropriate to be used with high-achieving youth (Byrne & Shavelson, 1996).

14. Summer residential program: Opportunities available for high-achieving students offered during the summer where students are provided with rigorous academics in a supportive living environment for a period of time during the summer. Traditionally summer programs last four to six weeks. (Olszewski-Kubilius, 2010)

15. Verbal self-concept: Is the perception of self as related to verbal skills and reasoning ability as measured by the verbal scale of the SDQ III (Marsh, 1990a). The subscale for this construct is a 1-8 Likert type scale where 1 means "definitely false" and 8 means "definitely true" (Marsh, 1990a, p. 1). For this construct, there are 10 questions, the maximum score is 80 and the minimum score is 10.

16. VIEW: An assessment of problem-solving style (VIEW): An instrument used to assess problem-solving style in persons 12 to adult developed by Selby, Treffinger and Isaksen and is used to provide insight into creative problem-solving theory (Selby, et al., 2002a).

17. Ways of deciding: One of three independent dimensions of the VIEW instrument that represents an individual's preferences in making decisions as measured by the Ways of deciding scale of the VIEW (Treffinger, et al., 2008). This construct has a subset range of 1 to 7 with seven representing the highest scale. Within the VIEW, ways of deciding is comprised of eight questions, with a maximum score of 56 and a minimum score of eight.

Summary of the Chapter

This chapter introduced the research topic by presenting a need to explore the interconnectivity between problem-solving style, self-concept, and problem-solving ability. Within this chapter, the problem statement and the research questions were included. In addition, presentation of the theoretical framework for the study was introduced to outline the exploration of the relationship between non-cognitive outcomes and a task through social cognitive and social comparison theory. This chapter contained a brief overview of methodology, the delimitations and limitations, and definition of key terms of the study.

The second chapter will include the relevant literature in the areas of self-concept and problem-solving to present background for the theoretical framework and research questions. Major topics discussed in the review of literature will include theories and postulations of problem-solving ability, self-concept, and problem-solving style. The third chapter will contain the research methods of the study including research design, methods, procedures, and data analysis. The fourth chapter will include the results and findings of the study. The fifth chapter will contain discussion of the results from the previous chapter, conclusions from the study, and present suggestions and recommendations to the field.

<center>**Chapter II**</center>

<center>**Review of the Literature**</center>

Chapter II contained relevant research identified by the researcher, to include the theoretical and empirical research applicable to the study. Literature explored includes self-concept theory; self-concept research; self-concept and high-achieving students; and problem-solving theory, procedures, and instruction.

Study Significance

The relationship between self-concept, problem-solving style and the impact on problem-solving ability in high-achieving high school students was addressed in this study. Although both problem-solving style and self-concept have been studied throughout the fields of education and psychology, connectivity to problem-solving ability remained indeterminate. Chi and Glaser maintained that "there is considerable work left to be done" developing an understanding of problem-solving ability" (1985, p. 248).

The study sought to determine the relationship between perceived self-concept and perceived problem-solving style and how these two constructs compared and contrast in regards to a participant's perception of their problem-solving ability. The following research questions guided the study:

Research Question 1: What are the relationships between problem-solving style and perceived self-concept for this group of participants?

Research Question 2: How do participants describe their problem-solving ability for a given problem-solving task?

Research Question 3: How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

Overview

In addressing self-concept and problem-solving ability as they relate to a problem-solving task, this review considered both self-concept and problem-solving theory and practices. Self-concept theory had its foundation in the works of James (1890/1981) and other symbolic interactionists, while problem-solving theory research dated back to Newell and Simon (1961) and their research on artificial intelligence. Within the general area of psychology of high-achieving youth, self-concept and problem-solving were two current areas of study.

The central purpose of education entities, primary to graduate school was to impart knowledge. Problem-solving was considered by many researchers as one of the most influential ways to convey this knowledge. All areas of instruction had problem-solving elements. Some disciplines such as mathematics and sciences used problem-solving predominately, conversely others such as reading and writing used problem-solving as a minor strategy.

Instruction in problem-solving focused on well-defined problems rather than ill-defined problems (Chi, Glaser, & Rees, 1981). However, ill-defined problems tended to be the problems found in the real world. Education institutions rarely required students to solve ill-defined problems, that is, those that are not clearly defined, in which information must be discovered, or problems that did not have a single answer rather multiple plausible solutions (Flowers & Osborne, 1988). Thus, how could educators prepare their charges for real world problems? Simon (1980) argued that teaching standard problem-solving techniques allowed for the application of those techniques in new situations whether they are well or ill defined.

Researchers and educators recognize that cognitive skills were insufficient for academic and occupational achievement. However, non-cognitive factors including self-concept and problem-solving style may have contributed to the real-world achievement and performance (Brounstein, et al., 1991).

Self-Concept

In recent years, self concept experienced a resurgence in social psychology and education (Gecas, 1982). A review of the literature on self-concept revealed a number of studies addressing the relationship between self-concept and academic achievement. At the same time, self-concept was valued as a research interest due to the reemphasis on non-cognitive educational outcomes. In addition to being a valuable educational outcome, self-concept served as a moderator variable to explain an outcome such as academic achievement (Shavelson, Hubner, & Stanton, 1976).

Foundations of self-concept theory. When exploring self-concept theory it was imperative that two distinctions were made. The first was the distinction of self-concept from self and the second was the definition of self-concept. A clear relationship between self and self-concept existed, however, self was considered the relationship between "me" and "I" whereas self-concept was the value of "me" or "I" over a specific construct (J. D. Lewis, 1979). Self considered to be a reflective phenomenon that developed due to social interaction whereas self-concept was a result of reflective interface based on an individual's interpretation of his or her physical, social, and moral being (James, 1890/1981 ; Mead, 1934).

Many researchers used the term self-concept interchangeably with terms such as self-esteem, self-worth, and self-efficacy; others however denote subtle nuances between the terms (Bandura, Freeman, & Lightsey, 1999; Van Tassel-Baska & Olszewski-Kubilius, 1994; Zimmerman & Bandura, 1994). Currently, neither a universally accepted description for self-

concept nor a term for representing an individual's sense of self existed, therefore researchers were advised to use a theoretical position and the instrumentation that corresponds to that position (Markus & Wurf, 1987). Although there was not one central definition or theoretical approach for self-concept, the critical components of self-representation, social comparison and the cognitive construction of self were consistent throughout self-concept scholarly works (Gecas, 1982; Markus & Wurf).

Self-representation. Markus and Wurf (1987) stated that not all self representations were indicative of self-concept. There was a causal relationship between self-concept and self-representation in which one informed the other (Markus & Wurf, 1987). Self-representations were multiplicite in origin in which some representations developed because of self-awareness of actions and others result from emotions, cognition, and motivations (Andersen & Chen, 2002; Andersen, Thorpe, & Kooij, 2007; Bandura, 1977, 1989a; Harter, 2001; Markus, 1990). Andersen and colleagues (2002) substantiated that people's cognitive and affective attributes determine self-representations over behavioral characteristics.

Behavioral self-representation was influenced by self-assessment. Trope and Bassok (1982) stated that behavioral self-representations on a task are relative to performing the task as based on their abilities. In order to conduct a self-assessment of a task, individuals often used social comparison and direct interaction (Markus, 1990; Markus & Wurf, 1987).

Social comparison. Gecas described social comparison as "the process in which individuals assess their own abilities and virtues by comparing them to those of others"(1982, p. 6). Festinger's (1954) original social comparison theory postulated that the purpose of social comparison was for reality verification. However, Covington and Beery (1976) stated that social comparison often occurs amongst small competitive groups such as a classroom or enrichment

program. Alderman's work furthered this concept through his discussion of the change of social development in children. Alderman and associates discovered that as a child ages there was a shift from individual comparison to social comparison (Alderman & Wood, 1976). This change is a motivational result toward understanding of personal competence (Harter, 1990).

In adolescents, social comparison had a stronger impact than other age groups, in which their skills and abilities were not only being evaluated but their morals and behaviors as well (Rosenberg, 1979, 1989). Several studies examined social comparison and self-concept; these studies had similar results, in that the results determined that high-achieving students used social comparison more frequently than their counterparts (Rinn, 2006; Seaton, et al., 2008). Adolescence was a critical time period in which social comparison is used to develop a sense of self (Harter, 2001). During the developmental phase, youth experienced contradictory assessments resulting in diminished self-concept (Epstein, 1973). According to Epstein, it was during the adolescent phase that the true elements of self-identity (moral, emotional, physical, and cognition) developed. Epstein was not the first to postulate this idea, indeed, the concept of self identity was first presented by James (1890/1981) and further supported by the works of Cooley (1902), Mead (1934), and Baldwin (1988). It should be noted that although the relationship between self-concept and social comparison was assumed there was little empirical research supporting this relationship. Rinn and colleagues noted that "few researchers have addressed this gap in the research" (Rinn, et al., 2009, p. 255).

Construction of self. Self was constructed though multiple facets of being. Cognitive construction of self was an active process of meaning making concerning our experiences and reality (Heckman, Stixrud, & Urzua, 2006; Markus & Wurf, 1987). Throughout the research on self theory (including self-concept) there were three resounding concepts. The first was the

impact on individuals from multiple aspects such as judgment, memory, and behavior that impact attitudes, thought, and beliefs (Markus & Wurf, 1987).   Secondarily, self was not static and was constructed through social experiences (Mead, 1934). Finally, self could be both malleable and stable (Higgins, 1987). Through these three concepts, the influence of development was apparent.

Harter (1990, 2001) postulated that development of self concept occurs across the life span. Developmental constraints of self and self-concept were that individuals develop different cognitive abilities at various stages. Cognitive abilities were influenced by an individual's motivation and traditions.   The words of Harter (1990) and Ruble (1980) provided positive evidence of the use of social comparison to develop self concept in primary aged youth. The sense of self developed with cognitive abilities and as cognition develops views of self become domain specific (Harter, 2001). Finally, it is during adolescence when self became differentiated resulting in varying levels of self-concept and the creation of multiple selves, e.g., a professional self versus a home self (Harter, 2001). From this developmental research, the malleability self became evident and the multiplicity of self-concept imperative.

Self-concept Paradigms

Unidimensional

The first self-concept model was the unidimensional general factor model. This model based on Spearman's model of intelligence theory, in which there were two types of intelligence: "g" for general intelligence and "s" for specific intelligence (Horn, 1989). In this self-concept model, the premise was that there was one general type of self-concept which superseded other finite types (Marsh & Craven, 2006). This model and other similar models were used in the late 1960s but have had little use in later research (Marsh & Hattie, 1996). Proponents for this model

argued that the general component influences the other aspects of self-concepts and cannot be separated adequately (Coopersmith, 1967; Marx & Winne, 1978). In opposition to the unidimensional model, Marsh and Craven (2006) argued that the studies of the time were not reflective of the research question; rather they were the results of antiquated statistical analysis procedures. Supportive of Marsh and Craven, Shavelson et. al (1976) found that the general self-concept factor could be separated into three constructs: social, physical, and academic. Shavelson's work was the foundation for the second self-concept paradigm (Marsh & Shavelson, 1985). In Shavelson's work, he concluded that self-concept was multidimensional and hierarchical (Shavelson & Bolus, 1982; Shavelson, et al., 1976). From this initial study, researchers developed the multidimensional model and subsequent instruments to test this model.

Multidimensional

The multidimensional hierarchical model was first developed by Shavelson (1976). In this model, Shavelson defined self-concept as a person's self-perception. Self-perception was influenced by a person's environment and the experiences within the environment. Furthermore, self-perception was influenced by evaluation of an individual's behavior, how that behavior is supported, and how others behaved. Self-concept as postulated by Marsh (1990b) can be best described as an organized hierarchical multifaceted concept. As a hierarchical structure, general self-concept was the most stable whereas delineation into domain specific self-concept became less stable (Marsh & Shavelson, 1985). The original theory proposed that global/general self-concept was the highest level and the secondary level was composed of academic self-concept and nonacademic self-concept components. These components were further deconstructed into more specific components such as math and history for academic and social and emotional for nonacademic (Shavelson, et al., 1976). This model had undergone extensive construct validation

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(Byrne & Shavelson, 1996). However, most of the focus of this validation had been in the area of academic self-concept rather than the nonacademic components (Byrne & Shavelson, 1996; Marsh, et al., 1988). Initially, this model was unable to be tested due to the lack of a multidimensional instrument (Craven & Yeung, 2008).

Based on the Shavelson et al. model, Marsh developed the Self-Description Questionnaire instruments (Marsh, 1987, 1990a). These instruments received resounding endorsements from the research community. Hattie regarded the instruments as "an excellent measure of the various first-order dimensions of self-concept as proposed by Shavelson et al." (Hattie, 1992, p. 82). In 1996, Byrne conducted a review of Marsh's instruments and found that these instruments were "well-planned" and the "most validated" self-concept instruments available (Byrne, 1996, p. 117). In addition to furthering the validity of the instruments, Byrne strengthened the support for the multidimensionality of self-concept (Craven & Yeung, 2008). Additional research exploring the multidimensionality of self-concept found that self-concept could not be understood if multidimensionality was disregarded (Byrne, 1996; Byrne & Shavelson, 1996; Hattie, 1992; Marsh & Craven, 2006).

Empirical research on the original model as proposed by Shavelson et al. led to this model undergoing modifications in recent years (Byrne & Shavelson, 1996; Marsh & Hattie, 1996). The most substantial change was the change in the hierarchical nature of the self-concept, in which several studies depicted a definitive separation between reading and mathematics constructs in that they could not be incorporated into the general academic self-concept as the original model proposed (Marsh, 1986). The resulting revision of Shavelson's original self-concept model was the creation of two separate academic factors, verbal and mathematics rather than a single factor of academic self-concept (Craven & Yeung, 2008). This revised model was

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referred to as the Marsh/Shavelson Revised Self-concept model (Marsh, 1990b). In later years, Marsh and Craven argued that "the hierarchy is much weaker than anticipated-particularly for adolescents and young adults" (2006, p. 138) and recommended that further researchers concentrate on the domain specific (e.g., math, verbal, same-sex, problem-solving) attributes of self-concept relevant to their field of study.

Self-concept Research

Age and Gender

Numerous researchers studied relationships between self-concept and age and gender. Often gender and/or age are examined as a component of a large study (Bain & Bell, 2004; Brounstein, et al., 1991; Byrne, 1996; Byrne & Shavelson, 1996; Cunningham & Rinn, 2007; Dermitzaki, et al., 2009; Ginsburg-Block, Rohrbeck, & Fantuzzo, 2006; Loeb & Jay, 1987; Marsh, 1988; Marsh & Hau, 2003). Most notably, age has influenced the self-concept model due to the influences of developmental changes (Byrne & Shavelson, 1996; Ginsburg-Block, et al., 2006). Bryne and Shavelson (1996) noted that in pre-adolescent youth, self-concept can be inflated due to youth overestimating their abilities and lacking comparison skills. Harter (2001) contended that these comparison skills do not develop until early adolescence. The research on age and self-concept has shown that self-concept creates a bell-shaped curve in regards to age in which self-concept is high in preadolescents, lower in early adolescents, and increases in late adolescents and adulthood (Byrne, 1996; Byrne & Shavelson, 1996; Rosenberg, 1979, 1989). Although age and gender were often studied in conjunction with each other, gender also had been singularly studied.

While age had similar results across self-concept constructs, both academic and nonacademic, the research in relation to gender had mixed results. Worrell, Roth, and Gabelko (1998) examined academic self-concept and gender and found there was no significant difference

between males and females. In other research, females had higher self-concept in the verbal

construct but males had higher self-concept for math and nonacademic constructs such as sports

(Marsh, Gerlach, et al., 2007; Norman, Ramsay, Martray, & Roberts, 1999; Yun Dai, 2001).

These mixed research results have caused some researchers to contend that gender results are

inconsequential and add little meaning to self-concept research (Crain & Bracken, 1994;

Olszewski-Kubilius & Kulieke, 1989).

Self-concept and High-achieving Students

In high-achieving students, the majority of the research focused on academic self-concept

(Cunningham & Rinn, 2007; Rinn, 2006; Rinn, et al., 2009). Research has shown that high-

achieving students have higher self-concept for academic constructs than do their peers who are

not high-achieving. Although there is noted research supporting that high-achieving students

have higher academic self-concept, Marsh and Parker (1984) stated that when a student enters a

high-achieving program, global and academic self-concept decline. Preckel and Brull (2010)

supported the Marsh and Parker findings and contended that self-concept is positively influenced

by high-achieving students staying in their home environment. Preckel and Brull (2010)

attributed this to Big-Fish-Little-Pond Effect (BFLPE) and argued that although it is evident that

high-achieving students have an increased self-concept when they are in their home

environment, the impact of participation in traditional gifted programs such as a pull-out

program provides the youth access to better resources and sophisticated teaching skills.

In nonacademic self-concept areas, little research had been conducted. The social aspects

of self-concept depicted mixed results as to the impact of self-concept on high-achieving youth.

Ross and Parker (1980) reported significant differences between high-achieving youth and their

average peers, in which the high-achieving youth had lower than average social self concept.

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However, Norman reported that high-achieving students had higher social self-concept than their average peers. The majority of research has shown that there is no statistical significance in high-achieving youth in social self-concept. Because of this lack of significance, researchers in the field of self-concept maintained the necessity of continued examination of the social constructs as a part of any self-concept study (Ablard, 1997; K. R. Kelly & Colangelo, 1984; S. Kelly, 2008).

Physical Self-concept

The research in physical self-concept has shown that overall there were no statistically significant differences between high-achieving students and their average counterparts (Hoge & Renzulli, 1993). Other researchers argued that although results lack significance, physical self-concept studies highlight the influences of gender and age on self-concept (Marsh, Gerlach, et al., 2007). In addition to gender and age influencing physical self concept, Rinn and Wininger (2007) found external variables such as sports participation influences physical self-concept. Fox (1997) as cited in Jackson, Thomas, Marsh, and Smethurst (2001) stated that physical self-concept is a critical factor in determining mental health and well-being. Research in the area of sports and physical self-concept provided mixed results as to the impact of physical self-concept. An area that had more limited research was that of emotional self-concept.

Emotional Self-concept

Emotional self-concept was an area of self-concept research that lacks research most specifically when studying high-achieving youth (Cunningham & Rinn, 2007). Research exploring emotional self-concept found that other variables such as family structure and mental health contributed to positive emotional self-concept. Ablard's (1997) research found that emotional self-concept increased when a high-achieving student participated in a summer

enrichment program. Ablard (1997) postulated that this was due to the high-achieving students being in a peer group of like-minded individuals and in a situation that caused the group to experience similar stresses thus causing the group to form a united front and learn coping mechanisms from one another.

Problem-solving Self-concept

Problem-solving self-concept was similar to emotional self-concept in that there were very few studies that explore problem-solving self-concept as an impact variable. Many studies incorporated problem-solving self-concept; however, few noted statistical significance or the impact of problem-solving on other self-concept constructs (Marsh & Byrne, 1993; Marsh, et al., 1988; Marsh & Shavelson, 1985). Problem-solving was a domain specific self-concept construct; however, it did not fit in the academic or nonacademic classification system. Most often problem-solving has been studied in relation to mathematics self-concept (Montague, 1997). Schommer-Aikins, Duell, and Hutter (2005) postulated that problem-solving self-concept has five criteria: that it is time consuming, requires interpretation, involves complex procedures, uses verbal applications, and is improved with effort.   Schommer-Aikins, Duell, and Hutter's results found that beliefs in mathematics influence problem-solving preference. Although the aforementioned study explored problem-solving self-concept, problem-solving was examined as a component of mathematics. Dermitzaki, Leondari, and Goudas (2009) highlighted the limited availability of research exploring problem-solving self-concept in which the results were significantly related, however Dermitzaki, et al. noted "this relation was weak" (2009, p. 146). From these results Dermitzaki, et al. recommended further research measuring task-specific self-concept domains and their impact on problem-solving situations.

Educational Context and Self-concept

The influence of environment has been mentioned through studies exploring the self-concept domains. Summer enrichment programs have been studied in great detail in relation to high-achieving youth. University summer enrichment programs are rigorous and are highly selective. Most often, these programs target middle and high school students. Researchers have found substantial evidence depicting positive social self-concept in those youth who participated in a summer enrichment program (Olszewski-Kubilius, 2010; Olszewski-Kubilius & Kulieke, 1989; Olszewski-Kubilius & Lee, 2004). Additional studies have found that after participation in summer enrichment programs, youth enroll in more rigorous coursework, plan to attend a post-secondary institution, and pursue careers in mathematics and professional degrees (Olszewski-Kubilius & Lee, 2004). Rinn (2006) stated that summer programs have long term benefits of increased motivation, self-confidence, basic thinking skills, and academic achievement. Although summer enrichment programs have numerous positive outcomes, self-concept research has mixed results. Rather than focusing on self-concept as a complete entity, studies have focused on domain specific self-concept. Brookby (2004) found a significant increase in social self-concept whereas Manor-Bullock (1994) found a significant decrease in same sex-peer relations. As a result of this variation in domain specific results, Rinn (2006) recommended additional research exploring domain specific self-concept constructs and summer enrichment programs.

<p align="center">Problem-solving Theory</p>

For educators, the genesis of problem-solving theory lies with Dewey, the Gestalt psychologists, and Gagne. Dewey introduced the concept of problem-solving through reflective inquiry and its mental and social components (Dewey, 1916, 1929, 1997, 1998). Gestalt

psychologists have taken the mental components of problem-solving and created the ideas of perception and insight. Those abilities influence one's aptitude to solve a problem and to create structural understanding (Dominowski & Bourne Jr, 1994; Mayer, 1983). Gagne built upon the work of both Dewey and the Gestalt psychologists with his perspective that problem-solving is the most important learning outcome (Gagné, 1959, 1980). While Dewey and Gestalt are the genesis, Simon and Newell's (1971) human problem-solving theory is the hallmark for current problem-solving development. Human problem-solving theory is considered the cornerstone of problem-solving theory (Hunt, 1994). Human problem-solving theory refers to information processing systems that occur when the learner is confronted with a problem (H. A. Simon & Newell). Chi and Glaser considered problem-solving to be "a complex cognitive skill that characterizes one of the most intelligent human activities" (1985, p. 227). From theory, problem-solving has developed into a systematic process with several components including the problem, problem representation, and problem strategies.

Define a Problem

Within the context of problem-solving theory, there were many definitions of the term problem. According to Jonassen (2000) a problem is composed of two major attributes. The first is that it is the unknown component of a situation while the second is that the unknown component must have social, cultural, or intellectual value. Newell and Simon defined a problem as the "information about what is desired, under what conditions, by means of what tools and operations, starting with what initial information, and with access to what resources" (1972, p. 73). Chi and Glaser (1985) characterized a problem as the goal to be reached. Although each definition had strong merits, all have the underlying themes found within Chi and Glaser's characterization; therefore, this is the definition that was used for this study.

Well- and Ill- Defined Problems

How a problem is defined impacts the ability for knowledge to be acquired (Chi & Glaser, 1985). Problems can be either well defined or ill defined (Schraw, Dunkle, & Bendixen, 1995; Voss & Means, 1989). Ill-defined problems allow the learners to define problems better for themselves and result in more complex solutions (Voss & Means, 1989). Learners who can solve ill-defined problems demonstrate greater insight and creativity than those who cannot (Chi & Glaser, 1985). Through the problem being ill-defined, learners acquire a considerable amount of knowledge; however this knowledge may be seen as incorrect knowledge if the learner arrived at a tangential solution (Schraw, et al.). The antithesis of ill-defined problems is well-defined problems. Proponents for well-defined problems maintain that although knowledge acquisition is less than that acquired with ill-defined problems well-defined problems provide the opportunity for the learner to develop problem-solving strategies (Frederiksen, 1984).

Definition of Problem-solving

Problem-solving has been defined numerous ways by varying researchers (Anderson, 1993; Bransford, Haynes, Stein, & Lin, 1998; Chi & Glaser, 1985; Gick, 1986; Jonassen, 2000; Newell & Simon, 1972). Anderson (1993), Newell and Simon (1971), Chi and Glaser (1985), and Mayer (1998) agreed that problem-solving must have a goal and use cognitive thought to reach that goal. They differed in the manner in which one uses cognitive to reach the goal. Anderson depicted problem-solving as "any goal directed sequence of cognitive operations" (Jonassen, 2000) Chi and Glaser considered problem-solving as "a complex cognitive skill that characterizes one of the most intelligent human activities" (Chi & Glaser, 1985, p. 227) and as the method of reaching the goal. Similarly, Mayer stated that problem-solving is a "general procedure [to] analyze each problem into the cognitive skills needed for solution and then

systematically teach each skill to mastery" (Mayer, 1998, p. 51) . While both Mayer and Chi and Glaser were very general, Newell and Simon (1972) depicted problem-solving in five steps in which a separation in cognition occurs. The five steps are:

1. Selecting a goal or input

2. Choosing the problem-solving method

3. Applying the method

4. Evaluating the results

5. Reselecting a goal

Newell and Simon's definition of problem-solving placed cognition in two subsets, understanding and discovery (Jonassen, 2000; Newell & Simon, 1972). Newell and Simon's definition of problem-solving typically served as the basis of all subsequent strategies.

