**MEASURING BLACK PARENT ENGAGEMENT IN STEM: VALIDATION FOR A MULTIDIMENSIONAL ASSESSMENT OF PARENTING PRACTICES, STYLE AND CULTURE**

**by**

**Kristina Henry Collins**

**(Under the Direction of Tarek Grantham)**

## ABSTRACT

Embedded within an overarching research agenda, the research goal for this study was to address the shortcomings in the contextual examination of Black parent engagement in science, technology, engineering, and mathematics (STEM) as they relate to Black student STEM identity, STEM talent development, and STEM achievement. In this is study, the researcher developed the Black Parent STEM Engagement Questionnaire (BP-SEQ) as an instrument with construct validity to (1) foster awareness among parents regarding their role and benefit of parent engagement in their student's STEM development; (2) assert the importance of cultural capital and parent engagement in fostering STEM identity, development, and success for cultural and linguistically diverse (CLD) students at all developmental stages in K-12; (3) measure and quantify the multidimensional aspect of parenting practices, style, and culture in student academic development; and (4) promote deficit-free frameworks, talent development curriculum, and contextual research designs to close STEM gaps and strengthen STEM pipelines for underrepresented students. Parents of students enrolled in gifted, AP, magnet, and thematic programs from a rural, Title I school district in Georgia participated in a study that included

completion of the BP-SEQ and attendance of STEM parent workshops. Exploratory and confirmatory factor analyses along with structural equation modeling were employed to examine and discuss a model for Black Parent STEM Engagement informed by Bourdieu's Culture as Practice and Barton's Ecology of Parent Engagement.

**INDEX WORDS:** STEM, Black parent STEM engagement, STEM Identity development, Talent development, Construct validity, STEM self-concept, Exploratory factor analysis, Confirmatory factor analysis

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DOCTOR OF PHILOSOPHY

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**by**

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## DEDICATION

**It is from the bottom of a very grateful heart that I dedicate and share this achievement with my husband, Major Toney Collins, and two sons, Tony II and Ty. You are definitely the wind beneath my wings.**

**To Toney**, my best friend and biggest cheerleader in all things possible: Thank you for your unconditional support and sacrifice. Thank you also for taking on the many roles in our family to allow me to achieve this goal. Your belief in me lifts me when I need it most while your love keeps me grounded. Your prayers keep me moving. I love you.

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*And … **LaPorsche K. Thomas**, I see you! I am so proud to call you sister!*

**Together we did!**

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# CHAPTER 1

## INTRODUCTION

For the sake of clustering absolute support for pursuit and persistence in STEM (science, technology, engineering, and mathematics), the term STEM pipeline has been designated as a structural framework (Charleston, Gilbert, Escobar, & Jackson, 2014; Espinosa, 2011; Griffith, 2010; Hernandez, Estrada, Woodcock, & Chance, 2012; NSF, 2010) Insulated within the STEM pipeline, conversations surrounding achievement gaps in STEM among culturally different students have been just as prevalent as the promise and prediction of STEM career opportunities for our future (Hughes, 2012). Unfortunately and to no avail, America has been engaged in this conversation for decades with no significant strides in closing the gaps, or sealing the design leaks in the STEM pipelines (Ing, 2014; Kuenzi, 2008; Ramsey, Betz, & Sekaquaptewa, 2013). Almost 25 years ago in "A Nation at Risk", The National Commission on Excellence in Education (1983), stated that "educational reform should focus on the goal of creating a learning society" that "extend into the homes and the workplaces, into libraries, art galleries, museums, and science centers" (p. 14).We cannot continue to marginalize the cultural context and community of the child. As a result, it is the position of this research that a change in the conversation and the approach to addressing these STEM issues is warranted.

### Organizational Structure of the Research

This research begins with a critical examination and brief background about the economy of the STEM pipeline, or discipline, followed by hypothesized, underlying issues related to

STEM interest, development, and persistence among African American students. Changing the narrative of deficit conversations, this research is instituted within the notion of culture as capital practiced within the child's home and community (Bourdieu, 1977). Positing that the home and the community is the foundation for a strong STEM pipeline, the central focus of this study is the multidimensional assessment of Black parent engagement that fosters the child's earliest development of a STEM identity.

## The Economy of the STEM Pipeline

**The consequence of research leaks in the STEM pipeline.** A review of current research findings and practices of parent involvement within the school revealed gaps in the research literature to inform practice, representing voids in the conversations, especially as it relate to the relevance of STEM discipline and gifted education area of practice. In a special issue of Roeper Review on the history and nature of STEM schools, Subotnik Kolar, Olszewski-Kubilius & Cross (2010) suggested that "insufficient research exists to inform educators, researchers, and policy makers about how they contribute to the development of STEM talent" (Subotnik et al, 2010 as cited in Collins & Grantham, 2014, p.10). Yet, many K-12 schools implement STEM-ready programs as part of state-level initiatives STEM development and certification programs (Florida Learns Stem Scholar, 2012; Georgia Department of Education, 2013). Many educational institutions, including those in higher education, are attempting to answer a call to bridge the gaps in students' STEM skill development and the number of underrepresented population entering into the fast growing STEM job market (Lockard & Wolf, 2012; Robinson, 2010). They are implementing interventions show insignificant increase in overall student STEM achievement persistence of underrepresented students in STEM disciplines.

However, the without appropriate research to support the practice and vice versa, we continue to revisit the same conversations with no solutions. The researcher contends that we continue to haphazardly expand a hollow STEM pipeline with futile initiatives and rootless strategies. For example, a recent study reported that 84% of 413 STEM department chairs at leading research universities claim concern for recruiting and retaining underrepresented undergraduate populations, but only 33% even had a diversity plan in place that include STEM development for these students (Hughes, 2012). The National Science Foundation (NSF) Advisory Board (2010) contended that similar 'leaky pipes' exist across America as major institutions continually fails to identify its most talented and motivated students (STEM Action Plan, NSB-07-114, NSF, 2010). For instance, a 2009 survey conducted by National Association for Gifted Children (NAGC) revealed that all 45 states in the U.S. that acknowledge gifted education, struggle with appropriate programming and placement, inadequate teacher preparation, and accountability of professional development (NSF, 2010). That is echoed by another report noting that [STEM] needs of high ability Black students are not being met as a result of an antiquated educational system that inadequately serves culturally diverse students (Nisbett et al, 2012).

**Repairing the damage to the STEM pipeline.** As with any pipeline, there are joints that connect the STEM pipeline. These joints must have proper fit and be place strategically. For the same, the research contends that STEM talent development must be strategic and properly implemented. The NSF advisory board (2010) made three formal recommendations specifically for talent identification and development that included policy action suggestions for NSF and other federal entities:

(1) Provide opportunities that foster creativity, engagement, and problem solving within the students' talent and interest;

(2) Develop and implement appropriate assessment at multiple grade levels and properly training all stakeholders to identify and nurture potential in all types of talent and demographics especially from individuals whose talents may not have manifested in academic achievement; and

(3) Foster a supportive ecosystem for the success of all students regardless of their race/ethnicity, gender, socioeconomic status, or geographical locale.

Focused on the ecology of STEM talent development as indicated the latter , NSF recognized that the parent and the student have the most important role in the educational process and success of the student (NSF, 2010).Their report concluded that the parent and the student must be active participants and committed to the work of the school. However, no reciprocal support or consideration from the school to the parent and the community was suggested. Based on prevalent findings such as these in the research, Black parent STEM engagement within the context of the home and community is presented here to fill the gap in the literature as well as to inform effective STEM talent identification and development processes among culturally different students.

**Intellectual Merit of the Research Study**

The theoretical framework and research efforts exposed within this literature review for fostering parent engagement have spanned over 100 years. Yet, here we are a century later with hopes that what is written and read again will "spur a flurry of research, visits, convention

sessions, and collaboration with the faculties of specialized schools, along with staff from out-of-school programs, traditional school programs, and other educational professionals and researchers" (Subotnik, 2010). Embedded within the broader research topic surrounding STEM , it is the goal of this study to contribute to the literature by introducing empirical evidence to validate culturally empowered parenting style and practice as an effective tool and positive influence in the academic development of Black students. This study will ignite a change in the conversation that informs the process for implementing policy, program, and plans for models that include effective parent engagement to develop STEM identity for Black students; change the STEM conversation to promote a more contextual research of these topics; and suggest a non-deficit approach to research that improves education for public good. Scholarly significant, it will provide useful insight to guide the approach for application and evaluation of STEM curriculum; decrease the cultural discontinuity of home-to-school transition that affects student STEM achievement; and more significantly improve the quality of the overall educational experience for Black students that show interest and promise in STEM field.

## Research Design/ Approach

This research redresses student STEM development from a perspective that is ecologically relevant, culturally responsive, and practically grounded. Utilizing the manuscript-style dissertation, an examination of Black parent STEM engagement and its findings are discussed

**Scope of the research.** Grounded in separate theoretical frameworks related to Black parent engagement, Black student STEM identity, and gifted and talented education, Black parent STEM engagement is beneficial as an positive influence on Black students' STEM self-

concepts, interest and success is asserted. Within the scope of the research, Black parent STEM engagement (BPSE) construct is introduced and presented:

(1) through a review of the literature that informed theoretical concept, operational definition, and contextual model (Chapter 2),

(2) by evidence of construct validity offered through the development and validation of the Black parent STEM engagement questionnaire (BP-SEQ, Chapter 3), and

(3) In the measurement of BPSE for a selected group of parents within a Title 1 school district in Georgia is conducted (Chapter 4).

Through this empirical work, the generalizability and reliability is confirmed for the multidimensional assessment of parenting practices, style, and culture.

**Framework.** Grounded in theories of ecological student development and culture as practice, this study utilized the above research design approach to examine the contextual processes of Black parent STEM engagement (BPSE) that foster STEM self-concept and talent development of gifted and high-ability Black students from a rural, Title 1 high school district in Georgia. As such, a critical component of this study was the development and analysis of a sound instrument, the BP-SEQ, to capture data that lead to reliable and valid claims of the model and its use. Completing this task included a deliberate collection of evidence for construct validity throughout the instrument design process (American Educational Research Association [AERA], American Psychological Association [APA], & National Council on Measurement in Education [NCME], 2014). Collection of evidence commenced with a review of the literature in Chapter 2 to conceptualize, operationally define, and theoretically design a proposed model of Black parent STEM engagement. Table 1.1 and Table 1.2 outline the research design process,

including the research questions, for providing construct validity once the theoretical domain was solidified (Chapter 3 and Chapter 4, respectively).