Problem Representation

In order to develop an understanding of the types of strategies used in problem-solving, there must first be an explanation of basic terms and concepts. For instance, the problem space as explained by Newell and Simon is the mental environment in which probable solutions to the situation are extrapolated (Newell & Simon, 1972; H. A. Simon & Newell, 1971). The problem space can be divided into the problem state and the operator (Anderson, 1993; Newell & Simon; H. A. Simon & Newell). The problem state is indistinct, meaning that it can refer to the external influences on the problem or the internal influences on the problem such as encoding or perception (Anderson; Newell & Simon; H. A. Simon & Newell). In addition, these problem spaces may be acted on by operators.

The operator of a problem space is the action that is being done to reach the goal (Anderson, 1993). Internally the operation may have worked, but when external environment

factors are considered it does not (Newell & Simon, 1972). A common operator was that of heuristics (H. A. Simon & Newell, 1958). As a result of the problem state and the operator, the problem space did not have a defined space; rather it was a dynamic entity (Anderson; Newell & Simon; H. A. Simon & Newell, 1971). In addition to the impact of operators, problem space contained knowledge nodes. Knowledge nodes are considered states of knowledge about the problem that the learner has for that precise moment in time (H. A. Simon & Newell). Through the incorporation of knowledge nodes, problem space, and the influence of the operator, several strategies have developed to facilitate problem-solving.

<p style="text-align:center">Problem-solving Procedures</p>

Successful problem solvers depend on their ability to look at the task environment within the problem space. In addition, successful problem solvers must have multiple strategies within their repertoire. Therefore, the strategies and procedures learned must be generalized to a variety of situations. Generate and test, analogical reasoning, and discovery learning are such strategies that will be discussed in further detail as they relate to instruction for youth. Means-end analysis and brainstorming are discussed below as important techniques.

Means-ends analysis. Means-ends analysis was a powerful heuristic strategy which examined the differences between the current state and the goal state (Chi & Glaser, 1985; Hunt, 1994; Newell & Simon, 1972). Once examination concluded, means-ends analysis served to discover operations that will reduce the differences between current state and the goal state. (Anderson, 1993; Chi & Glaser, 1985). An additional attribute to this strategy is that it works from finish to beginning as well as beginning to end (Chi & Glaser, 1985; Hunt, 1994).

Newell and Simon conducted means-ends analysis using the General Problem Solver (GPS), a computer simulation program (Newell & Simon, 1961, 1972). These researchers (Newell & Simon, 1972) concluded the following:

1. If an incorrect solution was given then the differences between the present problem and the desired solution would be apparent.

2. Operators influence the operant or leave them unchanged. Therefore, they can be characterized by the changes that occur or the lack therein. Operators can be utilized to eliminate undesired solutions.

3. If the desired operator does not apply then one may want to change the inputs so that it applies.

4. The difference can prove to be difficult and these differences should be eliminated. This process should be repeated to reduce the difficult differences.

Newell and Simon had three goal methods to use with means-ends analysis. These were transforming, apply-operant, and reduce methods. Transforming method consisted of connecting goal one with goal two and discovering the difference between the two goals; once the difference is discovered, then reduce the differences to create a sub-goal; the final aspect is to transform the sub-goal into the second goal. Apply-operant method begins with determining if the operant could be applied to the problem and applying it to reach the outcome. If the operant cannot be readily applied then reduction of the difference through the use of a sub-goal is necessary. Once the difference has been reduced, then apply the sub-goal with the operator to reach the new goal. The reduce method consisted of finding the operator that reduced the difference between the problem and the solution. Once the operator was found then apply it to the problem to create a modified solution or goal (Newell & Simon, 1972).

In addition to Newell and Simon's methods, hill climbing is a method of working forward. This method starts with the present situation and changing it in order to get closer to the solution. This method requires several adjustments to be made in order to reach the solution. A limitation to hill climbing occurs when the learner solves a tangent solution rather than the goal specified in the problem (Mayer, 1983).

The primary limitation of the means-ends analysis method occurred when there was not an operant that reduced the difference between the problem and solution. When this occurs the problem required a detour to get to the solution. When a detour occurred then there is an increase in differences between the problem and the solutions (Chi & Glaser, 1985).

Means-end analysis and generate and test strategies were considered the conventional strategies for problem-solving (Chi & Glaser, 1985). These strategies require limited cognition (Chi & Glaser, 1985). In addition to low cognition, the level of difficulty of the problem was low, preventing the problem solver from learning essential aspects of the problem (Sweller, 1988).

Brainstorming. Brainstorming was a problem-solving strategy that produced good quality ideas regardless of the learners' knowledge base (Meadow, Parnes, & Reese, 1959; Parnes & Meadow, 1959). Osborn prescribed specific conditions for brainstorming: criticism is null, free expansion of outlandish ideas is welcome, quantity is a necessity, and combining and improving ideas amongst the participants is supported and recommended (Isaksen & Gaulin, 2005). Factors that influenced the effectiveness of brainstorming include group size, knowledge base of participants, and face-to-face or electronic meetings (Isaksen & Gaulin, 2005; Meadow, et al., 1959; Mullen, Johnson, & Salas, 1991; Parnes & Meadow, 1959; Pinsonneault, Barki, Gallupe, & Hoppen, 1999). Brainstorming was often treated as an isolated occurrence, however it can be

used as one idea creation tool for creative problem-solving (Isaksen & Gaulin, 2005; Treffinger, et al., 2008).

Like analogical reasoning, brainstorming placed emphasis on the learner's pre-existing knowledge base in order to effectively solve a problem (Isaksen, Dorval, & Treffinger, 1998). However, unlike analogical reasoning, brainstorming utilized the pre-existing knowledge during the initial stage of the problem-solving process (Isaksen & Gaulin, 2005). More often than not, brainstorming was used as tool rather than a strategy and because of this it is a less favorable problem-solving strategy (Isaksen & Gaulin, 2005; Treffinger & Isaksen, 2005).

Research Based Strategies

The research on problem-solving resulted in several general problem-solving strategies (Anderson, 1993; Anderson, Farrell, & Sauers, 1984; Gick, 1986; Gust, Krumnack, Kuhnberger, & Schwering, 2008; Isaksen & Gaulin, 2005; Mayer, 1983; Newell & Simon, 1972; H. A. Simon & Newell, 1958; Treffinger, et al., 2008). Among these strategies were generate and test, means-ends, analogical reasoning, brainstorming, and discovery learning. How the individual acquired knowledge and how that knowledge was impacted by outside influences such as the use of an expert in the group setting or whether or not a problem was considered well-defined or ill-defined influences the usability of problem-solving strategies (Charness, 1981; Chi & Glaser, 1985; Jonassen, 1997). Further development for problem-solving to enhance knowledge acquisition has met several mechanical concerns for the problem-solving strategies available (Tu, Eriksson, Gennari, Shahar, & Musen, 1995). Additionally, problem-solving methods must be broken down into sub-methods and mechanisms to enable their use in similar tasks for different domains (Tu, et al., 1995). Furthermore, once there is domain ontology, then the methods will be readily assessable for experts' use (Tu, et al., 1995).

Knowledge acquisition, expert interaction, and problem definition were the three mechanical concerns for the usability of problem-solving strategies. Knowledge acquisition was impacted by expert interaction and by how a well defined a problem is. Essentially knowledge acquisition was the outcome that a facilitator desires for problem-solving (Tu, et al., 1995). From this knowledge acquisition can be positively influenced by the incorporation of an expert into a group problem situation (Tu, et al., 1995). The expert provided the novices of the group a framework from which to build their knowledge (Gick, 1986). Experts typically work forward toward the goal while novices work backwards (Frederiksen, 1984; Gick, 1986; Voss & Means, 1989). Although working collaboratively may initially cause cognitive dissonance, the end result is the development of schemata that allows for sophisticated strategies (Frederiksen, 1984; Gick, 1986; Halpern, 1996; Voss & Means, 1989; Voss, Tyler, & Yengo, 1983).

Implications for Instruction

Learners could gain knowledge of problem-solving strategies and become better learners (Bruning, Schraw, Norby, & Ronning, 2004). However, cognition reached its limitations in the retention of knowledge and the influences of developmental stages (Blanchard-Fields, 2007). Even with these limitations, many current instructional models are depicting effective learning as a product of an problem-centered environment (Merrill, 2002). The learners within such an environment manifest four phases of learning: establishment of prior experience, exhibition of skill, application of skill, and amalgamation of the skills into the real world (Merrill, 2002). Although there are numerous theories, Nelson's theory on collaborative problem-solving, Jonassen's constructivist learning environments, and Schank's learn by doing theory were examined due to their correlation with the current view of problem-solving and the historical perspective. The theories of Nelson and Jonassen use ill-defined problems and support the use of

collaboration (Jonassen, 1991a, 1991b; Nelson, 1999). Like Nelson and Jonassen, Shank supported social interaction, but differed in that students individually conduct the problem, generate the solution, and then discuss their findings through story telling (Jonassen, 1991a, 1991b; Nelson, 1999). A substantial difference between Shank and Jonassen and Nelson was that Shank's problems are well-defined and have set answers (Jonassen, 1991a, 1991b; Nelson, 1999). Consequently, this influences the educator's role toward being a moderator of activities rather than a guide.

Nelson's collaborative problem-solving theory addressed all phases of problem-solving, placing considerable importance place on the application phase but minimizing the importance placed on the demonstration phase (Nelson, 1999). Through the use of an integrated guideline set, the learning environment delineated by Nelson provided for critical thinking, creativity, and complex problem-solving (Nelson, 1999). In addition, this theory provides for the expansion of social skills (Nelson, 1999). Nelson and Jonassen differed in how the facilitator or instructor should be used (Jonassen, 2000; Nelson, 1999).

Jonassen supported the instructor providing assistance in the beginning and slowly withdrawing from the group, while for Nelson, the instructor functions at the same rate of applicability (Jonassen, 1991a, 1991b; Nelson, 1999). In addition, Jonassen's constructivist learning environment emphasized problem-solving in its purpose, which is for the learner to understand and solve a problem in order to complete a project (Jonassen, 1991a, 1991b). Jonassen stressed that the problem is the driving force of learning and that in order to solve the problem the learner must comprehend the domain content (Jonassen, 1991a, 1991b). Furthermore, Jonassen was a strong proponent for the progression of a problem in which the educator starts the learner on a task the learner can solve and then expands the task to a more

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complex problem that requires collaboration to achieve solution (Jonassen, 1991a, 1991b). In Jonassen's constructive learning environment, the educator's role changes from facilitator to coach, in which the educator supervises, evaluates, and regulates the learner's skill development (Jonassen, 1991a, 1991b).

Shank's learn-by-doing approach was a problem centered approach that places the most emphasis on the application phase of problem-solving. Although integration of methods are mentioned no process is explicated (Schank, Berman, & Macpherson, 1999; Schank, Fano, Bell, & Jona, 1994). Shank's approach was goal-based; in which the learner has set goals to achieve and in order to accomplish those goals the learner must practice certain skills (Schank, et al., 1999; Schank, et al., 1994). Furthermore, the learner must gather relevant content in order to learn those skills (Schank, et al., 1994). Unlike the problems of Jonassen and Nelson, Shank's problems are considered to be well defined. Consequently, the learner stayed motivated to achieve the goal (Merrill, 2002). Shank, like Nelson, believed that social interaction was necessary for problem-solving to occur. Thus, Shank would advocated for learners to share their stories of how they accomplished their goals (1994).

Overall, Schank, Jonassen, and Nelson have shown that social interaction was necessary for problem-solving to occur (Jonassen, 1991a; Nelson, 1999; Schank, et al., 1999). An advantage of using social interaction in problem-solving was that the learner stays motivated to achieve the goal (Schank, et al., 1999). From the concept of a constructive, social learning climate, the model of creative problem-solving arose.

Creative Problem-solving

Creative problem-solving as an approach has been developed over the past five years (Treffinger, et al., 2008). Currently, there were a variety of different models and approaches to

creative problem-solving (Treffinger, et al., 2008). The most widely accepted model is that of

Treffinger and his associates (Isaksen, et al., 1998; Treffinger & Isaksen, 2005; Treffinger,

Isaksen, & Dorval, 2000; Treffinger & Nassab, 2000; Treffinger, et al., 2008). Treffinger's

creative problem-solving model was categorized into four main components: preparing for the

action, planning your approach, understanding the challenge, and generating ideas (Isaksen, et

al., 1998; Selby, et al., 2004; Treffinger & Isaksen, 2005; Treffinger, et al., 2000; Treffinger &

Nassab, 2000; Treffinger, et al., 2008). These four components encompassed eight different sub-

components. This model differed from other creative problem-solving models in that it is

circular in format. The purpose of this format was to depict the "reality that problem solvers

enter and exit the process based on their own level of readiness and understanding of the problem

situation" (Treffinger, et al., 2008, p. 391). This model depicted creative problem-solving as a

system to generate thinking tools that assist in extrapolating problem-solving options (Treffinger

& Isaksen, 2005; Treffinger, et al., 2008). This system facilitated response to a specific problem

through the use of strategy customization and tools (Treffinger & Nassab, 2000). Due to its

systematic approach, creative problem-solving enabled researchers to consider the interactions

between individual characteristics and the environmental influences (Treffinger, et al., 2000). In

addition, researchers postulated that the model has led to the development of quantitative and

qualitative assessment approaches as well as serving as a diagnostic tool for the identification of

problem-solving styles and behaviors (Treffinger & Isaksen, 2005; Treffinger, et al., 2008).

From the creative problem-solving approach, problem-solving styles have developed.

Problem-solving styles can be defined as an individual's predisposition "toward change

management and problem-solving is influenced in part by mindset, willingness to engage in and

respond to a situation as presented, attitudinal dimensions of one's personality" (Selby, et al.,

2004, p. 222). Measuring problem-solving style was essential to assisting the learner in the development of problem-solving ability, therefore this necessitated the need for an instrument (Selby, et al., 2004). The VIEW instrument was the preferred evaluation measure for problem-solving style (Selby, et al., 2004). The VIEW instrument assessed three components of individual problem-solving style: orientation-to-change, processing, and deciding (Selby, et al., 2004).

With regard to orientation-to-change, a learner could be either an explorer or developer. The explorer style was characterized by being adventurous in endeavors over expansive task domains. Explorers typically liked ill-defined problems and enjoyed the challenge of indistinct conditions. They enjoyed new experiences and situations. The explorers directed the problem to a new direction. They collected significant amounts of data for a tremendous number of problem solutions. Explorers found it challenging to move from the idea generation phase of creative problem-solving to the activities phase. They find plans and procedures limiting and confining and when left to their own devices will move from a project without closure. Another criticism of explorers is that they are not detail oriented; however their strongest attribute is their ability to be flexible (Selby, et al., 2004; Treffinger, et al., 2008).

The developer looks at a problem starting with the basics, then organizes and amalgamates a complete useful outcome. Developers are concerned with the practical aspects of a problem and that the problem's solution is applicable to a real life setting. Developers typically use creative and critical thinking in order to arrive at their problem solutions. Developers examine the problem in a realistic framework and tend to be efficient when exploring data. They tend to generate data that are focused on their understanding of the situation within reality rather than the desired problem solution. Developers have very detailed action plans and

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are focused on the culmination of the present problem. A criticism of developers is that they have difficulty with flexibility (Selby, et al., 2004; Treffinger, et al., 2008).

In the area of processes, the VIEW instrument determines which type of processing is preferred between external and internal processing styles. Learners with an external processing style prefer interaction, discussion, and collaboration with others. This type of learner is not bothered by extraneous noise and is apt to enjoy physical movement within the process. As a part of their collaborative nature, they compare their view of the problem with colleagues in order to develop the problem solution. Criticisms of external learners are that their plans of action lack specificity and often they rush toward completion (Selby, et al., 2004; Treffinger, et al., 2008).

In contrast to external learners, internal learners prefer to focus on personal resources; consequently, they prefer independent learning. This allows them to work at their own pace and reflect when needed. Internal learners contemplate the problem, generate ideas, create a personal understanding of the problem, and gather data prior to collaborating with a peer group. Internal learners establish an action plan after much contemplation (Selby, et al., 2004; Treffinger, et al., 2008).

The final component measured by the VIEW assessment evaluates how a person decides. The way in which they do so is characterized by either a person or a task style. Learners who prefer the person style examine how a decision will affect the emotions of the people around them. Person-style learners want their groups to be harmonious and positive. This type of learner is often seen as gracious, warm, and kind. In addition, they tend to be intuitive to the needs of others. When person-style learners examine a problem, they look at the data, challenges, and solutions and determine the personal impact that each will have on all concerned.

The person-style learners add a human element to the problem-solving group (Selby, et al., 2004; Treffinger, et al., 2008).

Task-style learners examine the problem in a logical format that can be justified impartially. They make decisions based on their understanding of the content before arriving at the best solution. The task style learner often appears to take an impersonal approach to the problem-solving process. In addition, they tend to offer strong leadership and generate action plans that are based on the cause and effect of the situation. Task-style learners ensure that the desired outcome of the problem-solving activity is clear and evident (Selby, et al., 2004; Treffinger, et al., 2008).

Creative problem-solving accentuates cognition, rationalization, and creativity (Selby, et al., 2004; Treffinger, et al., 2000; Treffinger, et al., 2008). However, the importance of individual characteristics, styles, and concepts may enhance the effectiveness and power of this approach (Selby, et al., 2004; Treffinger, et al., 2008). Treffinger and Isaksen stressed the need for research studies examining characteristics, style, impressions, and concepts and their influence on creative problem-solving (Treffinger & Isaksen, 2005). Creative problem-solving is an evolutionary process. The VIEW assessment provides a way to evaluate problem-solving style. With this assessment, individuals gain a better understanding of their problem-solving style and can apply that knowledge to their creative problem-solving (Selby, et al., 2004; Treffinger & Isaksen, 2005; Treffinger & Nassab, 2000; Treffinger, et al., 2008).

Instruction

For instruction to be effective in the development of youth as problem solvers, it must be on-going from primary through graduate school and procedures must be demonstrated across

domains to allow for knowledge acquisition and schemata development. Instruction in problem-

solving can be presented in six central objectives of:

1. Develop the problem structure
2. Edify pattern recognition
3. Develop problem-solving procedures
4. Expand knowledge and knowledge structure
5. Understand aptitudes
6. Provide practice with feedback and models

With previous literature and research, the argument for the use of these six central objectives was

presented.

Develop the Problem Structure

Central to Newell and Simon's problem-solving theory is how the problem solver

perceives the problem space (Newell & Simon, 1972). For the problem solver to develop an

understanding of the task environment or problem space, instruction should be given. Key to the

problem solver learning how to use the problem space is for the instructor to provide practice in

which the student can ask probing questions, attempt plausible solutions, and examine the

situation for redundancies (H. A. Simon, 1980). Glaser (1984) postulated the need for instruction

in defining the problem space and using information about the problem space to recreate the

problem in order to develop a solution.

Simon and Newell promoted a series of steps that should be used to develop an

understanding of the problem space. The first guideline is that only a few concepts from

information processing systems are characteristics of human problem-solving theory (Newell &

Simon, 1972; H. A. Simon & Newell, 1971). These concepts can best be summarized with the

thought that problem-solving occurs sequentially, one step at a time. From Newell and Simon's

(1971) research, the learner discovers the solution to the problem in a sequential fashion. The

steps to the solution are small and rapid bits of knowledge that steadily build on each other to

synthesize the solution. The second guideline is that the characteristics from information processing systems are used to determine the task environment, which is known as the problem space. Problem-solving occurs in the problem space (Newell & Simon, 1972; H. A. Simon & Newell, 1971). The third guideline is that the configuration of the task environment determines the probable arrangements for the problem space (Newell & Simon, 1972; H. A. Simon & Newell, 1971). Within the problem space, there is a series of states of knowledge for which the learner obtains knowledge about the problem for that specific moment in time. The fourth and final guideline is that the arrangement of the problem space establishes the probable methods that can be used for problem-solving (Newell & Simon, 1972; H. A. Simon & Newell, 1971).

Discovery learning. Discovery learning has been cited as a method that assists the learner in developing an understanding of the problem space and the ability to reorganize this space to begin to formulate a solution (Greeno, 1978; Newell & Simon, 1972). As with discovery learning, many researchers have postulated the importance of flexibility in instruction of the problem (Egan & Greeno, 1973; Greeno, 1978). A strategy to promote this flexibility is for the problem solver to communicate the goals and plausible strategies to be used to solve the problem (Resnick & Glaser, 1975).

Discovery learning is a constructivist approach that works within the constructs of problem-solving situations in which the learners use their preexisting knowledge to discover facts and relationship in the creation of new knowledge (Bruner, 1967). The learners interact by exploration and manipulation of objects while contemplating questions and performing experiments (Bruner, 1967). Due to the interactive nature of the process, learners are more likely to remember the concepts and knowledge than with the use of other strategies (Bruner, 1967). The advantages of discovery learning are numerous and include that it encourages interaction;

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sponsors motivation, responsibility, and independence; assists in the development of creativity and problem-solving skills; and provides an individualized learning experience (Bruner, 1967).

Pure discovery learning is often met with opposition due to the lack of interaction and guidance from the instructor (Mayer, 2004). A more popular strategy is guided discovery learning, in which the instructor serves as a coach through the discovery process (Mayer, 2004). A concern with discovery learning is that its purpose is for the learner to discover the outcome the instructor wants (Savery & Duffy, 1995). Proponents for this approach assert that when compared to analogical reasoning and brainstorming, the level of cognition is higher and the ability to transfer the problem-solving skills learned is greater (McDaniel & Schlager, 1990). Once the learners have developed their definition of the problem and strategies to be used to conceptualize the problem space, the next step is to teach pattern recognition.

Edify Pattern Recognition

Problem-solving skills require a certain amount of perception. Providing practice to improve the recognition of a problem, the type of problem, and strategies to use to solve the problems is imperative to the development of learners into problem solvers. Simon (1980) stated that expert problem solvers have prompt and automatic pattern recognition. Therefore, in order to develop learners into problem solvers there must be the allocation of time for the learners to test their strategies. In addition to practice, the instructor must use modeling to depict effective observational skills. The use of observational modeling is considered essential to those learners who have a low aptitude for problem-solving (Frederiksen, 1984). With practice and observational modeling, learners can develop their own pattern recognition ability. The next instructional step is to teach problem-solving procedures.

Develop Problem-solving Procedures

Both Glaser (1984) and Simon (1980) supported the use of instruction in general problem-solving techniques. These techniques can vary from means end analysis to analogical reasoning. Simon (1980) was a proponent for the instructor to explain the technique, demonstrating the technique, and providing opportunity for the learner to practice the technique. Resnick and Glaser (1975) depicted strategies as a means for the learner to learn how to learn. Both support the use of a procedural approach wherein the learner looks for cues in the problem space, then communicates the goals and strategies to solve the problem prior to attempting the solution. Resnick and Glaser (1975) postulated that the use of this method assists the learner in development the most correct strategy.

Rumelhart and Norman (1981) supported the use of analogical reasoning as the primary problem-solving procedure. Analogical reasoning is general problem-solving strategy that uses solution plans from familiar situations to solve the new problem situation (Anderson, Reder, & Simon, 1996; Chen, 1999; Gick, 1986; Hall, 1989; Sternberg, 1977). There are several approaches to analogical problem-solving but for any approach to be effective, analogical problem-solving requires knowledge of the familiar situations and problem situations (Anderson, et al., 1996; Gust, et al., 2008). Learners who have low knowledge about a problem will have difficulty forming a relationship between the problem and an analogy no matter the approach (Frederiksen, 1984; Gust, et al., 2008).

Analogical reasoning can be divided into two sub-categories: learning by transfer and learning by abstraction (Gust, et al., 2008). In learning by transfer, there is a basic premise that a large sample of examples is available to apply the problem to and to solve the problem or learn the procedure (Gust, et al., 2008). The size of the example pool can be reduced by

conceptualizing the problem (Gust, et al., 2008; Hall, 1989). In learning by abstraction, the learner must generalize the problem's components and then, with the use of those generalized components, determine how to solve the problem through a series of steps (Gust, et al., 2008; Sternberg, 1977). The differences between learning by transfer and learning by abstraction are that transfer places one solution over the existing problem in which abstraction takes general principles from pre-existing solutions and apply these to the existing problem (Gust, et al., 2008).

Analogical problem-solving differs from generate and test as well as means-ends analysis because the learner can often reach a solution to the problem that may not be the solution the facilitator wanted (Chi & Glaser, 1985). This solution is normally a correct solution and the reason for the difference is due to the transfer and abstraction that takes place during the problem-solving process (Gust, et al., 2008; Sternberg, 1977).

In order to teach analogical reasoning, the instructor must begin in an area the learner is familiar with and move into a new situation. This transition from one situation to the other is referred to as analogical transference and is considered by analogical reasoning researchers to be the central reason to teach analogical reasoning over other problem-solving methods (Gick, 1986; Gick & Holyoak, 1980, 1983).

Researcher had expressed concern that analogical reasoning may not be suitable for all learners and therefore some postulate that generate and test may serve as a beginning procedure for either the extremely young or inexperienced (Bransford, Sherwood, Vye, & Rieser, 1986; Resnick, 1987). Generate and test is a heuristic method that creates several solutions for one problem (Chi & Glaser, 1985; Frederiksen, 1984). These solutions are tested to determine if the correct solution was among the generated solutions (Simmons & Davis, 1987). Generate and test is useful when there are a reasonable number of solutions to be tested (Simmons & Davis, 1987).

Examples of generate and test are scientific research and medical diagnosis (Chi & Glaser, 1985). Disadvantages to this method are that it is the least structured method and the weakest correct solution generator (Jonassen, 1997).

Expand Knowledge and Knowledge Structure

Learners who have preexisting knowledge about a problem tend to function exponentially better than their counterparts who lack knowledge about the subject the problem pertains to. Education and knowledge gain in the subject area allows learners to contemplate variables and aspects that are innate to the subject. The amount of knowledge that is necessary depends on the level of the subject matter, an example would be solving a crossword puzzle verses a physics logarithm. Clearly, the crossword puzzle requires a limited amount of knowledge about the subject whereas the physics logarithm requires knowledge about physics principles such as Newton's law of gravity and propulsion. Additionally, the logarithm necessitates knowledge transference in mathematical computation. Therefore, in order to solve the problem of the physics logarithm, learners must have knowledge in both mathematics and physics whereas learners solving a crossword puzzle must know how to read and spell.

The amount of knowledge a learner has about the subject assists learners to manipulate the problem structure and apply problem-solving procedures that are justifiable. Glaser (1984) argued that the amount of knowledge one has influences the learners' ability to transcend from novice to expert problem solvers. In order to become expert problem solvers, learners must develop knowledge structures that occur over time through learning and experience (Azmitia, 1988; Chi, et al., 1981; Glaser, 1984). How novice and expert problem solvers create their knowledge structure is vastly different. Novice problem solvers organize their knowledge

around the problem space or statement whereas expert problem solvers organize their knowledge around principles and generalizations (Glaser, 1984).

The development of schemata is an adaptable information structure that represents general concepts stored in long term memory (Schunk, 2008). Schemata are useful tools in that they are used, tested, and amended based on the individual. They provide a source of reference and prediction for the learner. The influence of schemata on youth is paramount in so much that researchers have postulated that knowledge development in the schema improves youth's ability to gain knowledge and develop sophisticated problem-solving skills (Carpenter, Ansell, Franke, Fennema, & Weisbeck, 1993; Hiebert, et al., 1996; Kintsch & Greeno, 1985; Mary S. Riley & Greeno, 1988; M. S. Riley, Greeno, & Heller, 1983). Glaser (1984) substantiated that learners try to reference what they already know to new knowledge and therefore it is best to teach problem-solving as inference to previous knowledge and correcting error insight as learners progress in their understanding. Riley and Greeno (1988) supported this method of knowledge acquisition with the modification of that new knowledge should be presented in small tangible bits that depict how the new knowledge relates to the old thus promoting connection in the developing schemata. Although Carpenter, Ansell, Franke, Fennema, and Weisbeck (1993) were proponents of Riley and Greeno's (1988) method, they argued that the teacher influences the ability of the student to construct their schemata and that through observational modeling the youth develop understanding and make connections within their schemata.

Understand Aptitudes

Skill development and teaching procedures are important to the development of a problem solver. For problem solvers to develop into experts, they must understand their aptitude for problem-solving. Through understanding the ways and approaches that they are more

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inclined to follow, problem solvers can further develop their problem-solving strategies within their schemata and become more aware of how their aptitude affects their ability to solve problems.

Provide Practice with Feedback and Models

Many educators realize the importance of providing practice in order for the learner to grasp a concept. Practice across knowledge domains is essential to the acquisition of problem-solving skills (Anderson, 1993; Anderson, et al., 1996; Carpenter, et al., 1993; Newell & Simon, 1972; H. A. Simon, 1980). Most readily, educators need to provide adequate models that make connections with previous knowledge that a student should have (Carpenter, et al., 1993). To assist educators with both modeling and practice, many researchers support the use of peer learning groups also known as school-based problem-solving teams (Palincsar, Anderson, & David, 1993; Wilson & Berne, 1999).

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Summary

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Researchers using various instruments have addressed self-concept, most specifically academic self-concept. A review of the literature verifies a need for further research in domain specific areas of self-concept. Although there are many studies addressing self-concept, results from these studies have been inconsistent. In addition, inconsistencies in self-concept research can be attributed to the use of varying self-concept instruments. However, there is clearly a lack of research in areas such as problem-solving self-concept and social self-concept.

A review of available literature reveals that research in problem-solving falls into the general areas of historical influences on problem-solving, postulating the reason problem-solving was adopted as the pedagogical foundation for education, strategies for implementation, and the need for further research to determine problem-solving impact on the learner. The research has

shown that problem-solving is a benefit to the learner and influences critical thinking and cognition development.

In summary, a review of the available literature reveals that research informing the questions posed by this study is inconclusive and limited. Therefore, further research investigating the relationship between self-concept and problem-solving style and their impact on a problem-solving task as manifested by high-achieving students was warranted.

Chapter III

Methodology

Prior to initiating the study, the researcher successfully obtained institutional review board approval from the affiliated institution, provided justification for the study, identified the recruitment and consent processes, and provided a depiction of how the data would be used. The purpose of this mixed methods study was to investigate the relationship between perceived self-concept and perceived problem-solving style and how these two constructs compare and contrast in regards to a participant's perception of their problem-solving ability. This study sought to examine the following questions:

Question 1: What are the relationships between problem-solving style and perceived self-concept for this group of participants?

Question 2: How do participants describe their problem-solving ability for a given problem-solving task?

Question 3: How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

The specific mixed methods research design used in this study is concurrent triangulation design. The researcher selected this design due to its purpose, which is to gather a variety of corresponding data on the same topic. In addition, this design was appropriate for this study because this research sought to compare and contrast qualitative and quantitative results (Creswell & Clark, 2007). The research methodology used was mixed methods as postulated by Creswell and Clark. Since mixed methods methodology is an emerging discipline, Creswell and

Clark recommended that the researcher describe the mixed methodology to be used as well as following that methodology's terminology throughout the research.

Mixed Methods

Mixed methods research has been a staple to enhance evaluation design since 1989 when Green, Caracelli, and Graham (1989) postulated five major ways to enhance evaluation. Green et al. maintained that using mixed methods, a research strategy that integrates both quantitative and qualitative methods, would produce sound results that are anchored in quality and scope. Many researchers in the fields of family science, education evaluation, and psychology have worked toward developing mixed methods research practices within their fields (Creswell & Clark, 2007; Greene, 2006; Greene, et al., 1989; Hanson, Creswell, Clark, Petska, & Creswell, 2005; Johnson & Onwuegbuzie, 2004; Mertens, 2009; Plano Clark, Huddleston-Casas, Churchill, O'Neil Green, & Garrett, 2008; Sale, Lohfeld, & Brazil, 2002; Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009). Recently, Creswell and Clark (2007) provided a sound theoretical basis for mixed methods study with their definition of mixed methods as:

> a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative approaches in many phases in the research process. As a method, it focuses on collecting, analyzing, and mixing both quantitative and qualitative data in a single study or series of studies.
> (Creswell & Clark, 2007, p. 5)

Mixed methods research has three major tenets. The first is the idea that quantitative and qualitative methods are compatible and can be used as a part of a single research study. The second is the pragmatic philosophy that a research method should use an approach or a combination therein that is suitable for real world situations. Finally, the researcher should use a mixture of methods that have corresponding strengths and non-related weaknesses. (Creswell &

Clark, 2007; Greene, et al., 1989; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 1998, 2003)

Definitive characteristics of a mixed methods research study are mixing, timing, and priority. "Mixing" is a term that is unique to Creswell and Clark (2007) and was used in this study to describe what other researchers call "triangulation" (Caracelli & Greene, 1993; Greene, et al., 1989; Johnson & Onwuegbuzie, 2004; Tashakkori & Teddlie, 2003). "Mixing is the explicit relating of the two data sets" (Creswell & Clark, 2007, p. 83). Creswell and Clark (2007) stated that if a study does not have mixing of both quantitative and qualitative data then it is considered a multi-method study. Mixing can occur in three key ways: merging, embedding, and connecting. The present study employed merging by integrating the two data sets both in the data analysis phase through the use of a mixing table and in the interpretation phase through discussion (Creswell & Clark, 2007).

While timing, also known as implementation and sequence, can be either concurrent or sequential (Creswell & Clark, 2007; Tashakkori & Teddlie, 2003). This was a concurrent study. That is, this was a study in which both quantitative and qualitative methods are implemented during the same time frame unlike a sequential study in which one method would follow the other (Creswell & Clark, 2007; Morse, 1991). The timing of a study can help dictate the priority or weighting of one type of research method over another. The priority for a study refers to the emphasis between quantitative or qualitative research. For the purpose of the present study, the quantitative and qualitative research components had equal priority.

Mixed methods methodology is often seen as a component of multi-methods, however mixed methods methodology has been clearly defined as both a method and as a methodology and incorporates both research (quantitative and qualitative) methods in the analysis and

discussion (Caracelli & Greene, 1993; Greene, et al., 1989; Sale, et al., 2002; Tashakkori & Teddlie, 2003). Proponents of mixed methods asserted that qualitative and quantitative research methods complement one another both by enhancing one another and by compensating for each other's weaknesses (Caracelli & Greene, 1993; Creswell & Clark, 2007; Plano Clark, et al., 2008; Siefert, et al., 2009; Tashakkori & Teddlie, 2003; Teddlie & Tashakkori, 2009). Not only is validity enhanced when each method has similar result, but mixed methods allow researchers to effectively and decisively examine previous works for discrepancies (Creswell & Clark, 2007; Plano Clark, et al., 2008; Tashakkori & Teddlie, 2003).

Research Design

The specific mixed methods research design used in this study was concurrent triangulation design (depicted in figure 1). This design was appropriate for this study because this research sought to correlate qualitative and quantitative results (Creswell & Clark, 2007). The study design timing was concurrent due to the data collection for qualitative and quantitative occurring in a similar period. The use of a mixed methods approach enabled the researcher to use an inductive aspect to inform a deductive component.

```
Data Collection          Data Analysis          Merging of Data          Interpretation

QUAN: SDQIII         QUAN Data
                     Analysis Using        Compare and          Intepretation of
                     JMP & Excel           Contrast Data        QUAN  & QUAL
QUAN: VIEW                                 through the use of   in the discussion
                                           mixing tables in     section
                     QUAL Data             the results section
QUAL: Open-          Analysis: Content
ended Interviews     and constant
                     comparison
                     analysis
```
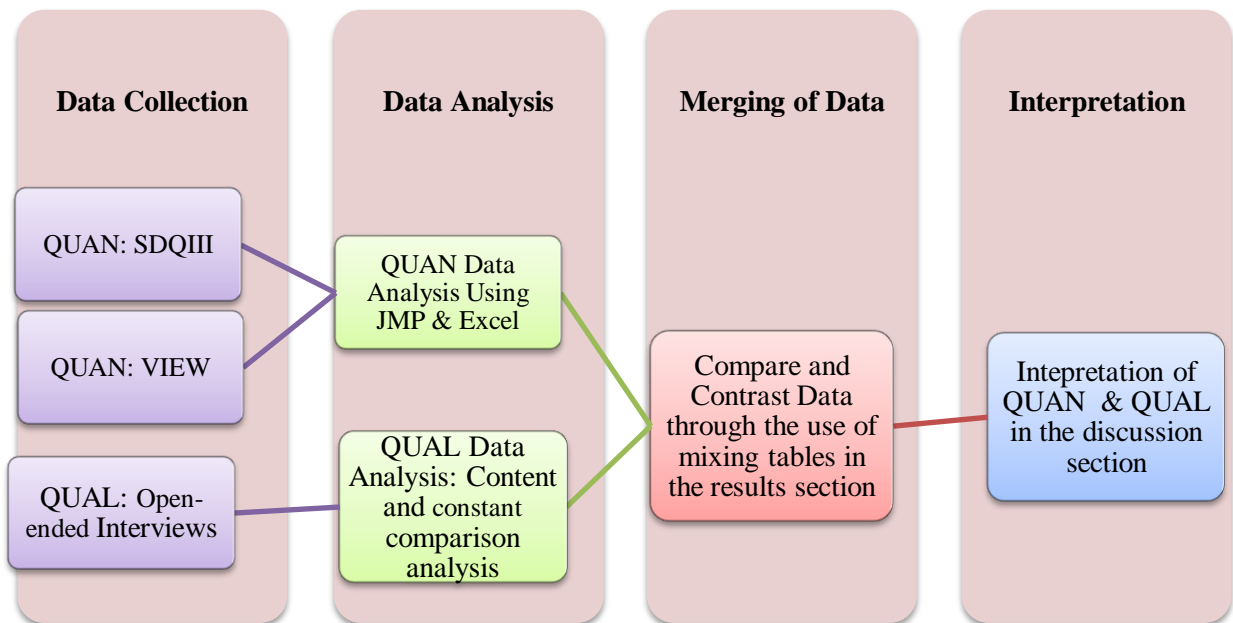
Figure 1. The triangulation design model adapted from J. W. Creswell and V. L. Plano Clark, 2007, *Designing and Conducting Mixed Method Research*, p 63.

Target Population and Subjects

The target population for this study was high-achieving rising 11th and 12th grade high school students and the assessable population is limited to those who attended a summer enrichment program for agriculture in the state of Virginia. The researcher identified participants as high-achieving due to gaining acceptance into this summer enrichment program, which is a selective, academically rigorous program that based admittance on previous performance. This program is a summer enrichment program with a focus on agriculture.

Recruiting of participants from the target population occurred in a multi-step process. First students applied to attend the summer enrichment program for agriculture. The criteria for acceptance into the program required that a faculty member at the local high school nominate the applicant as well as the applicant have a GPA of 3.0 or better and be a rising junior or senior in secondary education.

Students accepted into the summer program received an explanation of this research study as well as a written invitation to participate and a request for consent to participate in the study with their notification of admission to the program. Additionally, those who did not return signed consent forms with their registration were again invited to provide written consent to study participation upon arrival for the program. Previous research with a similar population achieved a 95% participant rate (Overbay, 2006). Study participants consisted only of those students who return their signed consent forms.

The subjects for this study were a convenience sample of approximately 100 high-achieving rising 11th and 12th grade high school students who attended a summer enrichment program for agriculture. From this subject population, all participated in the quantitative portion of the study. However only 15% of the study participants were selected for interviews to reach saturation. Selection for interviews was based on gender and locality in order to provide a representative group.

Data Collection: Instrumentation

This study used two quantitative instruments, the Self-Description Questionnaire III and the VIEW: an Assessment of Problem-solving Style. Both instruments were self-reporting and were designed to be self-explanatory. The Self-Description Questionnaire III was used to assess self-concept and the VIEW: an Assessment of Problem-solving Style was used to ascertain problem-solving style.

Instruments: Self-Description Questionnaire III

This study used the *Self-Description Questionnaire III* (SDQ III) (Marsh, 1990a), an available instrument, to measure the self concepts of the participants. While the instrument examines 13 distinct domains of self-concept, only six of those were pertinent to this study. The

59

relevant domains were general academic, verbal, mathematics, problem-solving, same-sex peer, and opposite-sex peer. The theoretical basis for this instrument was the Shavelson, Hubner, and Stanton multidimensional, hierarchical model of self-concept (Shavelson, et al., 1976). The SDQ III target audience is late adolescents and young adults; however, "it can be used for younger participants with consideration that the reading level may be inappropriate and could require explanation" (Marsh, 1990a, p. iii; Marsh, et al., 2008). This instrument was a self-reporting questionnaire that requires no specialized training, was designed to be self-explanatory, and could be utilized as a part of a mail survey. This survey took approximately 20 minutes to complete.

     Format of instrument. The SDQ III questionnaire is five pages in length. The first page is a participant informational page describing the purpose of the instrument, the instructions for the instrument, and participant questions such as gender, year of birth, and current date. The complete questionnaire is composed of 13 subscales of math, verbal, academic, problem-solving, physical ability, appearance, same-sex peers, opposite-sex peers, parents, spiritual/religion, honesty, emotional, and general esteem, totaling 136 statements. Each subscale contains ten to twelve items. The statements are randomly intermixed and none are identified by subscale heading (Marsh, 1990a). The 136 items are simple declarative sentences in which half are positive and half are negative. The respondent scale is one to eight with one being "definitely false" and eight "definitely true" (Marsh, 1990a).

The SDQII contains items such as those found below:

"I find many mathematical problems interesting and challenging."

"I have trouble expressing myself when trying to write something."

"I enjoy doing work for academic subjects."

"I am never able to think up answers to problems that haven't already been figured out."

"I have hesitated to take courses that involve mathematics."

"I can write effectively."

"I hate studying for many academic subjects."

(Marsh, 1990a, p. 2)

Scale norm, validity, and reliability. The SDQ III's norms are based on responses from 2,436 subjects through a sequence of ten studies wherein the subjects completed the SDQ III instrument (Marsh, 1990a). The instrument has been extensively evaluated as an instrument to measure self-concept and can be in the *Mental Measurement Yearbook,* however other researchers have also evaluated this instrument and found it to be a valid measure for self-concept (Harter, 1990; Marsh, 1987). Content validity of the SDQ instruments (I, II, and III) was supported in the work of Shavelson, Hubner, Stanton (1976) and their model for self-concept. In addition to the work of Shavelson, Hubner, and Stanton, Marsh and colleagues have over 80 publications that provide articulation of the theoretical components and justifications for self-concept (Marsh, 1987). Construct validity was examined through exploratory and factor analysis of the 2,436 responses from the normative database. Additional construct validity was presented within individual variables in which theoretical relationships amongst variables were presented, examples include academic achievement, self-efficacy, and study skills (Marsh, 1987). Factor analysis and correlational indices provide the empirical validity evidence for the

SDQ III (Marsh, 1987). The reliability of the SDQ III was reported through alpha coefficient estimates for each scale with a range of 0.76 to 0.95 with a median of 0.89. The alpha coefficient values for the subscales used in this study are Mathematics 0.95, Verbal 0.86, Problem-solving 0.84, General Academic 0.92, Same-sex Peer 0.87, and Opposite-sex Peers 0.92. The high level of reliability supports that each scale contains sufficient items and provides justification for the low standard error found in the measurement indices (Marsh, 1987, 1990a). The SDQ III is reliable in measuring aspects of self-concept and each item is "significant and substantially correlated" (Marsh, 1990a, p. 14) to each other. The reviewers in the *Mental Measurement Yearbook* found the SDQ to have "internal consistency and stability estimates . . .[that] are commendable and suggest accurate data will result" (Marsh, 1987, p. 3)

Instruments: VIEW: An Assessment of Problem-solving Style

This study uses the *VIEW: An Assessment of Problem-solving Style* (Selby, et al., 2002a), a commercially available instrument to measure problem-solving style. The VIEW measures three domains of problem-solving: orientation-to-change, manner of processing, and ways of deciding (Selby, et al., 2002a). The theoretical basis for this instrument is the creative problem-solving framework postulated by Treffinger, Selby. & Isaksen (2008). The VIEW's target audience is adolescent to adult. This survey took approximately 10-15 minutes to complete.

Format of the instrument. The complete questionnaire is composed of 34 items that are simple declarative sentences with half being positive statements and half being reverse coded statements. The statements are randomly presented and none are identified by domain heading. There are 18 items for the orientation-to-change domain, eight items for manner of processing, and eight items for ways of deciding. The respondent scale is one to seven; participants are asked to select the mark between two statements when considering "When I am solving

problems, I am a person who prefers . . ." (Selby, et al., 2002a, p. 5). Sample spectrum

statements are:

1. "To work with the guidance of a clear structure"	1. "To work without boundaries"
2. "To follow ideas wherever they lead"	2. "To direct ideas toward the task at hand"
3. "To let my ideas flow freely"	3. "To search for practical ideas"
4. "Quiet concentration"	4. "Involvement with others"
5. "Drawing energy from within"	5. "Drawing energy from talking with others"

(Selby, et al., 2002a)

The scale for orientation-to-change is 18 to 126 with a theoretical mean of 72 while manner of

processing and ways of deciding use scales of 8 to 56 with theoretical means of 32 (Selby, et al.,

2002a).

Each domain is further divided into polar opposite subsets. Orientation-to-change has the

two dimensional styles of explorer and inventor. Lower scores indicate the explorer style and

higher scores identify the inventor (Selby, et al., 2002a, 2004; Treffinger, et al., 2008). Manner

of processing has the styles of external and internal, with the higher score depicting an internal

processing style whereas a lower score identifies an external processing style (Selby, et al.,

2002a, 2004; Treffinger, et al., 2008). Ways of deciding has the styles of being person-focused

(lower scores) or task-focused (higher scores) (Selby, et al., 2002a, 2004; Treffinger, et al.,

2008). Table 1 provides a list of characteristics for each scale.

Table 1

VIEW Construct Characteristics

Explorer	Developer
Ill-defined problems	Task to solution
Various tasks	Practical applications and reality
Indistinct situations and challenges	Methodical
Creates original ideas	Organized
Observes unusual patterns and relationships	Employ plans, details and structure
Find exterior procedures and plans limiting	
External	Internal
Prefers to work a solution with others	Prefers to work a solution in solitude
Person-focus	Task-focus
Focuses on inter-personal relationships	Focuses on logical decisions

Note: Based on (Selby, et al., 2002a, 2004; Treffinger, et al., 2008)

Scale norms, validity, and reliability. The VIEW's norms are based on responses from 10,151 national and international respondents and are reported in the *Mental Measurement Yearbook* (Selby, Treffinger, Isaksen, & Lauer, 2002b; Treffinger, et al., 2008). Out of the 10,151, the participants' ages ranged from 12 to 82. Furthermore, 43 % of the sample population was male and 57 % were female.

The reliability of the VIEW is reported through Cronbach alpha coefficients for each domain: orientation-to-change, 0.87; manner of processing, 0.82; and ways of deciding, 0.84. The reliability is supported through several studies showing that across dimension and samples the test-retest correlations remain in the 0.80 to 0.89 range and the results are internally consistent (Selby, et al., 2002a).

The *Mental Measurement Yearbook* expresses concern for use of this instrument in that it lacks a clear link to a theoretical framework of Creative Problem-solving and also exhibits inadequate validity evidence (Selby, et al., 2002b). However, in relation to the concept of problem-solving style, reviewers find this to be a preferred instrument for identifying problem-

solving style. . Construct validity was examined through factor analysis of the initial 2,700

respondents and the instrument was found to be valid through the predicted factor analysis

(Selby, et al., 2002a). The VIEW manual addresses criterion-related validity through a sample

study of 118 participants in which the manual reports significant correlations (Selby, et al.,

2002a, 2002b, 2004). Despite the paucity of support for the instrument, the *Mental*

Measurements Yearbook does recommend its use for examining perceived problem-solving style

(Selby, et al., 2002a, 2002b) the intended use in this study.

Data Collection: Qualitative Protocol

To obtain the best possible data for the qualitative portion of this research study, the

researcher used a qualitative interviewing strategy that involved conducting two interviews with

the same participant and developing transcripts of those interviews. In order to obtain the most

accurate transcript, an audio recording device was used. A pilot test of the interview protocol

was conducted prior to implementation on the subject population.

Open-Interview Protocol

According to Rossman and Rallis (2003), this phenomenological interviewing method is

used to explore and gather experiential narrative material in order to develop a richer and deeper

understanding of a human phenomenon. Although Rossman and Rallis urged that three

interviews be conducted, Seidman (2006) stated that alternatives to the three-interview process

can be done as long as life histories, detailed experiences, and reflections of those experiences

are conducted during the interviews. Interviews were conducted using a standardized open-ended

format with carefully worded questions. This format is preferred over other interview formats for

this research since it minimizes variations, maintains focus during the interview so that time will

be used efficiently, establishes the priorities for the interview, simplifies the analysis and

comparison of the interviewees' responses, and assists in creating legitimacy and credability for the study (Creswell, 2007; Rossman & Rallis, 2003) .

Interview Prompts. This study used a priori propostions to support and guide the interview prompts found in Table 2. A apriori proposition is desideratum to the study because it provides empirical and theorectical justification for the interview prompts. Prior to the interview prompts, participants were asked to think of the specific teamwork case study that they have been using during Governor's School. In addition, probing follow-up questions were used as part of the open-ended interview format to increase the depth and clarity of the participants' responses. This study sought to infer phenomena that cannot be observed directly and to legitimize issues gained for this inference (Krippendorff, 2004).