**Table 1.1.** Research Design Outline for BP-SEQ Instrument Development

| Purpose/ Task(s) | Research Questions | Elements of the Construct/ Research Questions | Methodology/Data Collection Sources | Data Analysis | Reference(s) |
|---|---|---|---|---|---|
| ***Determine and model the domain structure of Black parent STEM engage-ment construct*** | 1. Does the structure of BP-SEQ align with the research and theory on Black parent STEM engagement? | **Domain Structure**<br>• STEM specific, goal-directed practices<br>• Parenting style<br>• Cultural context of parenting | **Domain Structure**<br>•Literature Review<br>•Previous Research Scales - Parent Involvement; Parenting Behavioral Questionnaire; parent influence; student development<br><br>**BPSE Conceptual Model**<br>Structured Equation Modeling (SEM) | **BP-SEQ**<br>1. Evaluate initial item pool for face validity (expert panel) | **BPSE Construct**<br>Baumrinds, 1967; Bronfenbrenner, 1997; Bourdieu 1977; Prasad, 2005; Bowers & Griffin, 2011; Epstein, 1995; Epstein, 2001; Halgunseth et al, 2009 |
| ***Develop and evaluate the BP-SEQ*** | 2. Is BP-SEQ internally consistent?<br><br>3. Are the findings from the BP-SEQ related to other indicators of Black parent engagement in theoretical, expected ways? | **BP-SEQ Development & BPSE Model**<br>Black parent STEM engagement practices and style can be generalized across a relevant set of items/indicators. | **BP-SEQ Development**<br>1. Generate survey items to directly address the domain structure/ elements.<br><br>2. Submit pilot BP-SEQ for review and gather responses from expert panel<br><br>3. Distribute BP-SEQ to pilot sample audience; interview with parents panel as needed regarding responses of BP-SEQ. | **BP-SEQ**<br>2. Conduct empirical evaluation of BP-SEQ for structural validity – exploratory and confirmator y factor analysis<br><br>3 Compare BP-SEQ's factor scores to other indicators of Black parent engagement | **Scale Development**<br>AERA, APA, & NCME, 2014; Benson, 1998; Kopp et al, 2011, DeVellis, 2005; AERA et al, 2014; Epstein, 2007<br><br>***Prev. Research/ Scales***<br>PICES - Fantuzzo, Tighe, McWayne, Davis, & Childs, 2002; PBQ-HS - Coolahan,, McWayne, Fantuzzo, & Grim, 2002 |

**Table 1.2.** Research Design Outline for the Measurement of BPSE

| Purpose/ Task(s) | Research Questions | Elements of the Construct/ Research Questions | Methodology/ Data Collection Sources | Data Analysis | Reference(s) |
|---|---|---|---|---|---|
| ***Measure BPSE*** | 1 What do Black parents' views about their STEM engagement reveal about their practices?<br><br>2. To what extent does the cultural structure of BPSE influence the practices and style of BPSE? | **Capital/resources** (human, social, economic, etc.)<br><br>**Infrastructure/ Habitus** (Parents' role, tools, rules, environment, expectations, space, etc.) | Administer BP-SEQ to larger population of parents of Rural, Title 1 School District (K-12) | **BPSE Model** Praxeology Research tradition (culture as practice) | Barton et al, 2009; Benson, 1998; Bowers & Griffin, 2011; Casanova, 1996; Embretson, 2007; Fields-Smith, 2005; Fields-Smith, 2007; Pushor & Ruitenberg, 2005; Roth, Lawless, and Tobin, 2000 |
| ***Provide a model for BPSE*** | 3. Does BPSE have characteristics distinct from other ethnic groups? | **Space/Field** (beliefs, actions, emotional climate, ethnic context, etc. | Administer BP-SEQ to larger population of parents of Rural, Title 1 School District (K-12) | **BPSE Model** Analysis – comparative experiences, construct, factor Relationship to external variables | |

# CHAPTER 2

# THE OPERATIONALIZATION OF BLACK PARENT STEM ENGAGEMENT: A REVIEW OF THE LITERATURE[1]

[1] Collins, K.H. *To be submitted to Journal for the Education of the Gifted*

## ABSTRACT

In a critical review of the literature on family engagement, specifically, the historical importance of Black family engagement, this paper focuses on the identification of unique characteristics and factors of Black parent engagement that may contribute or act as barriers to the development of STEM self-concept and achievement among African American students who have shown interest and/or exhibited gifts and talents in STEM discipline. Black parent STEM engagement is operationalized, and research methodology is proposed that can be employed to explore the extent to which Black parent STEM engagement fosters STEM identity development in African American students. Implications for parents and practitioners are offered.



***Key words:*** *Black parent STEM engagement; ecology of parent engagement; culture as practice; parenting styles; STEM talent development; gifted Black students*


Linda Halgunseth (2009) noted that "the two most influential environments in which young children develop are their homes and their early childhood education program" (p. 56). As the primary caretakers, parents are, by default, the child's first and earliest teacher, formally and informally. Halgunseth (2009) asserted that once a child begins school, parents are often times the only constant in an educational process that embodies frequent changes in curriculum, expectations, teachers, and administration. Parents are by far the most accessible link to connect classroom learning to real-world experiences and personal interest (Halgunseth, 2009). In its formal recommendations regarding education reform in 1983, The National Commission on

Excellence in Education detailed implementation goals for the instructional delivery of mathematics, science, and computer science, as well as outlined the uses of non-school personnel resources to resolve the math and science teacher shortage, in addition to providing fiscal support needed for reform (The National Commission on Excellence in Education, 1983). While there is a plethora of empirical research that has well established the fact that parent involvement in a child's educational process has tremendously significant and positive impact on student achievement. Parent involvement has been researched and confirmed through various testimonies of administrators and educators alike; parent involvement is the most significant resource that will bring about the best possible outcome in the quality of a child's education (Fields-Smith, 2005; Halgunseth, 2009). The belief that effective parental involvement has a significant influence on student achievement and career selection is evident through the numerous educational policy mandates regarding parent involvement; there are many state mandates that involve directives for schools to implement plans for parental involvement at different levels of school operation and support (Fields-Smith, 2005; Mendez, 2010). Most notably, the federal government enacted educational programs such as Project Head Start in 1967 (Mendez, 2010), public policies within "No Child Left Behind" Act of 2003, and various Title 1 programs, as an initiative to operationalize parent engagement.

**Theoretical Definitions of Parent Engagement**

While all stakeholders might agree on the benefits of parent involvement, most still struggle with appropriate and effective parent-as- partner involvement that will maximize student achievement in the child's educational experiences (Halgunseth, 2009). By the same token, the delineation of parents-as partners is dependent on the perspective from which it is defined

(administrative, political, educational, traditional, etc.), creating an even bigger discrepancy in what parent involvement means and entails. There are several terms that come to mind and are at times used interchangeably when referring to parent involvement as outlined in Table 2.1. More importantly, parent engagement - which is a distinguishable extension of parent involvement - is the meaningful collaboration in the educational process that influence student achievement and career selection by solidifying the educational identity of the student as an extension of his/her personal self. With this definition, there is also a commonsensical presumption that parents and families are involved in their child's educational process in one way or another (Halgunseth,2009) – informal, formal , supportive, provision of basic educational needs, etc.