Member Checking. The researcher employed a rigorous member checking practice where the researcher used multiple methods of communication. First, the research obtained interviewees email address and cell phone numbers. Email addresses were used to inform participants of interview selection as well as provide participants the opportunity to review transcripts and submit electron changes. In addition to email, participants received a cell phone text message notifying participants of the opportunity to review transcripts at the beginning of the second interview. At the beginning of the second interview, participants were provided with a hard copy of the transcript to review. The researcher asked participants to read over transcript and provided participants with a minimum of five minutes of review.

For the second interview transcripts, participants received electronic copies through the previously provided email addresses. When the second transcript was emailed participants also received a text message notifying them of the electronic transcript being sent to their email addresses. If the researcher had not receive a response from participants, participants were

contracted a second time via email and text with a friendly reminder that the researcher had not

received a response. In addition, the researcher contacted non-responsive participants by text

message inquiring if participants had read transcript and if there were any changes. The

researcher used this rigorous member checking procedure to insure the highest level of accuracy.

Table 2

A Priori Proposition

A priori proposition	Literature support	Associated research question	Interview questions/probes
In order to develop an understanding for the types of strategies used in problem-solving there must first be an explanation of basic terms and concepts.	(Anderson, 1993; Bransford, et al., 1998; Chi & Glaser, 1985; Gick, 1986; Jonassen, 2000; Mayer, 1998; Newell & Simon, 1972; H. A. Simon & Newell, 1971)	How do participants describe their problem-solving ability for a given problem-solving task?	When you think of the term "problem-solving" what comes to mind? How do you define this term?
A successful problem solver must have multiple strategies that can be generalized to a variety of situations	(Anderson, 1993; Chi & Glaser, 1985; Chi, et al., 1981; Hunt, 1994; Isaksen & Gaulin, 2005; Mayer, 1983; Meadow, et al., 1959; Newell & Simon, 1961, 1972; Parnes & Meadow, 1959; Sweller, 1988; Treffinger & Isaksen, 2005)	How do participants describe their problem-solving ability for a given problem-solving task?	Please walk me through the process or steps you took to deal with the problem found in the case study from your teamwork session at Governor's School?
Problem-solving skills require a certain amount of perception and there is a series of states of knowledge for which the learner obtains knowledge about the problem and establishes the probable method that can be used for problem-solving.	(Bruner, 1967; Egan & Greeno, 1973; Frederiksen, 1984; Glaser, 1984; Greeno, 1978; Gust, et al., 2008; Hall, 1989; McDaniel & Schlager, 1990; Newell & Simon, 1972; Savery & Duffy, 1995; H. A. Simon, 1980; H. A. Simon & Newell, 1971)	How do participants describe their problem-solving ability for a given problem-solving task?	Describe how you decide what information is needed to go about solving this problem You can use your story as an example
Schemata are a source of reference and prediction for the problem solver. Problem solvers try to reference what they already know to new knowledge.	(Carpenter, et al., 1993; Gick, 1986; Halpern, 1996; Hiebert, et al., 1996; Kintsch & Greeno, 1985; Mary S. Riley & Greeno, 1988; M. S. Riley, et al., 1983; Tu, et al., 1995; Voss & Means, 1989)	How do participants describe their problem-solving ability for a given problem-solving task?	Describe how you received/obtained the information you needed in order to solve the problem in your story
Problem solvers can further develop their problem-solving strategies within their schemata, and become more aware of how their aptitude affects their ability to solve problems through understanding the ways, approaches that they are more inclined to follow.	(Isaksen, et al., 1998; Selby, et al., 2004; Treffinger & Isaksen, 2005; Treffinger, et al., 2000; Treffinger & Nassab, 2000; Treffinger, et al., 2008)	How do participants describe their problem-solving ability for a given problem-solving task?	Describe yourself as a problem solver.

Field notes. In addition to making an audio recording of each interview, field notes were taken during each interview. The field notes provided supporting documentataion of the participants' responses and assisted the researcher in understanding and interpreting those responses. The researcher noted the participants' appearance, body language, demeanor, and other non-verbal queues.

Credibility, transferability, reliability and validation. In order to establish credibility and rigor, both triangulation and participant validation were used. Triangulation strengthened the confidence of the findings. This study triangulated data sources by cross checking and comparing information gathered at different times. Another validation method used was participant validation or member checking in which the researcher took transcripts and preliminary interpretations to participants to reflect on accuracy and alternate interpretations. To promote transferability, the researcher used rich, thick descriptions to provide the readers of the study an opportunity to determine if this information could be transferred due to shared characteristics. In this study, reliability was addressed through the researcher using detailed field notes, recording the interviews, and transcribing the interviews. Trustworthiness was established through triangulation, member checking, and chain of evidence. Chain of evidence is a logical relationship between the research questions, procedures, data, and results as intially represented in the apriori table (Table 3). This research study used pattern matching and representativeness check for chain of evidence.

Procedure

This study followed the triangulation model depicted in Figure 1. Following Institutional Review Board approval, parental and participant consent were obtained during the

registration process of the summer enrichment program. Detailed research procedures are depicted in Figure 2.
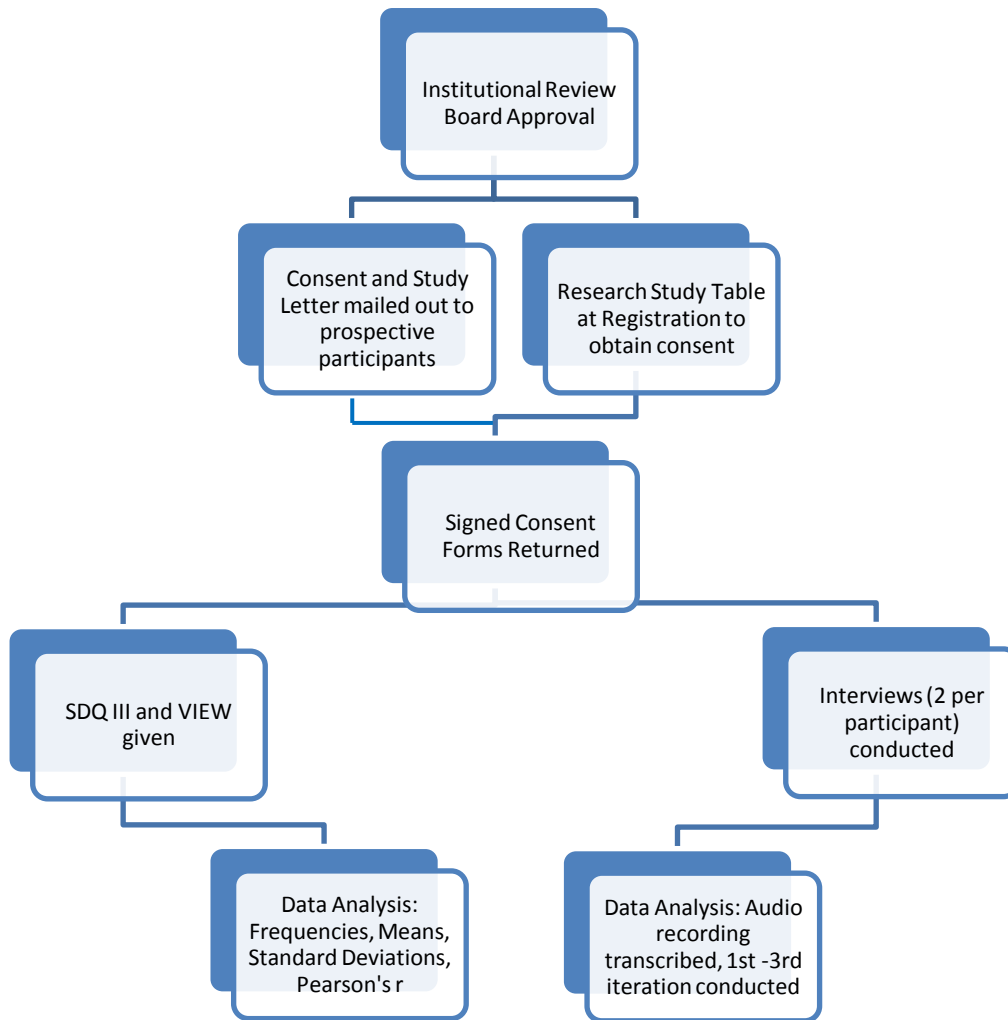
Figure 2 Research procedures. The above depicted a flow diagram for the research procedures used for this study.

During the data collection phase of this study, completion the quantitative instruments occurred on two different occasions at the culumination of a summer enrichment class. Select participants were intially contacted by email to notify them of their selection as an interview participant. The selected interviewees were interviewed twice following the interview protocol for approximately 20 to 40 minutes. The initial interview and the follow-up interview occurred

approximately one week apart in order to allow the interviewee time for reflection on the questions and the opportunity to review the transcript from the previous interview.

Quantitative Data Analysis

The quantitative data analysis used JMP statistical software to calculate means, standard deviations, and Pearson's r correlations. Means and standard deviations for each domain of self-concept (verbal, mathematics, academic, problem-solving, same-sex, and opposite-sex) and problem-solving style (orientation-to-change, manner of processing, and ways of deciding) were computed for the data collection period. Frequencies were computed for demographic data. Selected inferential statistics were used to answer the research questions. Pearson's r correlations were used to determine if there was a statistically significant relationship between the constructs that were examined.

The current study was composed of a small sample size (n=86); in such cases type II error can be increased due to the expected small effect size of the independent variable. This research reduced the likelihood of a type II error by establishing *a priori* the threshold for statistical significance at the .05 level (Coolidge, 2000).

Qualitative Data Analysis

The primary types of qualitative data analysis for this research study were content analysis and constant comparision analysis (Rossman & Rallis, 2003). The researcher examined the transcripts to analyze what categories emerged and how those categories were related. Subsequently, these categories became the themes of the study. Data analysis began with the coding of each individual interview transcript. The researcher reviewed the interview transcripts to identify key terms or phrases that summarized participant responses related to problem-

solving, self-concept, and problem-solving ability. After the second iteration of the transcripts, a table of all open coding was created.

Following coding, the researcher identified patterns within the open codes. These patterns developed into categories of common responses among all participants. These categories further narrowed into themes which framed the descriptions of the main ideas found by the researcher to answer the research question posed.

The Mixed Methods Data Analysis: Merging of Data and Interpretation

For a concurrent model, data analysis occurs in two stages. The first is separate qualitative and quantitative analyses. The present study used the data analysis previously depicted for the both the qualitative and quantitative analysis sections for stage one of the mixed methods data analysis. It should be noted that results for both the qualitative and quantitative analyses were represented in the results section separately rather than only being represented in the mixed methods results section.

The second stage merged the two datasets so that a complete picture developed. Since the present study used a triangulation design, Creswell and Clark (2007) recommended that the research addressed the following questions in order to substantiate the merging of data:

1. To what extent do the quantitative and qualitative data converge? How and why?
2. To what extent do the same types of data confirm each other?
3. To what extent do the open-ended themes support the survey results?
4. What similarities and differences exist across levels of analysis? (Creswell & Clark, pp. 136-137)

Data were merged through a matrix comparison as presented in Table 3.

Table 3

Comparison Matrix: Emergent Themes

Problem-solving styles/self-concept levels	High self-concept	Medium self-concept	Low self-concept
1	(Themes and frequencies, category name)		
2			
3			
4			
5			
6			
7			

As is typical of this type of research, the researcher compares the quantitative and qualitative results by examining the similarities and differences through discussion. Quantitative results were assessed using the Pearson's r correlation coefficient and confirmed by examining the results of the quantitative interview process.

Validity of mixed methods analysis. Validity for the separate qualitative and quantitative components of the present study was maintained by using traditional approaches for data collection, analysis, and interpretation for the aforementioned components (Creswell & Clark, 2007). With traditional approaches, the mixed methods analysis did not minimize validity. Since the present study employed the triangulation approach, triangulation validity was used. Creswell and Clark (2007, p. 146) defined triangulation validity as "the research draw[ing] on evidence from different datasets that provide better results than either dataset (qualitative or quantitative) alone." In addition to triangulation validity, validity of the research was further enhanced through discussion of potential threats to the validity that may occur during data collection. Table 4 depicts the potential threats to validity for the present study and the proposed steps to reduce those threats.

Table 4

Potential Threats to Validity

Population	Use same population for both qualitative and quantitative samples
Data Collection	Employ standard data collection procedures
Results	Follow up on paradoxical results or revisit the data
Data Analysis	Develop a comparison matrix with categorical data and themes present
Validity	Address the probable concerns for validity for both qualitative and quantitative

Note: This table is based on Creswell and Clark's chapter entitled "Analyzing Data in Mixed Method Research" (Creswell & Clark, 2007, pp. 128-150)

Research Permission and Ethical Consideration

At each phase of the present research study, ethical issues were addressed. As previously stated, prior to conducting the proposed research, the researcher obtained institutional review board approval at the affiliated institution. The Institutional Review Board received the necessary forms to include a description of the study including the significance for the study, the methods and procedures, and the proposed participant population. The informed consent form (Appendix A) stated that the participant had certain rights, had agreed to participate in the study, participation was voluntary and his or her identifying information was not be disclosed. Furthermore, since the participants are minors, written consent was obtained from both the participants themselves and from a parent or guardian. The anonymity of the participants was protected through the use of a numerical coding system for the quantitative instruments and the qualitative interviews. In addition, those individuals who participate in the interviews were assigned fictitious names for reporting results. All materials containing study data were kept in an electronically encrypted storage apparatus that is also password protected. Tangible materials

such as artifacts, transcripts, and paper copies were kept in a locked metal file cabinet in the researcher's office.

The Role of the Researcher

In the quantitative phase, the researcher administered the instruments and collected the data using standardized procedures. Data analysis used rigorous statistical analysis techniques using the JMP statistical software. The results were interpreted based on the established values for statistical significance for the computation used.

In the qualitative phase, the researcher served as the instrument for the research. Therefore, the researcher was in an observation rather than participatory role since she was not a part of the community being examined but did have personal involvement with the research topic (Patton, 2002). Due to the researcher having conducted, published, and presented studies dealing with problem-solving style and self-concept, these experiences introduced a possibility for subjective interpretation of the phenomenon being studied and could have created the potential for researcher bias (Patton, 2002). It should be noted that even though this research occurred within an environment that the researcher was a part of (the institution's campus), the researcher was not a part of the community being studied and did not interact with the participants for purposes other than the research study. Therefore, the researcher was not infringing on Creswell's recommendation to not conduct research within one's home community. Extensive verification procedures were used; these include triangulation of the data, member checking, and the use of thick and rich descriptions to provide for accuracy in the findings. Finally, the researcher's dissertation committee conducted a review of all research procedures and data analysis conducted within the scope of this study.

Summary

This study used a concurrent triangulation mixed methods design, in which different but complementary data was collected on similar aspects of problem-solving ability, to investigate the relationship between self-concept, problem-solving style, and problem-solving ability in high-achieving high school students participating in a residential summer enrichment program (Creswell & Clark, 2007). Research participants completed two quantitative instruments, the Self-Description Questionnaire (SDQ III) and the VIEW on one occasion and select participants completed two qualitative interviews on two separate occasions. The SDQ III subscales investigated are general academic, verbal, mathematics, problem-solving, same-sex peer, and opposite-sex peer. The VIEW subscales are orientation-to-change, manner of processing, and ways of deciding. Chapter 4 will contain the results of the study for the quantitative, qualitative, and mixed methods components. Chapter 5 will contain a presentation of the findings, discussion, and implications for research and practice.

Chapter IV

Results and Findings

In order to investigate the relationship between perceived self-concept and perceived problem-solving style and how these two constructs compare and contrast in regards to a participants' perceptions of their problem-solving ability among high-achieving rising 11th and 12th grade secondary students attending the a summer enrichment program for agriculture, this study posed the following research questions:

Research Question 1: What are the relationships between problem-solving style and perceived self-concept for this group of participants?

Research Question 2: How do participants describe their problem-solving ability for a given problem-solving task?

Research Question 3: How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

This chapter includes the results of the research starting with question one and the quantitative results, then question two and the qualitative results, and ending with question three and the mixed-methods results. Prior to addressing the research questions, the participants were described. The first question was addressed by collecting data from Self-Description Questionnaire III (SDQ III) subscale data (general academic, verbal, mathematics, problem-solving, same-sex peer, and opposite-sex peer) and the VIEW: An Assessment of Problem-solving Style (VIEW), describing the variables, and conducting correlations using Pearson's r product moment as the statistical measure.   The second question was addressed by the researcher examining the transcripts to explore what categories emerged and how those

catergories were related. Subsequently, these categories became the themes of the study. Data analysis began with the coding of each individual interview transcript through content analysis and constant comparision analysis. The researcher reviewed the interview transcripts to identify key terms or phrases that summarized participant responses related to problem-solving, self-concept, and problem-solving and self-concept theory. The third and final question was addressed by comparing and contrasting the themes developed in the qualitative results and the quantitative results of the SDQ III and VIEW constructs.

Educational Context

The educational context of this study was a summer enrichment program that focused on agriculture. The summer enrichment program used a problem-solving teambase format where youth were divided into groups of five to solve an agricultural issue. In addition to the teambase format, participants attended short courses in the agricultural areas such as veterinary medicine and horticulture. During the first class, all summer enrichment participants participated in a problem solving task discussion however due to the nature of the summer enrichment program and its provision of multiple problem solving opportunities emerged.

Description of the Participants

A description of the sample of participants (n=86) was provided in Table 5. Study participants were predominately female (76.74%). The remaining 23.26 % were male. The participants' academic standing was reported as 34.88 % rising juniors and 65.12 % rising seniors. Regional distribution, as defined by Virginia's Department of Education, was determined to be 64.34 % from Northern Virginia, 12.79 % from the Valley, 11.49% from Tidewater, 3.49 % from the Central, Southwest, and Western regions.

Table 5
Description of the Participants

Variable	*n*	%
Gender		
Male	20	23.26
Female	66	76.74
Locality		
Northern	56	64.34
Valley	11	12.64
Tidewater*	10	11.49
Central	3	3.45
Southwest	3	3.45
Western	3	3.45
Academic Level		
Rising Junior	30	34.88
Rising Senior	56	65.12

*Note: * includes both Northern Neck and Tidewater Regions*

Selection and Description on Interview Participants. Interview participants were selected based on gender, academic level, locality, and response. Initial selection of participants was a representative group of gender and academic level. The research notified interview participants of selections to participate in the interview portion of the study by email. The researcher contacted 37 prospective interviewees in order to obtain 13 responses. Out of those 13 responses, five were male and eight were female. Eleven were rising seniors and two were rising juniors. Of the selected interview participants, eight were from Northern region, four were from the Valley, and one was from the Western region. Participants from the remaining regions were contacted to participate in the study however the researcher did not receive a response from these participants. The selected interview participants provided a representative subgroup from the quantitative sample.

Table 6
Description of the Interview Participants

Variable	*n*	%
Gender		
Male	4	30.77
Female	9	69.23
Locality		
Northern	8	61.54
Valley	5	30.77
Western	1	7.69
Academic Level		
Rising Junior	2	15.38
Rising Senior	11	84.62

Quantitative Results

The quantitative results informed the first research question "What are the relationships between problem-solving style and perceived self-concept for this group of participants?" In order to investigate this research question there were three objectives. The first objective was a description of the participants, the second objective was a description of the variables, and the third objective was determining the relationship between the SDQ III and VIEW constructs.

Description of the Results

The second objective sought to determine the participants' perceived self-concept and problem-solving style; the results are provided in the Table 7. General self-esteem self-concept (mean score of 78.05 and standard deviation of 13.87) and academic self-concept (mean score of 64.63 and standard deviation of 8.72) were both higher. Same-sex self-concept mean score was 61.29 with a standard deviation of 11.20. Students surveyed exhibited similar mean scores for math, opposite-sex, and problem-solving self-concept (math mean of 56.93 and standard deviation of 11.9; opposite-sex mean 55.52 and a standard deviation of 10.78; problem-solving mean score of 55.41 and standard deviation of 9.82). Verbal self-concept had the lowest mean score (mean of 54.88 and a standard deviation of 6.99) of this set of constructs.

General self-esteem self-concept had the highest maximum of 96.00 and a minimum of 31.00. Same-sex self-concept had the second highest maximum of 80.00 with a minimum of 23.00. Math self-concept (minimum of 23.00 and maximum of 76.00), problem-solving self-concept had very similar maximums (minimum of 30.00 and maximum of 76.00) and opposite-sex self-concept (minimum of 30.00 and maximum 74.00). However, verbal self-concept (minimum of 35.00 and a maximum of 67.00), and academic self-concept (minimum of 39.00 and maximum of 79.00) had similar minimums but varied maximums.

Table 7

Means, Standard Deviations, Minimums, and Maximums for SDQ III Constructs of Math, Verbal, General Self-esteem, Academic, Problem-solving, Same-sex, Opposite-sex

	Mean[a]	SD[b]	Min[c]	Max[d]
General Self-esteem	78.05	13.87	31.00	96.00
Academic	64.63	8.72	39.00	79.00
Same-sex	61.29	11.20	23.00	80.00
Math	56.93	11.99	23.00	76.00
Opposite-sex	55.52	10.78	30.00	74.00
Problem-solving	55.41	9.82	30.00	76.00
Verbal	54.88	6.99	35.00	67.00

Notes: [a] is the average of all the scores. [b] is the standard deviation. [c] is the minimum value of all the scores. [d] is the maximum value of the score.

Table 8 depicts the results for perceived problem-solving style. The orientation-to-change variable had a mean score of 80.78 and a standard deviation of 15.25. The mental-processing variable had a mean score of 28.64 and a standard deviation of 8.84. The way-of-deciding variable had a mean score of 37.84 and a standard deviation of 8.51. When examining the maximum and minimum for the orientation-to-change variable, it had a minimum of 44.00 and a maximum of 116.00. The mental-processing variable had a minimum of 11.00 and a maximum of 55.00. The final variable, way-of-deciding had a minimum of 16.00 and a maximum 56.00.

Table 8

Means, Standard Deviations, Minimums, and Maximums for VIEW Constructs of Orientation-to-change, Mental-processing, Way-of-deciding

	Mean[a]	SD[b]	Min[c]	Max[d]
Orientation-to-change	80.78	15.25	44.00	116.00
Mental-processing	28.64	8.84	11.00	55.00
Way-of-deciding	37.84	8.51	16.00	56.00

Notes: [a] is the average of all the scores. [b] is the standard deviation. [c] is the minimum value of all the scores. [d] is the maximum value of the score.

Relationship Between Perceived Self-concept and Perceived Problem-solving Style

Correlations using Pearson's r product moment were conducted to determine if there were a statistically significant relationships between the perceived self-concept constructs of math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite-sex; the perceived problem-solving style components of orientation-to-change, mental-processing, and way-of-deciding, and between perceived self-concept and perceived problem-solving style. Using Pearson's r product moment, correlations were conducted to determine if there were significant relationships between the perceived self-concept constructs of math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite-sex. The resulting correlation coefficients for math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite-sex as depicted in Table 9, show that statistically significant relationships existed between the self-concept of math and the self-concepts of general self-esteem (r=0.22, p<.05); academic (r=0.34, p<.01); and problem-solving (r=0.33, p<.01). Furthermore, statistically significant relationships existed between the verbal self-concept and general self-esteem self-concept (r=0.34, p<.01); academic self-concept (r=0.26, p<.01); problem-solving self-concept (r= 0.25, p<.05), same-sex self-concept (0.22, p<.01), and opposite-sex self-concept (0.27, p<.01). In addition to being statistically significantly correlated to the math and verbal self-

concept, general self-esteem was also statistically significantly correlated to academic (r=.39, p<.01), problem-solving (r= 0.48, p<.01), same-sex (r=.26, p<.01), and opposite sex (r=.27, p<.01). Academic self-concept was also statistically significantly related to problem-solving self-concept (r=.30, p<.01). Problem-solving self-concept was statistically significantly correlated to same-sex (r=.28, p<.01) and opposite sex (r=.26, p<.01) self-concepts. Finally, same-sex self-concept was statistically significantly related to opposite sex self-concept (r=.27, p<.01). The remaining correlation coefficients showed that there was no statistically significant relationship between the following construct pairs: math and verbal; math and same-sex; math and opposite-sex; academic and same-sex; and academic and opposite-sex.