[Insert Table 2.1 here]

Based on the meanings established in the research, I contend the following: (a) parent involvement is grounded in a framework and perspective of the school's needs, expectations, and goals for children learning; (b) parents-as-partners should acknowledge cultural considerations in the process of parent involvement, that values the knowledge that the parent brings to the formal educational framework; and (c) parent engagement, as a distinguishable extension of the parent involvement and parents-as-partners concepts, offers a more comprehensive view of what it is that parents do and the style in which they do it that is independent of the educational framework. More importantly, I further suggests that parent engagement places the school's role in educating the child inside of the parent engagement framework and not vice versa, and this important distinction compels the necessity to rethink students' academic and talent development processes within the educational structures. Halgunseth (2009) described parent engagement to

be the meaningful collaboration in the educational process that influence student achievement and career selection by solidifying the educational identity of the student as an extension of his personal self. With this definition, I would further contend that there is a commonsensical presumption that parents and families influence their child's learning in one way or another – informally, formally, directly, indirectly, etc. – that serve to offer provisions of at least a child's basic educational needs, etc. This engagement is not dependent on the educational system's acceptance or acknowledgement of its existence.

Pushor and Ruitenberg (2005) asserted, "Although the common term in this field of research is parent involvement, we chose to use the term parent engagement because it reflects the reciprocity and mutual commitment we feel is essential in developing lasting relations between schools and families" (p.1). And although partnership is another term that has often been used, its use to build relationships among the home and the school lacks the equality of leadership, authority, and development of learning objectives and student activities that distinguishes a partnership from any other relationship. Many school-community partnerships limit the role of parents and community to fulfill a predetermined need within a support entity such as school councils, PTOs, booster clubs, and "room moms" that serve as teacher assistants (Pushor & Ruitenberg, 2005).

**Benefits of Effective Parent Engagement**

Effective parental engagement occurs everywhere learning takes place for the student, and therefore, should be implemented as a standard component within the teaching strategies of the school. The Michigan Department of Education's (MDE), in their "Parents Engagement and Information Tools" toolkit, list what they consider are the top 6 reasons to engage parents:

1. Students achieve more, regardless of socio-economic status, ethnic/racial background or the parents' education level;
2. Students have higher grades and test scores, better attendance, and complete homework more consistently;
3. Students have higher graduation rates and greater enrollment rates in post-secondary education;
4. Educators hold higher expectations of students whose parents collaborate with the teacher;
5. Student achievement for disadvantaged children not only improves, but can also reach levels that are standard for middle-class children. In addition, the children who are farthest behind make the greatest gains.
6. Children from diverse cultural backgrounds perform better when parents and professionals collaborate to bridge the gap between the culture at home and at the learning institution

(MDE, 2015, p.7)

As such, parent engagement is a better predictor of student success compared to other indicators such as social economic status of the student, race, or ethnic background.

**Historical Context of Black Family Engagement.**

Often times, and regardless of, economic status or educational background, African American parents are viewed as disconnected and even sometime unconcerned about the educational process of their children (Fields-Smith, 2005). This judgment is more often than not based on an approach that values a "tally" of the number of school visits, the number of volunteer organizations in which the parent is engaged, monetary donations, and other activities that contribute to the success of the school (Bowers & Griffin, 2011). And this standard of judgment comes from the influences of White, middle class perspectives of a parental involvement that often times marginalize the other cultural values (Casanova,1996; Fields-Smith, 2007) and subsequently, approach family engagement of those cultures as a deficit that needs to be improved or changed (Halgunseth, 2009). For example, the Head Start program, designed to buffer the impact of poverty on pre-school children, was initiated to offer comprehensive

services to families and promote child learning based on the critical role that parents play in child development. At a core of the Head Start program, The Companion Curriculum (TCC), was used as a preventive intervention to increase parent involvement and the teacher-parent relationship. However, its premise for parent involvement was centered on parents' presence in actual school activities and parents supporting and/or extending school- initiated endeavors and values (Mendez, 2010).

**Challenges, stereotypes, and threats of Black family engagement**. There are many challenges faced by Black families as they attempt to engage in collaboration with the school on behalf of their children. In addition to the deficit thinking about their level of engagement, they also must battle the stereotypes about who they are ethnically. This is especially true for Black mothers, in particular. Camille Wilson Cooper (207) studied the advocacy roles of 14 Black mothers through detailed interviews. These mothers of low income or working-class status discussed what Cooper refers to as "motherwork", "an important act of cultural resistance and empowerment" (p.491) as well as their educational views, school choice making, and experiences. Her findings revealed a prevalent stereotype that portrayed Black mothers as uncaring, angry, and combative in their interactions with school officials and therefore are of the mindset that "African-American parents are more of a deficit to their children's educational development than an asset" (p.492). This mindset creates questioning around learning at home and Black parents' views on school achievement. As a result, additional research is warranted to learn more about these "motherwork" practices and dispositions of involvement where racialized understanding of empowerment, identity, and survival are critical.

A view that disadvantaged or culturally different families are not capable or willing to contribute the development of their child's education creates exclusionary practices

within the school that also lead to unwelcoming and unequal involvement of these families (Abrams & Gibbs, 2002; Cooper, 2009). I suggest that this further alienate parents and marginalize their values, intensifying the very issues that the institutions are claiming to be the problems. Subsequently, schools and research maintain a focus on the parents attendance, or the lack there of, and not the positive influences of their cultural presence in their children's educational development. Rejecting the deficit-based framework of Black parent engagement allows researchers to systematically reveal the cultural capital that parents bring to the educational table as well as breakdown the structural constraints that bound them.