Table 9
Correlations for the SDQ III Constructs of Math, Verbal, General Self-esteem, Academic, Problem-solving, Same-sex, Opposite-sex

	Math	Verbal	General Self-Esteem	Academic	Problem-solving	Same-sex
Math	---					
Verbal	-0.01	---				
General Self-esteem	0.22*	0.34**	---			
Academic	0.34**	0.26**	0.39**	---		
Problem-solving	0.33**	0.25*	0.48**	0.30**	---	
Same-sex	0.06	0.22*	0.26**	0.12	0.28**	---
Opposite-sex	-0.06	0.27**	0.30**	0.03	0.26**	0.27**

Note: *p<.05; **p<.01

Correlations using Pearson's r product moment were conducted to determine if there were statistically significant relationships between the perceived problem-solving style components of orientation-to-change, mental-processing, and way-of-deciding. The resulting correlation coefficients for perceived problem-solving style, as depicted in Table 10, show that a statistically significant relationship exists between the constructs mental-processing and way-of-deciding (r=.035, p<.01). The remaining correlation coefficients showed that there was no

statistically significant relationship between orientation-to-change and mental-processing or orientation-to-change and way-of-deciding.

Table 10

Correlations for the VIEW Constructs of Orientation-to-change, Mental-processing, and Way-of-deciding

	Orientation-to-change	Mental-processing	Way-of-deciding
Orientation-to-change	---		
Mental-processing	0.13	---	
Way-of-deciding	0.13	0.35*	---

Note: *$p<.05$

Correlations using Pearson's r product moment were conducted to determine if there were statistically significant relationships between perceived problem-solving style components of orientation-to-change, mental-processing, and way-of-deciding and the perceived self-concepts of math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite-sex. The resulting correlation coefficients for the perceived problem-solving style and perceived self-concepts, as depicted in Table 11, show that statistically significant relationships existed between verbal self-concept and orientation-to-change ($r=0.27$, $p<.01$); general self-esteem self-concept and orientation-to-change ($r=0.30$, $p<.01$); academic self-concept and orientation-to-change ($r=0.27$, $p<.01$); and problem-solving self-concept and orientation-to-change ($r=-0.35$, $p<.01$). A statistically significant relationship also exists between the constructs of math self-concept and mental-processing ($r=0.22$, $p<.01$); opposite sex self-concept and mental-processing ($r=-0.23$, $p<.05$); and way-of-deciding and math self-concept ($r=0.25$, $p<.05$). The remaining correlation coefficients showed that there was no statistically significant relationship between orientation-to-change and the self-concepts of math, same-sex, and opposite sex, nor were there statistically significant relationships between mental-processing and the self-concepts of verbal, general self-esteem, academic, problem-solving, or same-sex. Finally, there

were no statistically significant relationships between way-of-deciding and the self-concepts of verbal, general self-esteem, academic, problem-solving, same-sex, and opposite sex.

Table 11

Correlations for the SDQ III and VIEW Constructs

	Math	Verbal	General Self-Esteem	Academic	Problem-solving	Same-sex	Opposite Sex
Orientation-to-change	-0.12	0.27**	0.30**	0.27**	-0.35**	0.06	-0.08
Mental-processing	0.22**	0.15	-0.01	0.21	0.13	-0.10	-0.23*
Way-of-deciding	0.25*	0.04	-0.02	0.17	0.09	-0.11	0.05

Note: *p<.05; **p<.01

Qualitative Findings

The qualitative findings explored the second research question, "How do participants describe their problem-solving ability for a given problem-solving task?" In order to explore this question in depth and with clarity, there were seven objectives. The first objective was to illustrate how this participant population described problem-solving. The second objective was to explore depiction of the problem-solving process from the participant perspective. The third developed an understanding of how the participant selected key information about problem-solving. The fourth objective examined how the participants describe themselves as a problem solver. The fifth through seventh objectives emerged from the follow up interview sessions. The fifth objective described how working in a team of similar-ability peers impacted the participants' perception of their problem-solving ability. The sixth objective depicted how working in a team of varying levels of ability impacted the participants' perceptions of their problem-solving ability. The seventh and final objective developed an understanding of how the

participants switched from an individual problem solver to a team problem solver and the factors influencing that decision.

Illustrate how the participant population described problem-solving

When exploring the definition of problem-solving, two central definitions emerged as depicted in Figure 3. The first definition was "solutions for conflict." Out of the 13 interview participants, six used this terminology directly to define problem-solving. Participant Lilac depicted, " in problem-solving what comes to mind is probably working towards solving a specific question or issue and it usually takes several processes with figuring things out, organizing your thoughts etcetera." Participant Lilac followed this statement with, "problem-solving is working toward solving an issue or conflict." The second definition was "effective solutions to an issue." Seven out of the 13 interview participants used "effective solutions to an issue" terminology to define problem-solving. Participant Tigerlily stated:

When I think of problem solving . . . I think of my DI team because I do Destination Imagination. We have to work on a problem for six months and perform in front of judges. And last time we had to do, we had to figure out how to make a structure out of newspaper and glue that would hold as much weight as possible. So I think problem-solving is creatively coming up with solutions to issues that need to be solved.
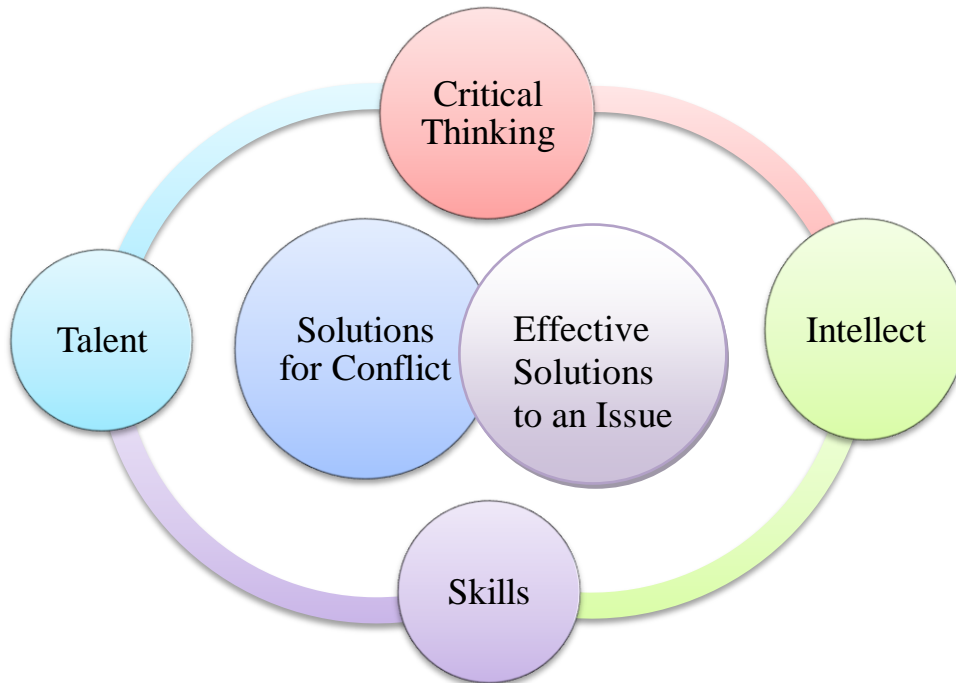
Figure 3. Theme for definitions of problem-solving. Illustration of the interrelationship between the definitions of problem solving and other factors influencing the description of problem solving

In support of the central concepts of solutions for conflict and effective solutions to an issue, participants maintained that to solve a conflict or issue, "critical thinking," "intellect," "talent," and "skill" are necessary to determine the conflict and decide the course of action to take. This was supported by Participant Amaryllis' when she described problem-solving as, "using your intellect and skills and talents as well to formulate a solution to an issue." Participant Begonia expressed concern when describing problem-solving:

When I think about it right away, literally I just think of doing math problems. I

[also] think about the confusing word problems too that don't have short answers.

I think about one of our first classes here, with Dr. [Strelitzia]. He started off with

just asking us these random just critical thinking questions.

Although participants had clear concepts about defining problem-solving, participants expressed that the issue or problem determines how the problem should be solved.

An evolving, emergent theme that developed during the interview process was that the conflict or issue determines if the problem should be solved individually or in a team format. Participant Boronia best expressed this concept by saying:

I think problem-solving to me basically means like solving a difficult situation or matter and dealing with difficulties whether sometimes it's difficult or easy depending on the circumstance. Sometimes problem-solving can be done individually or team-based, a lot of the worldly problems have to be solved through teams. If it is [a] simple problem, it can be done individually. That's what I think of when I think of problem-solving.

The final emergent theme was challenge. When participants referred to this theme they referred to it in two different ways as depicted in Figure 4. The first was as a mental or internal drive that motivated the individual to want to solve the problem or task. Participant Amaryllis described:

Well, when I think of the term "problem-solving," what comes to mind is challenge in the sense that usually when I think problem-solving, it involves my mind, and it requires me to put some effort into it. So that's why I think of challenge when I think of problem-solving.

The second way was defining the task, conflict, or issue as a challenge to overcome. Participant Cosmos explained, "definitely, the word "problem-solving," I think of challenges . . . Definitely, overcoming challenges and conflicts that come in your way, [they] could either be mental problems or math problems or word problems."

Figure 4. Challenge as a concept. Illustration of the two different definitions of challenge and the creation of an overall concept of challenge.

Overall, the interview participants had a clear definition of problem-solving. Participants related problem-solving to everyday tasks as well as conflicts. Participants had a clear understanding of their personal definition; however there was not one central theme rather two definitions emerged. The first was that problem-solving is the process of working toward a solution to a conflict and the second that problem-solving is generating an effective solution to an issue.

Explore the depiction of the problem-solving process from the participant perspective

When investigating how participants solve a problem, the central emergent theme was process. Each participant had a set approach to solving a problem. The overall process continuum, as depicted in Figure 5, began with determining the general topic or problem. The second step was background research about the general topic. Once the background research was complete, participants refined the problem and determined the components of the problem. The fourth step was to determine the solvable problem. It is at this point that there was

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divergence in the form of individualized or team-based work. If the participants choose to work in a group the next step was to divide the solvable problem into solvable subtopics and have each member of the team determine solutions for their solvable subtopics through independent research. Overall, each participant had a unique process that contained the aforementioned components. The process was personalized for each individual along the process continuum, whereby participants interjected additional steps.
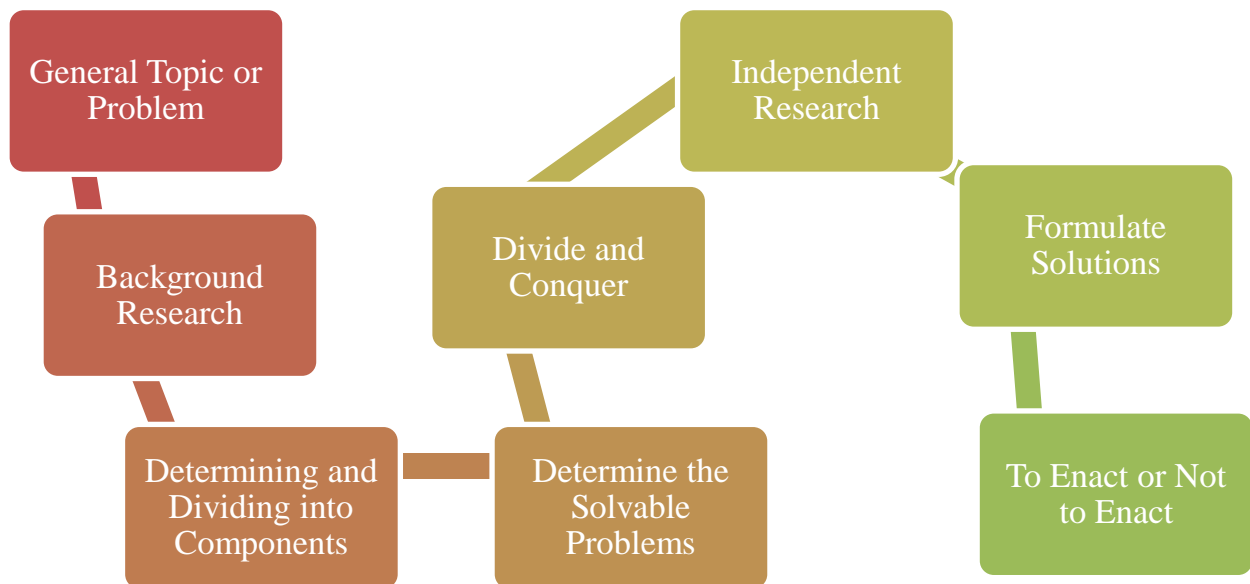

Figure 5. Problem-solving process continuum. The multi-step process that was depicted by the participants and their approach to solving problems.

Participant Crocus described his problem-solving process with:

First looked at the problem and we read through the scenario and we identify the

points of conflict. Like where people were either unhappy or upset, or something

was missing or something. I don't know all those . . . so, for example, the part

about people being unhappy or morale being low within the department, or like

the computers breaking down more, them not being able to fix it. So we had

identified all the little minor conflicts within the big problem of them being

understaffed and stuff. So we identified those and once we did that we looked at

the problem is a whole and saw what was really the kind of like a central conflict.

They didn't have enough money to pay for us -- so that's the reason why she

couldn't fix all the computers, which is why people are unhappy, which is why

they were complaining, which is why the morale is low within the department

among the staff because of the complaints. I don't know if we were actually

asked to find solutions, but we just thought about the problem okay so that's the

central idea with what you could do is come identify a way to make more money

perhaps.

These additional steps included creating an outline at some point in the continuum, generating

solutions prior to dividing and conquering, and enacting probable solutions. Participant Camellia

described the importance of these additional steps as:

A series of questions to help us . . . but besides that I read the case study and I

thought about it and from my point of view I took it as it was the problem of the

computer company I believe and not the consumer or the customers. Someone

thought that customers were the problem. But I just read it and I make lists, I love

to make lists. So what I do is they list all the originating something that would

give birth to the problem so I did that, and then see what the problem was.

Many participants felt the process concluded once the probable solutions are generated. When

questioned concerning enacting a solution, the participants felt that was up to the persons that the

conflict impacts to enact the solution not necessarily the problem solver themselves. Participant

Dahlia explained as:

We're working on climate change. That's our big topic in our sub topic for that is

'the responses of plant crops to elevated heat and carbon dioxide. So we basically

decided that we would start with all of our research first and kind of come up with some keywords that we could search on different databases . . . and we also went to the librarians and decided to get some help there to find some books that would be relevant . . . We split up kind of sections of the paper that we wanted to focus on. Everybody did kind of their own independent research.

Participant Nettle's thoughts differed when he stated:

I think the whole key to it is that you know what the problem is because a lot of times I feel like this in life. Like you could say okay I want all A's this quarter, well is the problem that you don't study enough? That you don't sleep enough? I think knowing what your problem is the key to it all from that it all comes naturally. I think it's really good to write it all out 'this is what the problem is,' 'this is what I could do,' and then you do pros and cons. I've tried to do that for big decisions or whatever like schoolwork and stuff for projects. You know like life decisions you don't always instinctively think 'let me take out a notepad and write down what's my problem.' But I feel like when you do that you make the best decision always, so I feel that something I should do more and then yes that's pretty much it.

Participant Amaryllis described the importance of using an outline to solve the problem and guide the team's research as:

We try to find ways to go about it but since we didn't know anything we decided to spend a little time researching it. After we had some information we came together and we start talking about ideas, and what we can do. We had to come up with an outline first, which we did, and then after that we went to more

detailed outline. Then we gave sections of the outline to people to take care of, to

do like more intensive research and write their own individual papers on and

[then] we put everything together.

Although the resounding theme is a process continuum and this interview population had central

components, finite components of each participant's personal problem-solving process were as

individualized and varied as the persons interviewed.

Develop an understanding of how the participant selected key information about problem-solving

When deciding what information was important, there were three themes: expert

knowledge, problem specific resources, and background research, as depicted in Figure 6.

Within expert knowledge, participants used resources such as the library, the librarian, and

persons informed on the topic such as the summer enrichment peer leaders. Participant

Amaryllis discussed the importance of expert knowledge as:

We use the databases and books at the library. We also used the Internet.

Heavily use the Internet. We also spoke to our [peer leaders] because some of

them had some information on the topic. We also talk about solutions, and then

come up with solutions after our research. So we use all the resources.

Problem specific resources ranged from books to peer reviewed journals to internet resources.

Participant Boronia described the importance of problem specific resources as:

 There's a lot of information on the topic and so finding the right information was

kind of difficult because we have to browse through a lot books [like] journals.

We really looked at the questions first . . . to see what they were asking for so if

we were looking for a book and it's not addressing the topic and it doesn't say a

benefit or limitation really anything we would just discard it and move on to the

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next source. The thing was most of the sources are about sugarcane which

technically isn't energy cane. It is like a variety of sugarcane and it's not the exact

same things so we tried to find information within the sugarcane books about

energy cane.

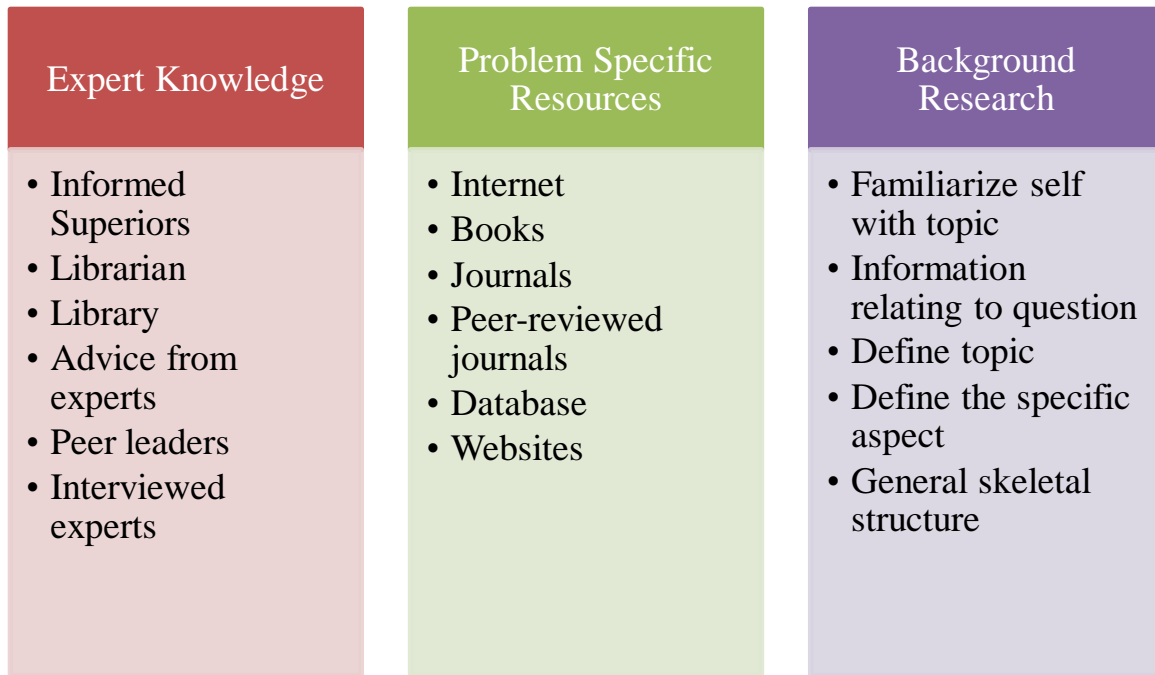| Expert Knowledge	Problem Specific Resources	Background Research
• Informed Superiors • Librarian • Library • Advice from experts • Peer leaders • Interviewed experts	• Internet • Books • Journals • Peer-reviewed journals • Database • Websites	• Familiarize self with topic • Information relating to question • Define topic • Define the specific aspect • General skeletal structure

Figure 6. Central informational themes. The above figure depicts the emergent themes for the key information that participants select.

Background knowledge encompassed some of the problem specific resources however

the knowledge gained from these resources gave the participant a working knowledge of the

problem versus research for a solution to the problem. Participants felt it was important to

"familiarize self with the topic." Participant Redbud discussed the importance of background

knowledge as:

We started out the library of course, and then we realized looking online you can

use Google scholar to look up things. We look for the ones that were most cited

in [and that] seemed to make a lot of sense. It's pretty easy to look at this. You

just kinda look at the abstract of one of the peer review journals and see what was

actually pertinent to the topic. So we went through those a whole lot, we looked

at some books. I was very lucky, I found a very, very useful book. We also went

to the farmers' market one morning. We interviewed some of the main directors

there and they were helpful in telling us what a lot of farmers' markets do and

what they are like and how they try to help low-income families as well.

In addition to these three themes, participants connected the problem-solving process continuum

into how they selected important information when researching their sub-problem. Participants

incorporated "note taking" and "lists" to familiarize themselves with the problem. Participant

Tigerlily referred to her problem-solving process as:

We figured that people wanted to know the benefits of changing the process

because whenever you change something you have to show this way's better than

the other way. And also, we needed to show the opposite side of the coin. We

explore both sides of it. It's not like, oh there's so much wonderful stuff about this

new change. But there's actually a lot of bad stuff going on behind the scenes.

Additionally, participants equated important information as that which "related" to the

problem and gave a "comprehensive" view of the problem.

Examine how the participants describe themselves as problem solvers

There was great variation in participants describing themselves as problem solvers. Most

participants (12 out of 13) personified themselves as individual problem solvers, however they

stated that "in teams you get better results" and that there are "good ideas and insights" in a team

setting. Participant Camellias supports this:

Well initially, I thought I like to work by myself as an individual but then
recently [we've] been doing a lot of teamwork stuff but I was really against it. I
don't like working with people but I'll do it if I have to. It's always good. I mean
for any career path you always have to have a team and I do enjoy it because they
have good ideas and insights that I might [not] always have. But in general I like
to be by myself more, alone if I can, so I guess I'm an individual problem solver.

In support of the use of team problem-solving, Participant Crocus explained:

I do things by myself and asked people what they think afterwards and I worked
on my ideas or I will suggest my ideas if I think I found a better solution, but a lot
of times, as a problem solver, I like to go about things logically and I don't like to
get emotions involved. . . .When I'm doing group work, I take into account other
people's feelings. I can read other people. It's not about hurting people's feelings.
It's about unifying the logical way, finding the most realistic way to complete
something get something done, and usually that's what I do. I'm very
straightforward. I don't usually find myself thinking outside the box you know
what I mean, you know a lot of people are [and] would've figured [the problem
out] this way. Usually I like my comfort zone and my comfort zone is usually
sticking with a defined plan . . . I don't like when teachers don't give a guideline
for things or whatever because I don't know what you're expecting . . . in order to
complete the task to the full extent. . . . I don't want to disappoint you and not
fulfill expectations. I like having boundaries. So I have a lot of trouble in
thinking outside of the box. A lot of people are like, let me go and do my own
thing. . . . I like hearing other peoples' ideas and I can build on peoples new

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ideas. A lot of times I need other people to come up with the original idea I guess.

Participant Begonia readily indentified herself in the team structure as:

I feel it was easier for my situation. It was easy because I like to working with people so it's easy for me to solve problems like my project. I couldn't do that all by myself. I mean, I could, but I don't think I could do all that great. I like working with people better, so I think that's one of my strong points .I like to collaborate with people. I mean I'd rather, it's nice to get other people's ideas too, because it's not like one person is going to have the best one.

As problem solvers, participants described themselves as "very analytical," "systematical," and "perfectionist." Participant Lilac further explains:

I don't like to go into a problem with any like randomness or not knowing what I'm doing and why I'm doing it. So yeah I think I'm just very systematical and I like solid facts rather than just going on whims.

Participant Dahlia stated:

Well I guess, as a problem solver, and general I'm very analytical. I like to look at all the details, and I think very concisely, and sort of look at the big picture and then find a way to break everything into smaller chunks so that I can focus on one thing first and work there other steps and then move to the next thing.

Participant Amaryllis described himself as a perfectionist, specifically:

I really go into detail, and I think that usually takes a lot of my time. But just from the [aspect] of making sure it's right. . . . I tend to address problems with an open mind, then narrow it down to specific tasks, specific aspects of it and

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address them methodically. So I usually use like an outline when I'm solving a

problem.

When questioned about how they generated solutions, participants stated that they were both

"open-minded" and "thinking outside the box" or they want to stay in their "comfort zone" and

"focus on a few things and know them really well." Participants depicted themselves as problem

solvers in relation to the methods and approaches that they preferred to use. In this regard,

participants incorporated "a defined plan," would "break everything down into smaller chunks,"

"have a goal system," and "write down" their plan through "lists" or "an organized structure."

When questioned about how they prefer to use their team-based groups, they "ask people what

they think" after they have a self-reflection period. Additionally they use a group format to work

from "multiple different perspectives," "strategize angles," and "understand the way people feel

about everything." Participant Nettle best described this as:

> Ideally you would think I would want to plan everything out but it doesn't always
>
> work out that way because that's the way life is. So I guess, I don't know there's
>
> some very instinctive things we do. I definitely feel like if it's a big decision, I
>
> always try to like strategize what angle can I come at this from. Not necessarily
>
> how this is going to make me feel but like what are the options.

 As described in previous participant statements, participants had definitive statements about the

issues that limit them as problem solvers. The first is understanding "what" they are doing and

"why" they are doing it. Additionally, being motivated through "curiosity" drives participants to

be "creative with solutions."