Just as parents who are more familiar with the discourse of the school are more likely to be involvement at the school, so will educators who familiarize themselves with the customs, style, and behaviors of the home. Likewise, they will be better equipped to implement complementary parenting-type and culturally responsive structures within the school.

## The Dynamics of Black Parent Engagement

To understand the dynamics and strength of African American parenting as it relates to engagement in schools, it is essential to consider the historical and culture context of successful involvement prior to desegregation. I offer this as a caveat of the culture, style, and successful practice of involvement during that time to inform the cultural values and strengths of contemporary, parent involvement practices of today.

**Cultural Structure.** Before Brown vs. Brown (1957), all of the stakeholders within the formal schooling environment - the educators, the principal, the school board members, the bus drivers, etc. - were also the neighbors, the relatives, the church members, etc. of the community where the child lived. Through the dynamics of this relationship, came a standard way of

educating the child, with parents assuming a more indirect role that is exemplary of the strengths of the social exchange theory. Halgunseth (2009) offers representation of the social exchange theory that grounds the development of social relationship in trust and an exchange of resources among the groups. Halgunseth's research-based family engagement model calls for practices that "promote engagement and positive child outcomes in families across ethnic and socioeconomic backgrounds" (Halgunseth, 2009. p.57).

**The Beliefs and Actions behind the Behavior.** While Halgunseth's model is not unique to Black family engagement, it does, when it is framed within Bronfenbrenner's 1977 ecological model (Woolfolk, 2010), confirm and further explain why the pre-Brown era was so successful for Black families. The strong home-school relationship, within the pre-Brown era, fostered high family engagement in terms of what they valued. At the core of this model, is the exchange of resources between home and school that fosters a strong home-school relationship that leads to high parent engagement and ultimately increased positive child and family outcomes. Fields-Smith (2005) stressed that with the positions and relationships that educators had in the community, there was a trust and empowerment endowed upon them that allowed parents to maintain a direct role that was not as active within the building and decision making of the schooling of the child; parents would often come in contact with the same school professional in an informal, community setting therefore was little or no need for parents to have a presence at school. Casanova (1996) also recognized that trust was as an essential element of the home and school relationship; parents trusted that teachers had the best interest of their children at the forefront of what they did so parents left educators to do their jobs. Like so, during this pre-Brown era, teachers maintained a mutual trust in the judgment of parents related to their own children's ability as well as the parent's ability to support their children at home.

**Boundaries of Social Dominant Practices**. Even though one might argue that trust is an important element in any relationship, and not unique to Black parent engagement, its relevance within the context of civil rights movement and desegregation makes it a cultural strength and foundation that was absent in the post-Brown era. I posit that mistrust existed that resulted from environmental factors such as unfamiliarity, intolerance, and unfair judgment that encompassed the educational relationships of White teachers and Black parents that now simultaneously existed alongside that of White teacher-White parent relationships. It would have been under these conditions, that Black parent engagement was defined as viewed by the today's educational system. After the desegregation of schools, most African American children and parents not only found themselves adapting to a new culture, but had done so without the benefit of those social exchange relationships that they once had with school officials that also served them in their respective communities (Fields-Smith, 2005). As a result, Black parents found themselves trying to maneuver through an educational system that did not consider the historical foundation of their relationships to the school or the successes of their parent engagement practices, style and cultural structure. The same practices of engagement that worked so well for them to support student achievement were under a different dynamics. Furthermore, the reinforcement of a social dominant practice and tradition disenfranchised many African American parents. Racial issues, violence, and discrimination leading to the civil right movement era played a major role in separating the parenting priorities, style, and practices of Black and White parents.

**Infrastructure of Black Parent Engagement**. In an economics perspective of the relationship of human capital (skills utilized to produce economic value) and parenting behaviors, Owen Thompson (2011) examined the child rearing practices of southern mothers born during the civil rights era (1957 – 1964), and found that there existed a strong relationship

between the significant racial difference in parenting practices formed and the rate of return on human capital. For southern, African Americans mothers who experienced severe and extended discrimination, a lower rate of return for skill was sustained and their parenting practices were, cognitively speaking, less stimulating (Thompson, 2011). These would be the parents who might believe that their parenting efforts have no real impact on the child's educational achievement or whose value for formal education might be lowered. As a result, as Thompson (2011) discovered, those southern African American mothers were less likely to engage in cognitive development activities with their children. While a gradual increase in the return rate for skill occurred, as a result of the policies implemented in the aftermath of civil rights movement, the legacy of the Black parenting norms that were established during those times may have been generationally passed down. So the cognitive development level in Black children as compared to the standardized levels set by White counterparts, contributed to school-readiness gaps between White and Black students that have subsequent, detrimental effects on Black student achievement. For example, Black students entering school exhibited less vocabulary mastery and lower reading levels compared to White students (Thompson, 2011). Thus, I infer that A low return rate on human capital, from this economic perspective that has historically affected minority families in disproportionate numbers, also provides insight into the sustained socio-economic divide that continues to plague our schools.

**Uniqueness of Black Family Engagement in Children's Learning**

Today, many contemporary, middle-class, African American parents may be found making their presence known and involved more directly in the school environment. However, those that do, may not necessarily view themselves as equal partners in the decision making

process; nor do they see their influence considered in the formal process of educating their children (Fields-Smith & Neuharth-Pritchett, 2009).Their involvement may not be seen as a positive or productive element. As a matter of fact, many Black parents will confess that the relationship they have with school personnel is often confrontational, grounded in mistrust and a perception of competition for control to ensure that their children are provided an equal chance and equity in education (Casanova, 1996; Fields-Smith, 2005). On the other hand, a contemporary African American parent whose presence is not felt in the school does not necessarily mean they are absent in their engagement of the child's educational process. On the contrary, I suggest that it is merely a characteristic and testament to the uniqueness of Black parent engagement in their children's learning.