Although the participants described themselves as individual problem solvers, several

expressed the usefulness of team problem-solving. These problem solvers used descriptions

such as perfectionist and analytical to personify problem-solving. Finally, as problem solvers,

the participants required understanding, motivation, and relativity to solve problems.

**Describe how working in a team of similar ability peers affected the participants'
perception of their problem-solving ability**

One of the emergent concepts that evolved during the second interview was the impact of

a team of similar ability peers, in this case high-achieving youth, on the participants' perception

of their problem-solving ability. The emergent themes are depicted in Figure 7, these themes are:

motivation, work ethic, communication, stress level, and problem task focus.
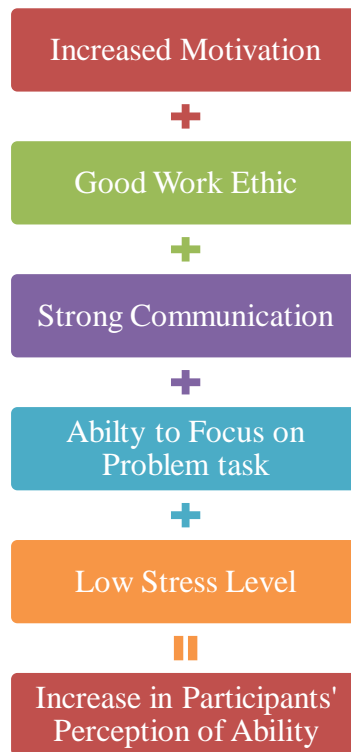
*Figure 7. Similar ability on problem-solving ability perception. The above figure depicts the participants' perceived
influence that team members of similar ability contribute to their problem solving ability.*

Overall, participants felt that working in a group of similar ability increased the participant's

problem-solving ability. The major contributing factor was motivation were being in a group of

similar ability gave the participants an impression that the group members are "very intelligent,"

"work well," and produce "high quality work." Participant Redbud expressed:

I think that it's a good motivator, because when I have people that I know are very

intelligent, they work well, and I see the high-quality work it pushes me and the

ideas are very good whenever anyone in your group is very intelligent. They can

look at what you do and it's very helpful considering that corrections are very

valid and very well thought out so we can all work [effectively]. For me looking

at the strengths and weaknesses [of the team] we all have a lot of very good

strengths.

Additionally, participants feel motivated because everyone in the group "wants to do their part."

Work ethic was another concept that influenced the participant's perception. Participants feel

that members in a high-achieving group "all want to work" and "all want equal work."

Participant Amaryllis describes:

It's a really good things that were working together as a group, because the

workload is just way too much to do on my own. Right now, the people I am

working with we are all wanting to do the work, because that's basically the most

important project we have a governor's school so no one slacking off or anything

like that. But at school, there are people that just don't care about their grade and

over here, we don't get graded on what were doing so. People are just doing it

because they want to do it. But in school, people just don't care about their grades

as much or contribute as much as I do, so to it I end up doing all the work and it

just gets frustrating sometimes.

In regards to work ethic, participants equate the amount of time to "effort and quality" of the

work. Finally, participants feel that it is easier to "trust" the group due to the expectation that

everyone is going to "do good work." Participant Tigerlily captured these aspects with:

It makes it a lot easier, because then you could just divvy up the work and give it

to everybody knowing that it's going to be done well, if not the way you want. It's

going to be at least on with a certain amount of effort and quality.

Communication was another contributing factor to participants' perceptions of their

problem-solving ability. In order to adequately solve the task problem, in a group setting

participants felt that good communication was important. One participant stated "everyone's

more straight forward." When asked about the importance of communication, participant

Cosmos stated:

It was definitely really important because we needed to know which person agrees

with what the main problem will be. . . . Because there are many possibilities and

many options and everyone has their different view and soon, by communicating

we talk to each other. We settled our differences and figured out which one is

most common with all of us.

Communication influenced participants' perceptions of each other, unlike stress that

influenced participants' achievement at the problem.

One theme that had differing view was that of stress level. The majority of participants

(5 out of 6) who discussed stress felt that there was less stress and the low stress level enabled

the participants to achieve more in a low pressure atmosphere. One participant who felt there was

more stress felt that the stress was useful thus causing her to push herself harder and produce

higher quality work. Participant Redbud iterated this in:

I find it almost a little more stressful, but it's useful. It's pushing me [since] I see

other people's work that is very high quality. It pushes me to push myself harder,

and it's a little more stressful, but it helps me a lot and actually coming out with a

good final product.

A low stress environment assisted most participants in their ability to focus on the

problem. The participants' ability to focus on a problem task emerged as a theme as well.

The participants' ability to focus on the problem task emerged as a unique theme that was

influenced by participants' perceptions of their group's structure. In the group of similar-ability

youth, a participant felt that she could "get a clear view of what the problem is and how to solve

it." Another participant stated that "if you know that everyone is the same level, makes you want

to help each other and pulls you up in ability." Participant Lilac expressed, "I think our ability as

a whole has increased. The final product should be one of quality that we should all be proud of

. . . overall it's more bright brains working towards solving common issues."

Finally, participants felt that because everyone was of the same ability level, they did not have to

divert their focus from the problem to deal with other issues such as leadership and management.

Participant Crocus described:

> I think there's some pros and cons to each if you were for instance in school, if
>
> you're with a group of people, but the more [variation in ability that] get assigned
>
> to a project. I will take over. . . . It kind of sounds cocky, but you get it done right
>
> when you do it yourself. You know what I mean, you make sure the job is done
>
> right. So if people don't have as developed school skills to use that would be a
>
> situation which you would take over. Maybe not forcefully, but you would
>
> emerge as the leader. At [summer enrichment program] we all pretty much have
>
> the same amount of skills. When people try to go about different ways of solving
>
> things like, if you're really set in your ways like for instance me I'm opinionated.

I'm not saying that I would like hurt someone's feelings and say 'no you're

wrong'. I feel like I'm pretty open-minded, but I will stick up if I think I have a

good idea. I think we should do it I will tell him why I think that would be the

best resolve the problem. So that can cause some conflict with two different

[people]. One might be like really opinionated and strongly believe that they have

the correct solution. But that already happened a bit here at [summer enrichment

program], but it's also is really good because you know the people you working

with are qualified and you have a lot more trust. I guess in the people and you

think that you're able to believe that they are going to follow through when you

set deadlines and when you give them work. Hopefully, I mean, sometimes you

can't, it depends on the skills.

Participant Crocus described the impact of working in a team of similar ability level and

effectively described the participants' ability to focus on the problem-solving task rather

than other extraneous factors such as leadership and management issues.

**Depict how working in a team of varying levels of ability affected the participants'
perceptions of their problem-solving ability**

When participants were asked to depict how working in a team of varying ability levels

impacts the participants' perceptions of their problem-solving ability, three main themes

emerged: lack of motivation, lack of trust, and poor work ethic, as their perceptions of their

group members. This caused participants to change their focus from the problem task to other

issues such as leadership and management or becoming an individual problem solver. When the

participants become an individual problem solver, this forced the participants to solve the

problem on their own. In most cases this is a more stressful situation were they carry the group

because they do not want their grade and public perception impacted by the limits of their team

members. This topic elicited the most emotion out of the interview participants and most of the discussions were animated where the emotions ranged from annoyance to frustration to in difference.

Participants expressed concern for lack of motivation due to participants having previous knowledge of an individual's performance. One participant expressed that classmates know that if they have him in their group they do not have to do any work because he would do it for them, as stated in:

I've been put with groups with people who were also conscious of their grades, and it was a really fun experience. I remember doing a PowerPoint presentation with another person. He did a really great job, because I did my side, he did his side, we e-mailed each other, he took some of the . . .and he took . . . he paid some of the money to produce the papers and everything so it was a really fun experience. But then also, like I said earlier on, [other group members] just wouldn't do their work, and they don't even try because they know I'm going to do everything so that just don't work anymore. I even hear them making jokes about it, like. "I have [participant's name] in my group. I'm not going to have to do anything." And it gets really frustrating.

Lack of motivation, trust, and work ethic were interrelated in that if a participate felt the group members were not motivated, they in turn had low work ethic, and the participant could not trust the group members to do their part thus causing the participants to have trepidation toward working in a team setting. One participant expressed that when asked to work in a team setting he would "work by myself." Another participant stated that she would manipulate the team so that she could work with individuals who had a similar work ethic and were of similar ability. A

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female participant expressed that work ethic was the biggest influence as to whether her ability would be impacted she doubted that the varying ability group would "lower my ability" but it would "definitely take longer" if she had to do all of the work herself.

In regards to participants becoming more focused on leadership and management aspects rather than the problem task, one participant felt that she had to "take over" because "if you want it done right you do it yourself." This participant expanded this thought and stated the reason she took over was due to people not wanting to "develop the school skills used" to solve the problem task. The majority of participants who discussed this topic felt that they were obligated to be "an emergent leader" and had to "take on more responsibility" including "delegating" tasks or simply completing the task and allowing the other group members to take credit for work they did not do. Participants justified giving others credit for work they did not do because "it's less stress" and they were not "going to be embarrassed" with the end-product. Participant Crocus described her experience as:

> When I said take over. It's more like emerge as a leader like delegate responsibility like a lot of times, it depends on how working with a given these people are kind of the slackers of the class of type given to a group of slackers. That sounds kind of judgmental, but you know what it means. If I'm put in a group of people who don't have high standards of achievement than I usually am more comfortable with taking on a lot. You want the job done right, so if you if you're more confident in your ability. Then someone else's then you take on more responsibility.

One participant felt being in a group of "lower-skilled people" would be easier because he could "step up and be the leader" and in his opinion participant, Nettle, stated:

When I'm with people who aren't as highly motivated or anything like that, the

highly-motivated people who are usually kind of the leaders are solving a

problem. I guess that's how come it works out that if I'm with a bunch of people

that don't really care about something but I do that [then] when I try to step up. I

always feel like it's easier to solve problems when you're the leader of solving the

problem. I get input and everything, but if decisions [are] easy enough I

think it's a lot easier to do it when you're in charge I guess.

When Nettle was asked if problem-solving would be easier in a lower-skilled group, he also

stated, "It's harder in school [because of] the whole drama drama, thing and everyone here can

be straightforward and upfront about what they want."

Overall participants felt that in most cases that their ability level would either be lowered

or their focus would change from the problem task to other issues like leadership and

management. One participant stated that it was "definitely harder to solve a problem" and "it

definitely takes up more time." Participants also felt that their focus on the problem would be

limited because they have to follow up behind their group members, Participant Tigerlily stated:

Sometimes when I work with people who are not on the same level of me, I

worry about the quality. Whether it be grammatically correct, or whether the

information is right, or even if they're just going at it. . . . This has happened

before I have done most of the project and given the part of the project someone

else, and he did not do it at all.

Participant Dahlia supported Tiger Lily's elaborated:

It's definitely harder to get problems solved that way, but I attempt to just not

dwell on it and move forward and try not to get really worked up [about] the fact

that they didn't do their whole part. If I can somehow take parts of one if need be

I will and try working with the other teammates. They are doing their parts. Then

hopefully we'll still be able to solve our problem, but it definitely takes up time

that we could've been . . . using to do other things. . . . Obviously it takes longer to

get our ultimate solution.

Both Tigerlily and Dahlia expressed how working with a group of different ability levels

caused solving the problem task to be more difficult due to concerns over performance of

the other team members and how the higher functioning participant felt that they had to

either do the entire project themselves or reeducate their team members in order to allow

the team an opportunity to solve the problem.

Develop an understanding of how the participants switched from an individual problem solver to a team problem solver and the factors influencing that decision.

When exploring why a participant would choose to work as an individual problem solver

or a team problem solver, the themes of scalable, situation specific, and level of detail emerged.

Scalable refers to the size or impact of the problem. Participants would work individually on

small scale problems such as math, academe, or personal problems and would work in a team

setting for large scale problems that required multiple perspectives, differentiated skills sets, or

requires creative solutions to conflict. Participant Nettle stated:

Well because it is really scalable in the sense that there could be a problem for the

world or there could be a problem for [the institution] or there could be a problem

for [summer enrichment program] or a problem for you. So I don't think. . I guess

you could really say a group of people but an individual person can also have

their own problem so I guess you have to think of that.

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The situation of the problem determined whether it was an individual or team problem. Participant Boronia supported this as:

> Well the easiest one is simply to be the math problem. I think because I encountered so often on a day-to-day basis during school and stuff like it's not too big of an issue for me so that certainly the easiest and probably the most simple problem . . . .But for the biofuels I'm researching, and now my groups have any research it and pretty much getting a lot more information than I would be if I was researching how to clean up the oil spill.

Participants felt that personal problems that impacted the individual required individual problem-solving. Participants felt that "anything else" should be in a team. The level of detail was the final theme to emerge. The level of detail is the amount of point specific knowledge that the participant had to incorporate into the overall problem. Participant Tigerlily supported this stating, "When it has a lot of detail-oriented work, I like to do the detail oriented work myself." Participants heralded individual problem-solving for those problems that had a lot of detail and were specific. Participants promoted team problem-solving when specificity was not needed. Out of the 13 participants interviewed, two felt that individual problem-solving was better for any type of problem-solving.

Mixed Method Results

The mixed method results sought to integrate the description of the problem-solving provided in the qualitative interview process with the non-cognitive outcomes of problem-solving style and self-concept. In order to accomplish this, only those perceived self-concept that were found to be statistically significant to the characteristic of orientation-to-change will be explored.

Orientation-to-change, defining problem-solving, and the statistically significant perceived self-concepts

The orientation-to-change construct of perceived problem-solving style has two categories, Developer and Explorer. For the perceived problem-solving style of orientation-to-change, there were 10 Developer and three Explorers in the interview population. Those classified as a Developer have a score greater than 73 and Explorers are those with a score less than 73. The perceived self-concept of verbal, general self-esteem, academic, and problem-solving were discussed due to being statistically correlated to the orientation-to-change construct. The SDQ III constructs were divided into high, medium, and low ranges. None of the interview participants' perceived self-concept scores classified in the low range for the constructs therefore the low range was excluded.

For the Developer classification of orientation-to-change, the qualitative themes for defining problem-solving had a total n size of 11 as found in Table 12. For the theme, solution for conflict (n=4), verbal self-concept had a frequency of 0.75 for high and 0.25 for medium; general self-esteem self-concept had a frequency of 0.75 for high and 0.25 for medium; academic self-concept had a 1.00 frequency for high; and problem-solving had a 1.00 frequency for high. For the theme, effective solution to an issue, verbal-high self-concept had a frequency of 0.80; verbal-medium self-concept had a frequency of 0.20; general self-esteem-high had a frequency of 0.80; general self-esteem-medium self-concept had a frequency of 0.20; academic-high self-concept had a 1.00 frequency; and problem-solving-high self-concept had a 1.00 frequency. For the theme, challenge, verbal-high self-concept had a frequency 1.00; general self-esteem-high self-concept had a frequency of 0.50; general self-esteem-medium self-concept had a frequency of 0.50; academic-high self-concept had a frequency of 1.00; problem-solving-high self-concept

had a frequency of 0.50; and finally problem-solving-medium self-concept had a frequency of 0.50.

Table 12

Orientation-to-change: Developer, Defining Problem-solving, and SDQ III Constructs

Themes/SDQ III Constructs *f*	Solution for Conflict	Effective solution to an Issue	Challenge
	n= 4	n=5	n=2
Verbal			
High	0.75	0.80	1.00
Medium	0.25	0.20	
General Self-esteem			
High	0.75	0.80	0.50
Medium	0.25	0.20	0.50
Academic			
High	1.00	1.00	1.00
Medium			
Problem-solving			
High	1.00	1.00	0.50
Medium			0.50

Note: Due to some participants using multiple definitions the n sizes will not correspond to the total n size.

For the Explorer classification, found in Table 13, of orientation-to-change, the qualitative themes for defining problem-solving had a total n size of three. For the theme, solution for conflict (n=2), verbal-high self-concept had a frequency of 0.50; verbal-medium self-concept had a frequency of 0.50; general self-esteem-high self-concept had a frequency of 0.50; general self-esteem-medium self-concept had a frequency of 0.50; academic-high self-concept had a 1.00 frequency; and problem-solving-high self-concept had a 0.50 frequency. For the theme, effective solution to an issue (n=2), verbal-high had a 1.00 frequency; general self-esteem-high had a 1.00 frequency; academic-high had a 1.00 frequency; and problem-solving-high had a 1.00 frequency. For the theme, challenge (n=2), verbal-high had a 1.00 frequency; general self-esteem-high had a 1.00 frequency; academic-high had a 1.00 frequency; and problem-solving-high had a 1.00 frequency.

Table 13

Orientation-to-change: Explorer, Defining Problem-solving, and SDQ III Constructs

Themes/SDQ III Constructs *f*	Solution for Conflict	Effective solution to an Issue	Challenge
	n= 2	n= 2	n= 2
Verbal			
High	0.50	1.00	1.00
Medium	0.50		
General Self-esteem			
High	0.50	1.00	1.00
Medium	0.50		
Academic			
High	1.00	1.00	1.00
Medium			
Problem-solving			
High	1.00	1.00	1.00
Medium			

Note: Due to some participants using multiple definitions the n sizes will not correspond to the total n size.

Orientation-to-change, description of the problem-solving process continuum, and the statistically significant perceived self-concepts

For the Developer classification, found in table 14, of orientation-to-change and the

qualitative themes for the problem-solving process continuum had a total n size of 10. The self-

concept construct of academic was high for all participants and therefore had a frequency of 1.00

for all themes of the problem-solving process continuum. For the theme of general topic, verbal-

high had a frequency of 0.78; verbal-medium had a frequency of 0.22, general self-esteem-high

had a frequency of 0.89; general self-esteem-medium had a frequency of 0.11, problem-solving-

high had a frequency of 0.89, and problem-solving medium had a frequency of 0.11. For the

theme of conducting background research, verbal-high self-concept had a frequency of 0.83,

verbal-medium self-concept had a frequency of 0.17; general self-esteem-high self-concept had a

frequency of 0.67, general self-esteem-medium self-concept had a frequency of 0.33, problem-

solving-high self-concept had a frequency of 0.83, and problem-solving-medium self-concept

had a frequency of 0.17. For the qualitative theme of determine the problem and divide into

components, verbal-high self-concept had a frequency of 0.78; verbal-medium self-concept had a

frequency of 0.22, general self-esteem-high self-concept had a frequency of 0.89; general self-esteem-medium self-concept had a frequency of 0.11, problem-solving-high self-concept had a frequency of0.89, and problem-solving-medium self-concept had a frequency of 0.11. For the theme, determine the solvable problem, verbal-high self-concept had a frequency of 0.71; verbal-medium self-concept had a frequency of 0.29; general self-esteem self-concept had a frequency of 0.86; general self-esteem self-concept had a frequency of 0.14; and problem-solving-high self-concept had a frequency of 1.00. For the theme of divide and conquer, where individuals in group setting take the subtopics and assign them to group members to determine the solution, verbal-high self-concept had a frequency of 0.86; verbal-medium self-concept had a frequency of 0.14; general self-esteem-high self-concept had a frequency of 0.71; general self-esteem-medium self-concept had a frequency of 0.29; problem-solving-high self-concept had a frequency of 0.86; and problem-solving-medium self-concept had a frequency of 0.14. For the theme of independent research, verbal-high self-concept had a frequency of 1.00; general self-esteem-high self-concept had a frequency of 0.83, and general self-esteem-medium self-concept had a frequency of 0.17; problem-solving-high self-concept had a frequency of 0.83; and problem-solving-medium self-concept had a frequency of 0.17. For the concluding theme of formulate solutions, verbal-high self-concept had a frequency of 0.80; verbal-medium self-concept had a frequency of 0.20, general self-esteem –high self-concept had a frequency of 0.80; general self-esteem-medium self-concept had a frequency of 0.20; problem-solving-high self-concept had a frequency of 0.90; and problem-solving-medium self-concept had a frequency of 0.10.

Table 14

Orientation-to-change: Developer, Description Problem-solving Process Continuum, and SDQ III Constructs

SDQ III Constructs/ Themes *f*	Verbal		General Self-Esteem		Academic		Problem-solving	
	High	Medium	High	Medium	High	Medium	High	Medium
General Topic n=9	0.78	0.22	0.89	0.11	1.00	--	0.89	0.11
Background Research n=6	0.83	0.17	0.67	0.33	1.00	--	0.83	0.17
Determine and Divide into Components n=9	0.78	0.22	0.89	0.11	1.00	--	0.89	0.11
Determine the solvable problem n=7	0.71	0.29	0.86	0.14	1.00	--	1.00	--
Divide and Conquer n=7	0.86	0.14	0.71	0.29	1.00	--	0.86	0.14
Independent Research n=6	1.00	--	0.83	0.17	1.00	--	0.83	0.17
Formulate Solutions n=10	0.80	0.20	0.80	0.20	1.00	--	0.90	0.10

Table 15 depicts the Explorer classification of orientation-to-change and the qualitative themes for problem-solving process continuum had an n size of three. For the self-concept constructs of academic and problem-solving were high for all participants and both had a frequency of 1.00. For the theme of general topic, verbal-high self-concept had a frequency of 0.50, verbal-medium self-concept had a frequency of 0.50; general self-esteem-high self-concept had a frequency of 0.50; and general self-esteem-medium self-concept had a frequency of 0.50. For the theme of background research, verbal-high self-concept had a frequency of 0.50, verbal-medium self-concept had a frequency of 0.50; general self-esteem-high self-concept had a frequency of 0.50; and general self-esteem-medium self-concept had a frequency of 0.50. For the theme of determine and divide into components, verbal-high self-concept had a frequency of 0.69; verbal-medium self-concept had a frequency of 0.33;general self-esteem-high self-concept had a frequency of 0.69; and general self-esteem-medium self-concept had a frequency of 0.33.

For the theme of determine the solvable problem, verbal-high self-concept had a frequency of 0.50, verbal-medium self-concept had a frequency of 0.50; general self-esteem-high self-concept had a frequency of 0.50; and general self-esteem-medium self-concept had a frequency of 0.50. The theme of divide and conquer had a verbal-high self-concept frequency of 0.69; a verbal-medium self-concept frequency of 0.33; a general self-esteem-high self-concept frequency of 0.69; and a general self-esteem-medium self-concept frequency of 0.33. Independent research had similar results to that of the theme, divide and conquer, were verbal-high self-concept had a frequency of 0.69; verbal-medium self-concept had a frequency of 0.33; general self-esteem-high self-concept had a frequency of 0.69; and general self-esteem-medium self-concept had a frequency of 0.33. For the theme of formulate a solution, verbal-high self-concept had a frequency of 0.50, verbal-medium self-concept had a frequency of 0.50; general self-esteem-high self-concept had a frequency of 0.50; and general self-esteem-medium self-concept had a frequency of 0.50.

Table 15
Orientation-to-change: Explorer, Description Problem-solving Process Continuum, and SDQ III Constructs

SDQ III Constructs/ Themes *f*	Verbal		General Self-Esteem		Academic		Problem-solving	
	High	Medium	High	Medium	High	Medium	High	Medium
General Topic n=2	0.50	0.50	0.50	0.50	1.00	--	1.00	--
Background Research n=2	0.50	0.50	0.50	0.50	1.00	--	1.00	--
Determine and Divide into Components n=3	0.69	0.33	0.69	0.33	1.00	--	1.00	--
Determine the solvable problem n=2	0.50	0.50	0.50	0.50	1.00	--	1.00	--
Divide and Conquer n=3	0.69	0.33	0.69	0.33	1.00	--	1.00	--
Independent Research n=3	0.69	0.33	0.69	0.33	1.00	--	1.00	--
Formulate Solutions n=2	0.50	0.50	0.50	0.50	1.00	--	1.00	--

Orientation-to-change, selection of key information, and statistically significant perceived self-concepts

For Developer classification of orientation-to-change and selection of key information as depicted in Table 16, the academic self-concept construct was in the high range and had a frequency of 1.00 for the themes of expert knowledge, problem specific resources, and background research. For the theme of expert knowledge, verbal-high self-concept had a frequency of 0.80; verbal-medium self-concept had a frequency of 0.20; general self-esteem-high self-concept had a frequency of 0.80; general self-esteem-medium self-concept had a frequency of 0.20; and problem-solving-high self-concept had a frequency of 1.00. For the theme of problem specific resources, verbal-high self-concept had a frequency of 0.88; verbal-medium self-concept had a frequency of 0.12, general self-esteem-high self-concept had a frequency of 0.75; general self-esteem-medium self-concept had a frequency of 0.25; problem-solving-high

self-concept had a frequency of 0.88; and problem-solving-medium self-concept had a frequency

of 0.12. For the theme of background research, verbal-high self-concept had a frequency of

0.80; verbal-medium self-concept had a frequency of 0.20; general self-esteem-high self-concept

had a frequency of 0.80; general self-esteem-medium self-concept had a frequency of 0.20;

problem-solving-high self-concept had a frequency of 0.80; and problem-solving-medium self-

concept had a frequency of 0.20.

Table 16
Orientation-to-change: Developer, Selection of Key Information, and SDQ III Constructs

SDQ III Constructs/ Themes *f*	Verbal		General Self-Esteem		Academic		Problem-solving	
	High	Medium	High	Medium	High	Medium	High	Medium
Expert Knowledge n=5	0.80	0.20	0.80	0.20	1.00	--	1.00	--
Problem Specific Resources n=8	0.88	0.12	0.75	0.25	1.00	--	0.88	0.12
Background Research n=5	0.80	0.20	0.80	0.20	1.00	--	0.80	0.20

For the Explorer classification of orientation-to-change and the selection of key information,

depicted in table 17, themes of expert knowledge and problem specific resources, the self-

concept constructs of verbal, general self-esteem, academic, and problem-solving respondents all

were categorized in the high range and had a frequency of 1.00.   For the theme of background

research, verbal-high self-concept had a frequency of 0.67; verbal-medium self-concept had a

frequency of 0.33; general self-esteem-high self-concept had a frequency of 0.67; and general

self-esteem-medium self-concept had a frequency of 0.33.

Table 17

Orientation-to-change: Explorer, Selection of Key Information, and SDQ III Constructs

SDQ III Constructs/ Themes *f*	Verbal		General Self-Esteem		Academic		Problem-solving	
	High	Medium	High	Medium	High	Medium	High	Medium
Expert Knowledge n=2	1.00	--	1.00	--	1.00	--	1.00	--
Problem Specific Resources n=2	1.00	--	1.00	--	1.00	--	1.00	--
Background Research n=3	0.67	0.33	0.67	0.33	1.00	--	1.00	--

Orientation-to-change, statistically significant perceived self-concepts, and description as a problem solver

For Developer classification of orientation-to-change, when examining high self-concept to medium self-concept there were clear differences between the descriptions of a developer with high self-concept and a developer with medium self-concept. For the participants to be classified in the medium self-concept category they must have had one or more of the statistically correlated self-concept constructs of verbal, general self-esteem, academic, and problem-solving. For those developers who were classified as high self-concept, they described themselves as large scale /"big picture" thinkers and were effective in their problem-solving process versus those developers classified as medium self-concept were more creative in their solutions and divided the problem into greater detail, as depicted in Table 18.

Table 18

Orientation-to-change, SDQ III Constructs and Description as a problem solver

SDQ III Constructs/ Orientation-to-change Classification	High Self-concept	Medium Self-concept
Developer	Very analytical Very concise* Look at the big picture and then find a way to break everything into smaller chunks Straight to the point Get it effectively done Focus on a few things and know them really well I think about what's best for myself Motivated Curiosity about solving the problem I do thinks by myself and ask people what they think afterwards I like my comfort zone	Open-minded* Creative in my solutions I think problem-solving works better I groups Perfectionist I really go into detail and I think that usually takes a lot of my time Narrow it down to specific tasks I'm systematical I like solid facts Problem-solving happens every day of my life and sometimes it's very quick and sometimes they take a lot of time.
Explorer	Individual at first to collect thoughts Enjoys collaborating with people	Very instinctive Strategic

Note: * depicts a item that was mentioned by more than one interview participant

Those developers with high self-concept preferred to work within their knowledge area or

comfort zone whereas medium self-concept developers were more able to be open-minded and

creative in their solutions. One medium self-concept developer Participant Cosmos expressed

that problem-solving was more innate and expressed this through "Problem-solving happens

every day of my life and sometimes it's very quick and sometimes they take a lot of time." An

additional difference between high self-concept and medium self-concept developers is that

medium self-concept developers prefer to attempt solving the problem using a system, most

often starting with problem-solving techniques such as "brainstorming." Participant Lilac

frankly stated:

"I'm very systematical. I don't like to go into a problem with any like
randomness or not knowing what I'm doing and why I'm doing it. So yeah, I
think I just very systematical and I like solid facts rather than just going on
whims."

Unlike medium self-concept developers, high self-concept developers prefer to separate the
problem into constituent components in order to solve it. Participant Dahlia described herself:

"As a problem solver in general I'm very analytical. I like to look at all the
details and I think very concisely, and sort of look at the big picture and then find
a way to break everything into smaller chunks so that I can focus on one thing
first and work on the other steps and then move to the next thing."

Participant Redbud stated that:

"Most of the time, I'm pretty straight to the point. I don't like to waste a lot of
time, looking around. I find I go to right to what I need and just kinda just try to
get it effectively done, which normally makes my projects and problems that I try
to solve pretty concise."

A final difference between a high self-concept developer and a medium self-concept developer
is their use of the team problem-solving format. A high self-concept developer prefers to first
analyze the problem and formulate a solution, then convene with the group, whereas the medium
self-concept developer prefers to start in a group and generate creative solutions. Participant
Crocus articulated the high self-concept mindset as:

"Well a lot of times as a problem solver, I usually do things by myself first, so
group work. I do things by myself and ask people what they think afterwards and
I work on my ideas or I will suggest my ideas if I think I found a better solution."

Whereas Participant Tigerlily when describing herself as a problem solver referenced herself to a team format with:

> "I'm one of the DI team. So I need to be fairly open-minded when coming up with solutions to problems. On a good day I can be creative with my solutions, like sometimes I'm just on the ball, oh we can do this, but other times it's just the creative juices aren't quite following."

Overall, a developer with a medium self-concept describes him or herself as a problem solver differently from a developer with a high self-concept.

When examining explorers, medium self-concept explorers were described themselves as instinctive whereas high self-concept explorers described themselves and their attitude toward working in a team format. Participant Nettle, an explorer with medium self-concept, stated:

> "Ideally you would think I would want to plan everything out but it doesn't always work out that way because that's the way life is. So I guess, I don't know there's some very instinctive things we do. Obviously you know I'm 17 and I'm not very mature, like it comes naturally so people make stupid decisions. Beyond that I definitely feel like it's a big decision I always try to strategize what angle can I come at this from not necessarily how this going to make me feel like, what are my options."

Unlike Participant Nettle, Participant Begonia focused on her team when she exclaimed:

> "I like working with people better, so I think that one of my strong points is that I like to collaborate with people. I mean I'd rather, it's nice to get other people's ideas too. Because it's not like one person is going to have the best one."

Both a high self-concept explorer and a medium self-concept explorer describe problem-solving as intuitive with the difference between the two being expressed in how they describe themselves as a problem solver and how they relate themselves to the team format.

Individuals who were classified as an explorer with high self-concept described themselves similarly to developers with a medium self-concept in relation to working in a team. Participant Begonia stated, "I like to work with people so it's easy for me to solve problems like my project. I couldn't do all of that by myself, I mean I could but I don't think I could do all that great." However high self-concept explorers described themselves similar to their high self-concept developer counterparts, participant Boronia stated:

> "I don't just like to jump right in with my teammates just to discuss right away
> because for me it's a little overwhelming. So I just like to first go and think for
> myself, get my thoughts collected and then take those thoughts within to my
> group."

Summary

This study investigated the relationship between perceived self-concept and perceived problem-solving style for high-achieving rising 11th and 12th grade youth attending a summer enrichment program. Self-concept constructs of math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite sex were correlated to the problem-solving style constructs of orientation-to-change, mental-processing, and way-of-deciding. Selected participants were asked in interviews to describe their problem-solving ability for a given problem-solving task. Finally, this study examined the descriptions provided by the participants and how those descriptions compared and contrasted to perceived problem-solving style and self-concept.

Chapter V

Conclusion

Overview

In Chapter 5, the purpose of the study, methods and procedures used to execute the study, and the findings pertaining to each of the research questions posed in this study will be reiterated. In addition, Chapter 5 includes a discussion of the results from the analysis, implications for education, implications in practice, future research and a summary.

Purpose

In order to investigate the relationship between perceived self-concept and perceived problem-solving style and how these two constructs compare and contrast in regards to participants' perceptions of problem-solving ability among high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture, this study posed the following research questions:

Research Question 1: What are the relationships between problem-solving style and perceived self-concept for this group of participants?

Research Question 2: How do participants describe their problem-solving ability for a given problem-solving task?

Research Question 3: How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

Methods and Procedures

The sample population (n=86) for this study was composed of rising junior and senior high-achieving youth participating a summer enrichment program for agriculture. Selected participants (n=13) participated in the qualitative section of the study. All participants and

parents or guardians of participants completed consent and assent forms and participants participated in data collection. All participants completed the Self-Description Questionnaire III and the VIEW: An Assessment of Problem-solving Style. Those participants selected for the qualitative component of the research were a subset of the total participant group. They each participated in two interviews lasting approximately 20-30 minutes. The interviews were recorded, transcribed, and coded to explore emergent themes in the research.

For the quantitative component of the study, participants' responses were scored according to the procedures for each instrument respectively. In order to determine if a statistically significant relationship existed between the self-concept components (mathematics, verbal, problem-solving, general academic, general self-esteem, same-sex peer, and opposite-sex peer) and the problem-solving style components (orientation-to-change, manner of processing, and ways of deciding), Pearson's r product moment correlation was conducted. The self-concept and problem-solving style components that were found to have a statistically significant relationship were used in the mixed method component of the study. The qualitative component of the study consisted of content and constant comparison analysis of interview transcripts. Each transcript was analyzed four times to identify patterns within the codes; these patterns were developed into categories; and the categories were further narrowed down into themes which framed the descriptions of the main ideas found by the researcher to answer the questions proposed.

Presentation of Findings

Three research questions were the basis for this study. The first question, which was quantitative in nature, used data analyses through statistical procedures to detect statistically significant results. Statistical significance was found for some components of the question but

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not others. The second question was qualitative in nature, and so the researcher used constant comparison to explore perceived problem-solving style were themes emerged. The third and final question merged the components of the first question with the second question to compare and contrast the findings by using a mixed method approach.

Research Question One

What are the relationships between problem-solving style and perceived self-concept for this group of participants?

The findings for perceived self-concept indicated that the constructs have statistically significant weak or positive relationships for many of the constructs. A statistically significant weak positive relationship exists between general self-esteem and math, same-sex, and opposite sex self-concept. A statistically significant positive relationship exists between general self-esteem and the constructs of verbal, academic, and problem-solving self-concept. Verbal self-concept has a statistically significant weak positive relationship with academic, problem-solving, same-sex, and opposite sex self-concepts. Similarly, academic self-concept has a statistically significant weak positive relationship with problem-solving self-concept. Problem-solving self-concept also had a statistically significant weak positive relationship with same-sex and opposite sex self-concepts. Opposite sex and same sex have a statistically significant weak positive relationship as well. Finally, math self-concept and academic and problem-solving self-concepts have a statistically significant positive relationship.

The findings for perceived problem-solving style indicate that there is a statistically significant positive relationship between mental-processing and way-of-deciding. The remaining constructs have no statistically significant relationship.

The findings indicated that perceived self-concept and perceived problem-solving style have a weak relationship for many of the constructs and a negative relationship for two constructs. The statistically significant weak positive relationship for this population exists between orientation-to-change and the self-concept constructs of verbal, academic, and general self-esteem. A statistically significant negative relationship exists between orientation-to-change and problem-solving self-concept. A statistically significant weak positive relationship exists between mental-processing and math self concepts and a statistically significant weak negative relationship exists between mental-processing and opposite sex. A statistically significant weak positive relationship also exists between way-of-deciding and math self-concept.

<u>Research Question Two</u>

How do participants describe their problem-solving ability for a given problem-solving task?

The findings indicate that the participant population has a clear description of problem-solving, were three themes emerged: Solution for conflict, effective solutions to an issue, and challenge. Additionally when exploring the participants' description of the problem-solving process, a problem-solving process continuum emerged. This continuum is composed of eight steps: a general problem, background research, determining and dividing into components, determining the solvable problem, dividing and conquering the solvable problem, conducting independent research, formulating the solutions, and enacting the solution or providing the solution to the group that is having the problem. In order to further understand the problem-solving, participants described how they selected key information about the problem, resulting in three central themes: expert knowledge, problem specific resources, and background research. In order to understand problem-solving, participants were asked to describe themselves as problem solvers which has a central concept that most preferred to solve problems individually

however a team setting provides better results. Due to participants discussing the differences between individual and team problem-solving, a distinction between working in a group of similar ability versus working a group of multiple abilities emerged. The results found that when working in a group of similar ability level peers, five themes emerged: motivation work ethic, communication, stress level, and problem task focus. When working a group of multiple ability levels, the themes of lack of motivation, lack of trust, and poor work ethic emerged. Finally, an understanding of how a participant switched from an individual problem solver to a team problem solver was explored. Participants switched from an individual problem solver to a team problem solver based on three themes: scalable, situation specific, and level of detail in relation to the problem.

Research Question Three

How does the description of the problem-solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem-solving style and self-concept?

The findings from the mixed question of the study explored the perceived problem-solving construct of orientation-to-change and its two sub-classifications: Explorer and Developer, the statistically significant perceived self-concepts for this construct, and the qualitative components of defining problem-solving, description of the problem-solving process continuum, selection of key information, and description as a problem solver. Both Explorers and Developers were similar when comparing high and medium self-concepts to the problem-solving definition themes. When Developers' self-concepts were compared to the problem-solving process continuum, individuals who used all processes along the continuum had high self-concept overall but problem-solving self-concept had the highest frequency. Due to the low n size for Explorers, the problem-solving process continuum was divided relatively equally

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between high and medium self-concept for the constructs of verbal, general self-esteem, academic, and problem-solving. In the selection of key information, Developers who chose information through the use of expert knowledge had high self-concept in academic and problem-solving areas. Those individuals who used expert knowledge often had high verbal and general self-esteem self-concepts as well. Individuals who used problem select resources frequently had high self-concept for verbal, general self-esteem, academic, and problem-solving. A limited number had medium self concept for problem-solving and verbal (n=1). General self-esteem had the highest incidence of medium self-concept (n=2). Those Developers who used background research had high self-concept for academic, verbal, general self-esteem, and problem-solving. When compared to the Explorers, those individuals that used expert knowledge had high self-concept for verbal, general self-esteem, academic, and problem-solving. Those Explorers that used problem specific resources also had high self-concept for verbal, general self-esteem, academic, and problem-solving.

Developers with high self-concept described themselves as very analytical and concise. They preferred to examine the larger prospective then focus on smaller, solvable components. Developers with high self-concept used curiosity as a motivational factor for solving the problem. High self-concept Developers preferred to work within their comfort zone and were very individualized in their problem-solving process. In comparison, Developers with medium self-concept preferred to work in a group setting to solve problems and enjoyed being open minded and creative in their solutions. Similarly both high and medium self-concept Developers preferred to take a problem and break it down into smaller components. Explorers with a high self-concept preferred to work individually at first and collaborate with people after

individualized reflection. Explorers with medium self-concept described problem-solving as instinctive and strategic in nature.

<div align="center">**Discussion**</div>

Theoretical Framework

This study investigated the impact of individual differences in the areas of self-concept and problem-solving style as well as their influence on a problem-solving task as associated with Big-Fish-Little-Pond-Effect (BFLPE) and reflected glory effect. Social cognitive theory provides the basis for connecting the cognitive and non-cognitive aspects within a social context.

Social cognitive theory views goals and motivation as critical components of learning. Within social cognitive theory, additional attributes like problem-solving style and self-concept influence motivation due to their impact on outcomes and expectations. The findings of this research are consistent with social cognitive theory, were participants depicted their perceptions of working in a group of either different ability levels or similar ability levels impacted the participants' perception of solving the problem and the ability to produce "good quality work."

A sense of self is developed during adolescence using social comparison (Harter, 2001). Social comparison is used for reality verification. Covington and Beery (1976) substantiated that social comparison often occurs in small group settings such as enrichment programs. It is during adolescence that self differentiates into multiple perspectives of self. The theoretical framework of this study suggests that social comparison should influence the participants' self-perceptions as related to self-concept and problem-solving style. Within the context of social comparison theory, BFLPE and reflected glory effect attempt to explain the basis for making comparisons.

BFLPE as proposed by Marsh suggests that when a high-achieving youth is removed from an environment of mixed achievement levels and placed in a high-achieving environment,

that youth's self-perception will decrease (Marsh & Hau, 2003). Within this environmental change, youth will evaluate themselves against individuals who they feel have equal or greater ability levels (Marsh, Trautwein, Ludtke, Baumert, & Koller, 2007). Within this framework, reflected glory effect has emerged as a subsequent theory.

Reflected glory effect occurs when a group of high-achieving individuals are placed in a group of high achievers and they have an increased self-perception of their ability. According to this framework, the participants of the present research would have high self-concept due to being among a group of high achievers for the academic self-concepts of math, verbal, general academic, problem-solving. The findings of this research are consistent with this theoretical framework in that high-achieving rising 11th and 12th grade high school students attending the a summer enrichment program for agriculture did have high mean scores for academic self-concepts of math, verbal, academic, and problem-solving.

Both social comparison theory and reflected glory effect impact changes in non-cognitive outcomes such as social self-concept and problem-solving style. Wright and Leroux (1997) postulated that a positive self-concept is an important concept for influencing student achievement. The findings of this research are consistent with both social comparison theory and reflected glory effect due to the non-cognitive outcomes such as social self-concept constructs of general self-esteem, same-sex, and opposite sex were high for this population.

Relationships between perceived problem-solving style and perceived self-concept

When examining the results for the relationship between perceived problem-solving style and perceived self-concept, a preliminary examination of the two constructs must first occur. Self-concept theory used two paradigms, the unidimensional and the multidimensional hierarchical model. Within this theory it is imperative that the multidimensionality of self-

concept be explored in order to understand self-concept as a whole (Bryne,1996). The self-concept sub-categories had unique correlations. According to the literature, verbal and math self-concept should be strong positively correlated to academic self-concept (Potterbaum, Keith, & Ehly, 1986). The results of this study found that academic self-concept was statistically correlated to both math and verbal self-concepts, however the relationship was only a weak positive between verbal and academic self-concepts. There was, however, a positive correlation between math and academic self-concepts. Similar to the findings of Marsh (1990), verbal and math self-concepts were not correlated in the present study.

Previous literature indicated that the problem-solving style constructs of orientation-to-change, mental-processing, and way-of-deciding are not related but "inform" the overall problem-solving style. The results from the present study support this concept with orientation-to-change not being significantly correlated to either mental-processing or way-of-deciding. It should be noted that mental-processing and way-of-deciding were positively related, however this result should be further examined in future research.

This study is innovative in that is examined the relationship between self-concept and problem-solving style. The findings from this study depict that the problem-solving style sub-category of orientation-to-change for this population is weakly correlated to the self-concepts of verbal, academic, and general self-esteem; additionally orientation-to-change is negatively related to problem-solving self-concept. The negative relationship between orientation-to-change and problem-solving self-concept may have implications for developing problem-solving in youth. For instance, when a student scores high on the orientation-to-change scale and has the developer classification, that student scores lower on the problem-solving self-concept scale. This relationship is neither weak nor strong and therefore implications cannot be made

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definitively; however this relationship does warrant further exploration to determine with certainty across multiple populations the relationship between problem-solving self-concept and orientation-to-change. Treffinger et al. (2008) described explorers, those individuals that score low on the orientation-to-change scale as individuals creating original ideals, observing unusual patterns and relationships. Explorers prefer ill-defined problems, various tasks, and indistinct situations, and challenges. Finally, Explorers find exterior procedures and plans limiting. Developers, those that score high on the orientation-to-change scale, are described as being methodical and organized. Developers prefer to focus on a task to the solution and generate solutions that have practical applications and are reality focused. Finally, Developers employ plans, details, and structure to solve a problem.

Describing problem-solving

Interview participants had clear and concise definitions of problem-solving; these definitions were: "solution for conflicts" and "effective solutions to an issue." These definitions differ from the definitions found in the literature were problem-solving is defined as "the process of finding a solution to a problem" (Chi & Glaser, 1985, p. 234). Unique to this group of participants, the term "problem" was not used to define problem-solving; rather, participants conceptualized "problem" as either a conflict or an issue. In addition, the persons contributing to the solution influence the quality of the solution through their skills, intellect, talent, and critical thinking. This thought is supported throughout the literature in the works of Alexander (2007), Anderson (1993), Davidson and Sternberg (2003), and Dominowski and Bourne Jr (1994).

Another concept that arose because of the present study was the idea of challenge. For this study, challenge had two vastly different meanings. The first was the use of challenge as a

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description for the conflict or issue. This usage is common in the literature specifically when describing ill-defined problems (Chi & Glaser, 1985; Schraw, et al., 1995). The second use of the term challenge was as the internal motivation to solve the problem. Participants felt the conflict was something to conquer and give them internal satisfaction for having conquered this difficult task. This is also supported in the literature through the works of Bandura (1991).

The problem-solving process

The results of this study supported previous research on schemata and heuristics were the participants of this study described a set way of solving the task. Each participant had a unique way of solving the problem, but all had core concepts within that were foundational and learned from expert knowledge such as a former teacher or life experience. This is supportive of the use of schemata in problem-solving education and the use of instruction in heuristics (Abel, 2003; Fikes & Nilsson, 1971; Glaser, 1984; Moustakas, 1990; H. A. Simon & Newell, 1958). It should be noted that the problem-solving process continuum from this study has definitive components for promoting both individual and team problem-solving. Within each component of the process are constraints to promote effective solution building. Although, this process continuum is in its foundational stage the malleability of the continuum and its use for promoting problem-solving within the classroom should be explored in future research due to providing a different approach to problem-solving that was generated from the perspective of youth.

Key information

Comparable to previous literature, the results of this study depicted that information is gathered from expert knowledge, problem specific resources, and background research. Although previous research does not use this terminology specifically, recent literature (Kim & Sin, 2007) explored the perception of resources and had similar findings as the present study.

Conversely, in information gathering research, the literature differs from the results of this study in that information gathering research explored well-defined problems unlike the present study which explored ill-defined problems (Greeno, 1978; H. Simon, 1978). The difference between information gathering research and the present study can be explained in that the present study investigated the selection of key information from a qualitative perspective and provided the participants an opportunity to explain their thought process of solving a problem whereas information gathering research is often quantitative in nature and is conducted through a series of field observations.

Team-based problem-solving

The results of the present study concurred with those of Maloney (1994) in that group formation is important to contributing to problem-solving ability, however the components of the group are equally important. The results of this study found that the ability composition of the group influenced how the group solves the problem. For those high-achieving students, focusing on the problem versus managing the group is impacted by whether the high-achieving students are in a group of similar ability level or differing ability levels. High-achieving students, when in a group of similar ability level, could focus on the problem task whereas when high-achieving students are placed in a group of differing ability levels, the students focus on managing the group rather than solving the problem. In addition to increasing the student's ability to solve the problem, students felt that when in a group of similar ability, members were motivated, had stronger work ethic, and had better communication. A topic that had mixed results was the concept of stress. Many students thought that it was less stressful to be in a group of similar ability, however other students thought that being in a group of similar ability is more stressful due to feeling like they needed to outperform their peers. However when in a group of mixed

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ability levels, high-ability participants expressed concern over the lower-ability group members being motivated, and as a result the participants could not trust the group members to do their work. This is important to instruction due to numerous pedagogical researchers finding that mixed ability levels provide an opportunity for the lower ability level students to be assisted by the higher ability level students or there is no impact between the groups (Ames, 1992; Novak, 1983).

Problem-solving style, self-concept, and the description of problem-solving

When the concept of an overall problem solver emerged in the mixed methods phase of the research, delineation between the orientation-to-change sub-classifications of developer and explorer emerged, but to more specificity the delineation between a high and medium self-concept for each sub-classification also emerged. Although no empirical research existed relating problem-solving style and self-concept specifically, Heppner (1985) and Anderson (1993) found similar results to the present study were self-perception of their problem-solving ability influenced problem solvers to effectively solve problems. Therefore, the results for the present study were consistent with previous research. Developers with medium self-concept described themselves as problem solvers who are creative and work in groups, and high self-concept developers preferred to work on their own and then consult group members when applicable. When compared with medium self-concept developers, high self-concept explorers were similar in their preference to work in a group setting. Unlike high self-concept explorers and medium self-concept developers, high self-concept developers and medium self-concept explorers had few similarities. Due to the small n size of the explorer population, this is an area where further research is needed.

When the orientation-to-change subcategories and self-concept levels of high and medium were compared to the themes resulting from the qualitative component of the study, there was little relation. Neither developers nor explorers with high or medium self-concept used any theme more prevalently for defining problem-solving, description of problem-solving process continuum, or selection of key information. Although, the results of this comparison showed no significant results, further exploration of these concepts is warranted.

Recommendations

Recommendations for the relationship between problem-solving style and perceived self-concept

In the present study, correlations were used to measure how related problem solving style and self concept were. With the present research, as with all correlation research, it is important to remember that correlation does not measure causation and therefore the present research is limited to stating whether these two variables are related. Therefore, this research shows that there is a relationship between the components from problem solving and self-concept. For the most part, this relationship is a weak positive one, however the negative relationship between orientation-to-change and problem-solving self-concept has a strong impact on how educators teach problem solving. The initial findings of the present research allows for prediction between self-concept and problem –solving style whereby as the value for orientation-to-change increases, the value for problem-solving self-concept decreases. From this research, exploration of the negative relationship between problem-solving self-concept and orientation-to-change warrants additional research prior to making definitive statements about the impact of the present research.