**Indirect School Engagement**. Black parents are generally indirectly engaged in the school through their children's direct school engagement. Evidence of indirect school engagement, on the part of the Black parent, can be measured on the level of engagement that the student exhibits in school; studies with Black adolescents have confirmed work that linked Black family cohesion and Black parent monitoring (parenting style or emotional climate of parent-child relationship) to increased motivation and school engagement of minority students. Monitoring was measured by practices that include positive parenting, discipline effectiveness, avoidance of discipline, and extent of parental involvement in the child's life and includes awareness of child's social and educational status as well as setting and enforcing boundaries, expectations, and rules (Annunziata, Hogue, Faw & Liddle, 2006; Hofferth, 2003; Lowe & Dotterer, 2013).

**It Takes a Village Mentality.** In the book, *Young, Triumphant, and Black: Overcoming the Tyranny of Segregated Minds in Desegregated Schools* (Grantham, Scott, & Harmon, 2013),

Black parenting issues (section VI) are addressed within an "it takes a village" perspective; the village mentality, a common belief among Black parents, is a belief that they cannot raise their children alone. This leads to significant parental-type engagement by extended family and community members (Pearson, Hunter, Ensminger, & Kellam, 1990). While this mindset contains benefits in child-rearing support, it can present challenges for the parent if there exist conflicts in expectations between the home and the school (Mendez, 2010).

**Multidimensional Cultural Attributes.** Considering the state of the leaky STEM pipelines (Ing, 2014; Kuenzi, 2008; Ramsey, Betz, & Sekaquaptewa, 2013) that contribute to the gaps in STEM interest, success, and persistence for students of culturally different backgrounds, it is equally important to understand the cultural attributes and style of Black parent STEM engagement (BPSE) as it is he practices that define Black parent STEM engagement. Embedded in the style dimension of BPSE are factors and influence of cultural traditions and uniqueness. One must consider the style of parenting that influence the STEM activities that parents choose to engage. The style of parenting to influence the child's STEM interest and development is closely connected to one's own STEM experiences and value systems that are grounded in cultural dynamics.

Distinguishable among leaders in the research of multidimensional and contextual Black family engagement is John Fantuzzo. Many of the studies of Fantuzzo and his colleagues, validated Black family engagement within the context of the cultural structures in the home and community. This research perspective allowed for identification of unique attributes in Black parenting style and practices that were not viewed as deficits in intellectual value in comparison to White, middle class parenting styles and practices (Bandura, 1972; Radin & Kamii, 1965 as cited in Coolahan,, McWayne, Fantuzzo, & Grim, 2002). Their empirical research with urban,

low-income, Head Start parents (Coolahan, McWayne, Fantuzzo, & Grim, 2002) and urban, low-income parents of kindergarten students revealed a multidimensional perspective of Black parent behaviors and styles. The work of Fantuzzo and his colleagues distinguishes Black family involvement dimensions from the Black parent-child relationship. Black family involvement dimensions that positively affect student learning include home-based involvement, school-based involvement; and home-school conferencing (McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004). Black parent engagement, based on the theories of Epstein and Bronfenbrenner within a cultural context, is the style (active-responsive, passive-permissive, and active-restrictive) and goal-directed, behavior, or activities (supportive home learning environment, direct school contact, and inhibited involvement) of Black parents practiced within the cultural context of child.

**Operationalizing Black Parent STEM Engagement Construct**

A critical review of the literature has revealed gaps in the research that addresses a contextual examination of Black parent engagement practices that effectively foster STEM identity and self-concepts for Black students who have shown significant interest and success in STEM disciplines. Based on the literature review, research about Black parent engagement that fosters Black student STEM identity is almost non-existent. Table 2.3 summarizes some of the most relevant and up to date research related to parent engagement and student STEM achievement.

[Insert Table 2.3 here]

The important issue within the documented research is that it fails to include contextual consideration for parent engagement, and when it does, it is typically from a deficit perspective. I contend that my research offered on Black parent STEM engagement that fosters student STEM talent development is necessary for the purpose of building contextual cultural STEM practices into the institutionalized structures of education that are meant to do the same. Therefore, it is through the strength of documented historical perspective of Black parent engagement and the related empirical research, that the Black parent STEM engagement construct was developed. Figure 2.1 below illustrates the theoretical domain of the BPSE construct as defined:

(1) STEM specific, goal-directed **practices** – those specific behaviors (beliefs and actions) that foster the student STEM competence and interest.

(2) **Style** of parenting – the emotional climate in which parenting behaviors, or activities are expressed.

(3) **Cultural structure** of parenting – the environmental and ethnic, contextual perspective of the parent-child interaction.

[Insert Figure 2.1 here]

**The Ecology of Black Parent STEM Engagement**

The historical perspective of Black parent engagement offers a foundation and cultural contextual perspective by which to examine the strengths of BPSE. Extending Bronfenbrenner's

view of ecology and framed within critical race theory (CRT), *The Ecologies of Parent Engagement* model (EPE; Barton, Drake, Perez, St. Louis, & George, 2009) goes beyond the cultural context of parent engagement. It includes the beliefs and actions of everyday social behavior, or practices of parent engagement. These beliefs and actions were believed to influence the decisions of what and why parents do what they do; this is comparable to what Fantuzzo et al. (2002) defined as parenting behaviors and styles (Coolahan, McWayne, Fantuzzo, & Grim, 2002). Barton et al. (2009) contended that parent engagement is a mediation process between space and capital with the community/home-based space as one of those spaces. Barton's terminology of space and capital was drawn from Pierre Bourdieu's Culture as Practice framework (Barton, 2009; Prasad, 2005) and Funds of Knowledge framework (Amaro-Jiménez & Semingson, 2011; Moll, Amanti, Neff, & González, 1992; Tan & Barton, 2010; Wright, 2011).