Recommendations for the description of problem-solving ability for a given task

In the present study, participants had clear descriptions of key phases in regards to problem-solving such as the definition of problem-solving and themselves as problem solvers. These definitions did differ from those found in problem-solving research. Therefore, further examination of the implications between the youth definition of problem-solving and the expert definition of problem-solving would further the knowledge base on problem-solving and provide additional insight into practical applications for instruction. The problem-solving continuum that emerged from the research warrants additional exploration in the feasibility of this heuristic as a teaching tool for problem-solving in a team-based environment. This continuum could provide a new and innovative means for instruction for ill-defined problems, an area which is often a challenge to teach. Finally, exploration of the team format and how being in a group of similar ability levels versus being in a group of differing ability levels should be conducted. The perception from this population that their ability to focus on the task and their perception of their team is impacted by the ability levels of others was a surprising finding. This perception should be explored to determine if this perception is specific to this population.

Recommendation for the description of the problem-solving task and the integration with the non-cognitive outcomes of perceived problem-solving style and self-concept

By combining qualitative and quantitative research, the present research provided the opportunity for comparison and merging of information using the mixed method format. The results of this comparison found interesting findings in that the variation in overall self-concept and the classification for orientation-to-change. The impact of level of self-concept on both subcategories (Explorer and Developer) provided additional understanding of how persons in those subcategories depict themselves. The similarities between explorers with high self-concept and developers with medium self-concept and how these two groups prefer team-based problem-

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solving is an area that needs further research. This preference toward working in a team-base group has multiple implications for problem-solving theory and instruction. Again, the present study is the first to use a mixed method approach in order to explore problem-solving ability and self-concept and therefore results should be examined further to determine if in fact these results are consistent as is the nature of good research. Therefore, each component explored within this study should be examined further.

Implications for Education

The overall implications in education are evident; the findings of in this study further the understanding of the problem-solving process for high-achieving high school aged youth, specifically the influence of the ability level of individuals within a group setting. The components of this research have provided a keystone opportunity for further exploration of the concepts that emerged. According to Partnership for 21st Century Skills, providing instruction in problem-solving skills is a critical needs area to prepare youth for the global economy (2010).

Within the first research question, this study sought to determine if there was a relationship between problem-solving style and self-concept. The results depict that there were weak relationships between many of the constructs and a negative relationship between orientation-to-change and problem-solving self-concept. This negative relationship is an area that warrants additional research. Due to this study being one of the first to investigate whether problem-solving style and self-concept are related, additional research is recommended to further strengthen the result that when students score high in the orientation-to-change problem-solving style category and would be classified as developers, their self-concept in problem-solving declines. As is the nature of self-concept, students having a lower self-concept in problem-solving would in turn be less confident in their ability to solve problems.

Within the second research question, were participants described their problem-solving ability in relation to a problem-solving task, the results showed that this group of participants' description of problem-solving differed from the literature, had a problem-solving process continuum that was unique, and identified key information with some variation to previous research. Each of the aforementioned concepts impacted education. The participants' description of problem-solving did not use the term "problem" but rather "conflict" or "issue," posing additional questions and further research into how a teacher could present problem-solving these definitions in mind and how the use of those key terms impact how a teacher could present this information and build upon this definition. The problem-solving process continuum is a concept that emerged from the study and could have significant impact on instruction in problem-solving. This continuum should be further explored as a heuristic method to determine the feasibility of its use in instruction. How the participants selected key information provided additional insight into how a student chooses critical information and provides educators an opportunity to design lessons that incorporate the themes of expert knowledge, problem specific resources, and background research into their curriculum. In addition to these findings, the second question had emergent concepts that related to team-based problem-solving.

In regards to team-based problem-solving, the impact of working with a team of similar ability versus a team of multiple abilities was a clear point of concern. The findings show that participants felt that working on a team of similar ability increased their ability to solve the problem were as when working in a group of multiple ability levels, participants felt that they had less ability to work on the problem and had to assume a leadership role within to the team. This area could have a significant impact on team formation for team-base problem-solving and

the development of curriculum for problem-solving. Finally, the participants' impression of problem-solving within a team does raise additional research questions to be conducted.

Implications in Research

A number of additional research questions have been suggested by from the results of the present study. The quantitative component of this study depicted weak relationships between orientation-to-change and self-concepts of verbal, general self-esteem, and academic. Additionally, orientation-to-change and problem-solving self-concept had a negative relationship. Due to this being an initial study determining the relationship between problem-solving style and self-concept, further exploration into this area should be conducted to determine if these results could be replicated within similar populations.

The qualitative component of the study raised questions as to the problem-solving process continuum that emerged and its usability in the classroom setting is an area that is of interest to the researcher. Further developing curriculum on the problem-solving process and implementing this curriculum in a classroom setting to determine the functionality of the process for teaching is another area of interest. A second qualitative aspect of the present study that is of interest was the students' perception of the team composition and the impact of working in a group of similar ability versus a group of mixed ability levels. This aspect is of interest due to determining whether perceptions of the ability levels reflect the functionality of the team.

With the mixing component, additional research exploring the relationship between orientation-to-change and self-concept levels (medium and high) should be conducted. Further exploration of the relationship between the two subcategories of orientation-to-change (Explorer and Developer) and difference in those levels and the self description of problem solvers warrant

further investigation. A key component of this new area of research would be having a similar number of explorers and developers from which to compare.

This study provided insight into the relationship between problem-solving style, self-concept, and the impact on a problem-solving task in high-achieving youth; additional questions developed from the results. Simultaneously, the results from the present study have implications for the interrelation of problem-solving style and self-concept and their impact on how an individual solves a problem. These implications are of importance to both the researchers and educators alike.

Summary

The current study investigated the relationship between perceived self-concept and perceived problem-solving style. How self-concept and problem-solving style compared and contrasted in regards to participants' perceptions of their problem-solving ability was explored among high-achieving rising 11th and 12th grade high school students attending a summer enrichment program for agriculture. This study focused on the problem-solving style categories of orientation-to-change, mental-processing, and way-of-deciding and the self-concepts of math, verbal, general self-esteem, academic, problem-solving, same-sex, and opposite sex. Problem-solving style was measured using the VIEW instrument and the aforementioned self-concepts were measured using the Self-Description Questionnaire III (SDQIII). The population for the quantitative component of this study was 86 students attending a summer enrichment program for agriculture. Out of those 86 students, 13 participated in the qualitative component of the study. While the results of this study agreed with the findings from previous research related to either problem-solving style or self-concept, little research has been conducting between the two.

The quantitative component of the study was collected one day at the end of a class; the qualitative component was collected over the span of the summer enrichment program in agriculture. The analysis of the quantitative data used Pearson's product moment correlations to determine the relationship between the constructs. The qualitative analysis occurred through content and constant comparison methods with four iterations. The quantitative results indicated that perceived self-concept and perceived problem-solving style have a statistically significant weak relationship for many of the constructs and a statistically significant negative relationship for two of the constructs. The statistically significant weak relationships for this population exists between orientation-to-change and the self-concept constructs of verbal, academic, and general self-esteem. A statistically significant negative relationship exists between orientation-to-change and problem-solving self-concept. A statistically significant weak relationship exists between mental-processing and the self-concepts for math and opposite sex. A statistically significant weak relationship also exists between way-of-deciding and math self-concept. The qualitative findings indicate that the participant population has a clear description of problem-solving. Additionally from the participants' description of the problem-solving process, a problem-solving process continuum emerged. The results depicted that key information about the problem was gathered using expert knowledge, problem specific resources, and background research. When participants described themselves as problem solvers, most preferred to solve problems individually, however they perceived a team setting provided better results. A depiction between working in a group of similar ability versus working a group of multiple abilities emerged. The results found that when working in a group of similar ability level peers, five themes emerged: motivation, work ethic, communication, stress level, and problem task focus. When working a group of multiple ability levels, the themes of lack of motivation, lack of

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trust, and poor work ethic emerged. The final qualitative aspect of how participants switched from individual problem solvers to team problem solvers was due to three criteria scalable, situation specific, and level of detail in relation to the problem. For mixing methods of the study, the quantitative and qualitative components were combined and compared and contrasted to provide an overall picture. Although the majority of the comparisons yielded no results of merit, when comparing the self-descriptions of a problem solver between an explorer and developer with either high or medium self-concept similarities or differences are numerous.

This study also compared the current results with previous results found in problem-solving and self-concept research. The current research extends previous research by providing a bridge between self-concept and problem-solving research for this population. This study suggests future areas of research to include study replication, use of the problem-solving process continuum in the classroom, further exploration of participants' perceptions between teams of multiple ability levels versus teams of same ability levels, and further depiction of the relationship between orientation-to-change, self-concept levels, and self-description of a problem solver. Finally, this study highlights the use of mixed methods research because without the use of the mixed methods approach, the interrelation between problem-solving style, self-concept, and problem-solving task could not have been explored to the extent found in this study.

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Appendix A
Informed Consent

Virginia Polytechnic Institute and State University

Informed Assent for Participants and Consent for Participant's Parent in Research Projects Involving Human Subjects

Project Title: Exploring the dimensions of problem solving ability on high achieving youth in the agricultural concentration: A mixed methods study

Investigators: Ms. Jolene Hamm, Doctoral Candidate
Dr. Thomas Broyles, Assistant Professor

I.   Purpose of Research

The purpose of this mixed methods study is to investigate the relationship between perceived self-concept and perceived problem solving style and how these two constructs compare and contrast in regards to a participant's perception of their problem solving ability. This study seeks to examine the following questions:
Research Question 1: What are the relationships between problem solving style and perceived self-concept for this group of participants?
Research Question 2: How do participants describe their problem solving ability for a given problem solving task?
Research Question 3: How does the description of the problem solving task provided by the participants integrate with the non-cognitive outcomes of perceived problem solving style and self-concept?

II.   Procedures

At the beginning of the meeting, you will take the following assessments: VIEW (problem solving style assessment) and Self-Description Questionnaire III (SDQIII) (self-concept assessment). After the assessments, you will be asked to complete two (2) 60 minute interview using the following interview prompts:
1.   When you think of the terms "problem solving" what comes to mind? How do you define this term?
2.   Given the sample problem, describe how you would go about solving this problem.
3.   Please give me a specific example of how you obtained information to solve a problem. What was the problem and how did you decide what information you required?
4.   Describe yourself as a problem solver.
5.   What is your approach to managing important projects?
6.   When faced with a work-related or school-related problem, what steps do you take to address the issue?

III.   **Risks**

This study has been reviewed and approved by the Virginia Tech Institutional Review Board. It received the "Expedited" status that means that it is seen as the safest of all possible research. Individual answers and identities of the participants will be protected all times

IV.   **Benefits**

There are no direct benefits to the study participants. The indirect benefits to participants knowing how your problem solving style and self-concept are correlated. Additional indirect benefits are to the educational communities that these findings will be shared with. Even so, there has been no promise or guarantee of benefits that have been made to encourage you to participate. Subjects may contact the researchers for a total summary of the study results.

V.   **Extent of Anonymity and Confidentiality**

Protecting your identity is a top priority of this study. By participating in this research project, your information will be kept strictly confidential. At no time will information be released that allows an individual to be identified. At no time will the researchers release the results of the study to anyone other than individuals working on the project without your written consent. Only the research team will have access to your data.

It is possible that the Institutional Review Board (IRB) may view this study's collected data for auditing purposes. The IRB is responsible for the oversight of the protection of human subjects involved in research.

VI.   **Freedom to withdraw**

Participants are free to withdraw from the study at any time without penalty. Subjects are free not to answer any questions without penalty.

VII.   **Subject's responsibilities**

I voluntarily agree to participate in this study. I have the following responsibilities:

- Complete the following measurement instruments
    - VIEW (problem solving style assessment)
    - SDQ III (self-concept assessment)
- Complete two (2) 60 minute interviews
- Review the transcripts of previously mentioned interview

Appendix B
Letter to Participants

VirginiaTech
College of Agriculture
and Life Sciences

Virginia Governor's School for Agriculture
2270 Litton Reaves Hall (0343)
Blacksburg, Virginia 24061
540/231-6836 Fax: 540/231-3824
www.gsa.vt.edu

To: Parents/Guardians of VSGA Participants

From: Dr. Tom Broyles, Program Director
　　　 Mrs. Jolene Hamm, Doctoral Candidate, AEE

Re:　　 Informed Consent

Dear Parent/Guardian:

Congratulations on your child's selection in the Virginia Summer Residential Governor's School of Agriculture (VGSA)! We are looking forward to their participation in the program. Previous participants have found the VGSA to be a rewarding and fun experience.

In order to continue to improve our programs offerings, we need your assistance. One of the objectives of the VGSA is to increase awareness of problem solving skills and ability to participants. To that end, we are asking your permission to allow your attendee to participate in *a study aimed at helping to understand how high achieving students like yours come to* decisions using problem solving skills.

Enclosed you will find an informed consent document approved by the Virginia Tech *Institutional Review Board. Within that document, you will find information about the study* including the information that will be collected from the participants as well as information protecting the identity of those participants. Please review this document and feel free to contact us with any questions or comments you may have. Thank you for your consideration and again congratulations!

Sincerely,

Dr. Tom Broyles
Program Director
Virginia Summer Residential Governor's School of Agriculture

Jolene Hamm
Doctoral Candidate
Agricultural and Extension Education

Invent the Future

Appendix C
Self-Description Questionnaire III

SDQIII©

INSTRUMENT

PLEASE READ THESE INSTRUCTIONS FIRST

This is not a test - there are no right or wrong answers.

This is a chance for you to consider how you think and feel about yourself. **This is not a test** – there are no right or wrong answers, and everyone will have different responses. The purpose of this study is to determine how people describe themselves and what characteristics are most important to how people feel about themselves.

On the following pages are a series of statements that are more or less true (or more or less false) descriptions of you. Please use the following eight-point response scale to indicate how true (or false) each item is as a description of you. Respond to the items as you now feel even if you felt differently at some other time in your life. In a few instances, an item may no longer be appropriate to you, though it was at an earlier period of your life (e.g., an item about your present relationship with your parents if they are no longer alive). In such cases, respond to the item as you would have when it was appropriate. Try to avoid leaving any items blank.

After completing all the items, you will be asked to select those that best describe important aspects – either positive or negative – of how you feel about yourself. Consider this as you are completing the survey.

1	2	3	4	5	6	7	8
Definitely False	False	Mostly False	More False Than True	More True Than False	Mostly True	True	Definitely True

Participant Number: _____

___ 1	I find many mathematical problems interesting and challenging	___37	Relative to most people, my verbal skills are quite good	
___2	I have trouble expressing myself when trying to write something	___38	Overall, I have a very good self-concept.	
___3	Overall, I have a lot of respect for myself.	___39	I am not particularly interested in most academic subjects	
___4	I enjoy doing work for academic subjects	___40	I have a lot of intellectual curiosity.	
___5	I am never able to think up answers to problems that haven't already been figured out.	___41	I share lots of activities with members of the same sex.	
___6	I have few friends of the same sex that I can really count on.	___42	I am quite shy with members of the opposite sex.	
___7	I get a lot of attention from members of the opposite sex.	___43	I have always done well in mathematics classes	
___8	I have hesitated to take courses that involve mathematics	___44	I often have to read things several times before I understand them	
___9	I can write effectively	___45	Overall, nothing that I do is very important.	
___10	Overall, I lack self-confidence	___46	I learn quickly in most academic subjects	
___11	I hate studying for many academic subjects	___47	I am not very original in my ideas, thoughts, and actions.	
___12	I am good at combining ideas in ways that others have not tried	___48	Not many people of the same sex like me.	
___13	I am comfortable talking to members of the same sex.	___49	I make friends easily with members of the opposite sex.	
___14	I find it difficult to meet members of the opposite sex whom I like.	___50	I never do well on tests that require mathematical reasoning	
___15	I have generally done better in mathematics courses than other courses	___51	I am good at expressing myself	
___16	I have a poor vocabulary	___52	Overall, I have pretty positive feeling about myself.	
___17	Overall, I am pretty accepting of myself.	___53	I hate most academic subjects	
___18	I like more academic subjects	___54	I am an imaginative person	
___19	I wish I had more imagination and originality	___55	I am popular with other members of the same sex.	
___20	I don't get along very well with other members of the same sex.	___56	I have had lots of feelings of inadequacy about relating to members of the opposite sex.	
___21	I have lots of friends of the opposite sex.	___57	At school, my friends always came to me for help in mathematics	
___22	Mathematics makes me feel inadequate	___58	In school I had more trouble learning to read than most other students	
___23	I am an avid reader	___59	Overall, I have a very poor self-concept.	
___24	Overall, I don`t have much respect for myself.	___60	I get good marks in most academic subjects	
___25	I have trouble with most academic subjects	___61	I would have no interest in being an inventor	

___26	I enjoy working out new ways of solving problems	___62	Most people have more friends of the same sex than I do.
___27	I make friends easily with members of the same sex.	___63	I am comfortable being affectionate with members of the opposite sex.
___28	Most of my friends are more comfortable with members of the opposite sex than I am.	___64	I have never been very excited about mathematics
___29	I am quite good at mathematics	___65	I have good reading comprehension
___30	I do not do well on tests that require a lot of verbal reasoning ability	___66	Overall, I have pretty negative feelings about myself.
___31	Overall, I have a lot of self-confidence.	___67	I could never achieve academic honors, even if I worked harder.
___32	I am good at most academic subjects	___68	I can often see better ways of doing routine tasks.
___33	I am not much good a problem solving	___69	I have lots of friends of the same sex.
___34	Other members of the same sex find me boring.	___70	I never seem to have much in common with members of the opposite sex.
___35	I am comfortable talking to members of the opposite sex.	___71	Overall, I do lots of things that are important
___36	I have trouble understanding anything that is based upon mathematics	___72	Overall, I am not very accepting of myself.

An Assessment of Problem Solving Style

Please read these directions before you answer the questions on the other side of the page.

There are 34 sets of statements that ask you about your preferences when you are solving problems. Read both sides of each item. Then, blacken one of the circles between the pair of statements. Blacken the circle closer to the left or right, so it will be nearer to the statement that best describes your personal preference. Your preference is the way you usually do things when you're solving problems. It is the way of working that is most comfortable and natural for you. Your preference or style is the way you are, *not* the way you might wish you could be, or the way others want you to be!

If *both* statements seem accurate to you, but at different times and to different degrees, blacken a circle on or near the center of the row that best describes how you prefer to balance the two. For each item, think about both phrases, at the left and right, before blackening the circle that describes you best; think carefully about the full range of circles when you are deciding where to mark your response.

Example: When I am solving problems, I am a person who prefers...

1. Working in the early morning   ○○●○○○○   1. Working late at night
2. Working at the last minute   ●○○○○○●   2. Working well in advance of deadlines
3. Working on a computer   ●○○○○○○   3. Working with pencil and paper
4. Working in bright light   ○○○○●○○   4. Working in soft or low light

Item #1 The person prefers balance between working in the morning and working late at night.
Item #2 The person strongly prefers to work with plenty of time, not waiting until the last minute.
Item #3 The person strongly prefers working on a computer, rather than working with pencil and paper.
Item #4 The person slightly prefers to work in soft or low light rather than in bright light.

When you make your choice, blacken the circle completely. Please be sure to mark all 34 items. The statements on one side are not "better" than the statements on the other side, but one might be more accurate in describing your own style.

Be sure to enter your name and complete the other information at the bottom of the page. Once you are finished please turn in the completed form. Please do not open the booklet. Thank you!

Please read the directions on the other side of the page before making your choices.

When responding to these questions, please keep in mind the following:

"When I am solving problems, I am a person who prefers…"

	Left statement		Right statement
1.	To work with the guidance of a clear structure	○○○○○○○	1. To work without boundaries
2.	To follow ideas wherever they lead	○○○○○○○	2. To direct ideas toward the task at hand
3.	To let my ideas flow freely	○○○○○○○	3. To search for practical ideas
4.	Quiet concentration	○○○○○○○	4. Involvement with others
5.	Drawing energy from within	○○○○○○○	5. Drawing energy from talking with others
6.	Looking first at feelings	○○○○○○○	6. Looking first at evidence
7.	Outcomes that are well-reasoned	○○○○○○○	7. Outcomes that maintain harmony
8.	To develop and improve what exists	○○○○○○○	8. To explore new directions
9.	To assume approval and go ahead	○○○○○○○	9. To seek approval before going ahead
10.	To change gradually and carefully	○○○○○○○	10. To go in fresh new directions
11.	Taking time alone for reflection	○○○○○○○	11. Forming ideas through discussion with others
12.	Talking through my ideas with a group	○○○○○○○	12. Writing down my ideas in a quiet place
13.	To recognize people's needs first	○○○○○○○	13. To recognize logical flaws first
14.	To put step-by-step directions aside	○○○○○○○	14. To look for and use step-by-step directions
15.	To define the problem my own way	○○○○○○○	15. To work on the problem as given
16.	Thinking aloud about ideas	○○○○○○○	16. Thinking quietly about ideas
17.	Making decisions in a caring, personal way	○○○○○○○	17. Making decisions in a cool, analytic way
18.	Weighing the evidence	○○○○○○○	18. Weighing the impact on people
19.	To improve on the familiar	○○○○○○○	19. To seek change that leaves the familiar behind
20.	To know and follow the rules	○○○○○○○	20. To modify or change the rules
21.	To be seen as cautious	○○○○○○○	21. To be seen as spontaneous
22.	Following a familiar routine	○○○○○○○	22. Making my own path
23.	Finding solutions to work on with others	○○○○○○○	23. Finding solutions to work on by myself
24.	To be persuaded more by emotion	○○○○○○○	24. To be persuaded more by logic
25.	Ideas that are original	○○○○○○○	25. Ideas that are workable
26.	To explore without limits	○○○○○○○	26. To work creatively within limits
27.	To search widely, following my hunches	○○○○○○○	27. To search efficiently for realistic possibilities
28.	To do the job as directed	○○○○○○○	28. To do the job my own way
29.	Generating options with a group	○○○○○○○	29. Generating options on my own
30.	Fair and just decisions	○○○○○○○	30. Sympathetic and caring decisions
31.	Finding better ways to do the job	○○○○○○○	31. Finding different ways to do the job
32.	To develop my plan as I go	○○○○○○○	32. To develop my plan before I begin
33.	To clarify my thinking by myself	○○○○○○○	33. To clarify my thinking by talking with others
34.	Appreciating careful analysis	○○○○○○○	34. Appreciating people's feelings

Please press firmly and fill the circle completely. Please do not open the booklet.

Name: _____   Date: _____

For research use only: Age: _____   Job: _____   Male ☐   Female ☐

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VirginiaTech

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MEMORANDUM

DATE: June 9, 2010

TO: Thomas W. Broyles, Jolene Hamm

FROM: Virginia Tech Institutional Review Board (FWA00000572, expires June 13, 2011)

PROTOCOL TITLE: Exploring the Dimensions of Problem Solving Ability on High Achieving Youth in the Agricultural Concentration: A Mixed Methods Study

IRB NUMBER: 10-464

Effective June 9, 2010, the Virginia Tech IRB Chair, Dr. David M. Moore, approved the new protocol for the above-mentioned research protocol.

This approval provides permission to begin the human subject activities outlined in the IRB-approved protocol and supporting documents.

Plans to deviate from the approved protocol and/or supporting documents must be submitted to the IRB as an amendment request and approved by the IRB prior to the implementation of any changes, regardless of how minor, except where necessary to eliminate apparent immediate hazards to the subjects. Report promptly to the IRB any injuries or other unanticipated or adverse events involving risks or harms to human research subjects or others.

All investigators (listed above) are required to comply with the researcher requirements outlined at http://www.irb.vt.edu/pages/responsibilities.htm (please review before the commencement of your research).

PROTOCOL INFORMATION:
Approved as: **Expedited, under 45 CFR 46.110 category(ies) 6, 7**
Protocol Approval Date: **6/9/2010**
Protocol Expiration Date: **6/8/2011**
Continuing Review Due Date*: **5/25/2011**
*Date a Continuing Review application is due to the IRB office if human subject activities covered under this protocol, including data analysis, are to continue beyond the Protocol Expiration Date.

FEDERALLY FUNDED RESEARCH REQUIREMENTS:
Per federally regulations, 45 CFR 46.103(f), the IRB is required to compare all federally funded grant proposals / work statements to the IRB protocol(s) which cover the human research activities included in the proposal / work statement before funds are released. Note that this requirement does not apply to Exempt and Interim IRB protocols, or grants for which VT is not the primary awardee.

The table on the following page indicates whether grant proposals are related to this IRB protocol, and which of the listed proposals, if any, have been compared to this IRB protocol, if required.

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