**The BPSE framework**. The BPSE construct is built around the cultural capital, or resources, of the home and community, which allows for identification of the multidimensional attributes in Black parenting style and practices that are not viewed in comparison to White, middle-class, parenting styles and practices or deficits in intellectual value (Bandura, 1977 as cited in Woolfolk, 2010; Radin & Kamii, 1965 as cited in Coolahan,, McWayne, Fantuzzo, & Grim, 2002; Wright, 2011). These resources are the framework for guiding and developing members of the community/home space. However, the more salient dynamics that surround the framework of BPSE and its effects on BPSE are just as important to understand. It is when social dominant practices contradict, or at best, do not encompass that which is valued within the framework of BPSE that boundaries are created. These boundaries impact the transferability of the BPSE and the STEM skills that are being developed. Barton's and Bourdieu's work offers a

fitting example of complex analysis of "relations between lifestyle, life chances, and material resources" (Prasad, 2005, p.9) by which to examine BPSE more validly. Barton's spaces, similar to what Bourdieu called fields, are bordered by different types of environmental boundaries: social, cultural, political, economic, etc. (Barton et al, 2009; Prasad, 2005). Substantiated for the field of STEM, Archer et al. (2012) affirmed that the extent to which science identity is internalized, can be fostered by families through cultural, economic, and social capital is structured by social inequalities (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). It is through the critical analysis of these works that the theoretical domain of BPSE, as illustrated in Figure 2.2, is offered.

[Insert Figure 2.2 here]

***BPSE boundaries.*** Vygotsky and other constructivists contend that all knowledge is socially constructed (Gergen, 1997; Woolfolk, 2010). Therefore, social boundaries refer to the unequal power that people have in defining what constitutes knowledge. The value of that knowledge is determined, in part, by how well information fits into the current, accepted community of practice (cultural boundaries), while political boundaries are the systematic processes and issues that affect the meaning of knowledge. Financial situations and power (economic boundaries), however, can affect the social negotiation, or communication methods of that knowledge.

***BPSE cultural capital & infrastructure***. Within these spaces are the underlying structures of everyday STEM practices such as expectations, rules, and tools (habitus; Bourdieu, 1977 as cited in Prasad, 2005) that shape STEM activities in their scope, focus, and purpose (the

game; Bordieu,1977 as cited in Prasad, 2005). The STEM practices are used to steer the student toward goals that the culture values and are bounded by the [cultural] capital or resources (human, social, material, etc.) that individuals (players; Bourdieu, 1977 as cited in Prasad, 2005) bring to that space. Human resources are the people in that space that act as more knowledgeable others (MKO; Vygotsky, 1978 as cited in Woolfolk, 2010). Accepting that all knowledge is socially constructed and culture creates cognition (Gergen, 1997; Phillips, 1997), social resources include commonly held, everyday practices and interactions used to communicate knowledge, or ways of thinking and doing. Material resources are marked by the multiple representations of the knowledge. I confer that identified and sometimes intertwined boundaries are important to consider because they determine if knowledge is internal, general, and transferrable or bound to the time and place in which it was constructed.

***Culture as Practice at work.*** Critical to Black student's STEM self-concept and talent development, parents must nurture a love for STEM subjects and expose students to STEM careers and programs that support the STEM disciplines they have shown interest or emerging talent in. Similarly, as a source of successful identity development and borrowing from the concept of strong, athletic identity development, sports sociologists have noted "family, including parents and siblings, is the earliest and most influential socializing agent into sports participation" (Beamon, 2010). And, while there may be controversial opinions and negative effects related to such African American athletic social patterns, especially for those elite athletes, it cannot be denied that there is an overwhelming presence in skill development and successful participation in athletics that could inform strategies for the same within STEM skill and talent development that begin with a positive STEM self-concept in African American students.

**BPSE at Work.** As an example, a recreational coach (MKO/ human resource) for a local community center (material resource) may incorporate STEM practices through the use of the game of basketball (social resource) to foster STEM skill development in basic math, geometry skills, statistics, etc. and/or peek STEM interest careers such sports analyst, sports medicine and kinesiology, design engineers (flooring, balls, score boards, etc.) as part of his coaching techniques (style). As iterated in Figure 2.1, embedded in this practice and style is the impact of the cultural structure that values extended family relationships and shared mentoring, or it takes a village mentality. All of these underlying elements explain the "what and why" the recreational coach do what he does (Fields-Smith, C., 2009; Grantham, Scott, & Harmon, 2013; Mendez, 2010; Pearson, Hunter, Ensminger, & Kellam, 1990). In addition, it may be possible that the coach is strategically navigating within the social, cultural, political, and/or economic boundaries that elevate the attractiveness and importance of sports in that community. "We can point with some degree of success in the identification and cultivation of talent among disadvantaged groups in instrumental and vocal music, dancing, dramatics, visual art, and athletics … these are kinds of talents that are valued among disadvantaged cultures in the United States" (Torrance, 1969, p.73).

## Implications for Research Methodology & Further Study

A critical review of the literature has revealed gaps in the research that addresses a contextual examination of Black parent STEM engagement practices that effectively foster STEM identity and self-concepts for Black students who have shown significant interest and success in STEM disciplines. Therefore, this paper serves to augment existing knowledge of how Black parents' engagement in STEM areas influence the development of Black students' STEM

identity through a detailed analysis of cultural as practice. Singer, Hilton and Schweingruber (2005) recognized that [STEM] development through experiential activities can ensure an integrated, comprehensive, and affective curriculum that lead to stronger self-concepts and scholarly identities (Singer, Hilton, & Schweingruber, 2005). Agreeing with them, I conclude that a critical examination and further research of Black parent STEM engagement in developing strong STEM self-concept and achievement in their children for the purpose of identifying key components is worthwhile. These components, or cultural schemas, of BPSE can be further examined to determine if those schemas can be applied and built into educational structures.

**Qualitative Research Methodology.** Validated by the historical context of Black Parent engagement, pre- and post-civil right movement era, a deeper understanding of this relationship between human capital and parenting practices as explained by Thompson (2011) is warranted. However economically sound, parenting practices are best understood within its socialized domain (Lowe & Dotterer, 2013). Starting from the role of economic capital for social positioning, French anthropologist Pierre Bourdieu extended the concept of human capital to include cultural capital, social capital, economic capital, and symbolic capital (Prasad, 2005). Stemming from the work of Bourdieu, praxeology research tradition, as noted in *Crafting Qualitative Research* by Pushkala Prasad (2005), is grounded in the existence of social practice. It has inspired such studies as political movements; internationalization of financial and legal expertise; legacies of colonialism; ethical discourses in accounting; cultural organizations; and popular subcultures, etc. An individual implicitly acquires habitus, or culture as practice, as a system of dispositions through the culture in which he lives; the habitus constantly adapts to "produce practices that are appropriate in their context" (p.8). Even though habitus is formed implicitly, it can be transformed through a reflection on action, or socio-analysis over time that

can evoke awareness of disposition and lead to a specification of techniques and practices that are deliberate (Prasad, 2005). Utilizing this approach, we could seek to answer the following questions related to STEM talent development for Black STEM students:

1. How do Black parents view their participation in their child's skill development of STEM disciplines? What does this reveal about their habitus/capital?
2. Do Black students who experience STEM experiential activities within the social context of their culture become more interested in these STEM areas and want to continue that path into college?
3. Do Black students who develop STEM scholarly identities understand concepts more deeply?
4. Are Black STEM scholars better able to apply what they have learned in other contexts?

**Connecting qualitative research tradition to the quantitative concept of causation**. Joseph Maxwell (2004) exerted that "qualitative studies that are based on process approach to causation … attempt to directly investigate causal mechanisms" citing Pawson and Tilley's formula: mechanism + context = outcome (Maxwell, 2004, p.6). He notes that, "for the social sciences, the social and cultural contexts of the phenomenon studied are crucial for understanding the operation of causal mechanisms" (p.6) and "to develop adequate explanations of educational interventions, we need to use methods that can investigate the involvement of particular contexts in the processes that generate phenomena and outcomes" (p.7). It is through this perspective that researchers can examine the accounts and perception of an individual's experience over time that speaks to the causal process. This approach can help other researchers and practitioners to better understand the complexities (and often times the inequalities as well)

within significant and sometimes implicit structural forces embedded in this particular phenomenon. Thus, a praxeology research tradition complemented by a causal analysis provides a unique focus of inquiry characterized by distinct elements that go beyond the observation of general patterns. It legitimizes social practice with an emphasis on some struggle with a cultural limitation of choice, competence, and/or action.

**Quantitative research methodology**. Studied and validated within the context of the cultural structures of the home and community, an instrument designed to study Black parent STEM engagement would allow for identification of attributes in Black parenting style and practices as it relate to its influence on the development of Black students' STEM identity. Measurement and findings would allow the researcher to identify unique practices within Black parent STEM engagement that effectively develop or enhance the distinct characteristics of Black students' STEM identity. The intended uses for the findings will, in turn, inform culturally responsive strategies and initiatives that (1) increase/maintain Black students' interest and achievement in STEM disciplines, (2) provide contextual and experiential guidelines for parents, to further develop the talents of Black students that show interests, potential, and achievement in STEM related disciplines, and (3) infuse the cultural practices of effective Black parent STEM engagement into existing institutional STEM structures that are meant to teach and retain Black students in STEM disciplines.

## Implications for Teachers and Educational Institutions

There are many implications for parents and teachers related to the uniqueness of Black family engagement. Fields-Smith suggests that Black families must develop an awareness of appropriate support resources outside of the community, a partnering relationship with the

schools similar to that of the extended family, and an ability to effectively advocate for the needs of their children on a local, state, and national level (Fields-Smith, 2005). This does not, however, excuse the school in their responsibility to effectively support the parents as they support their children.

Teachers must understand and consider that Black parents do not often initiate parental involvement within the school, especially when the Black parent *does* trust and respect the school building's stakeholders and the role of the teacher (Bowers & Griffin, 2011; Fields-Smith, 2005). Therefore, formal educators should explicitly and consistently offer opportunities and call for parent STEM engagement at school. They must effectively and explicitly communicate STEM goals and concerns to Black parents. In addition, schools must embrace an extended definition of parent STEM engagement to include those activities that Black parents value and consider critical to the educational success of their children, including but not limited to setting school [STEM] conversations about school, and fostering a sense of student independence, etc. (Bower & Griffin, 2011). To validate their style and traditional ways of engaging in their child's educational process, educators must involve Black parents in more meaningful and closely connected endeavors, which allow them to complete STEM-related tasks that complement their career, interests, or self-perceived expertise and efficacy. It is equally important for Black parents to maintain a strong expectation from schools to include parents in STEM talent development.

While existing institutionalized STEM efforts are necessary, their structures lack the critical and most effective inclusion of the most intimate influence and cultural responsive catalyst for STEM identity development of Black students – the parent. Black parents serve as socializing agents in the core of STEM identity development that is separate from and is not

determined by institutionalized designation. NSF reported reflections from a STEM Instructional Design Workshop conducted by the Center for the Study of Mathematics Curriculum's (CSMC) which indicated that by the age of 18 a student would have only spent 20% of his life in the classroom; this fortifies the need to reinforce, enhance and extend classroom learning with outside school resources that will more likely influence STEM career choices (NSF, 2010). Black parent STEM engagement is more than an educational support system; it is an effective teaching strategy for student learning and development. This significant role in STEM talent development necessitates an interconnected view of education that must include parent STEM engagement in the intellectual development and implementation of the STEM curriculum.

**Table 2.1:** Common Terms Used to Describe Parent Involvement

| Term | Definitions |
|---|---|
| **Parent Involvement** | "the participation of parents in regular, two-way, and meaningful communication involving student academic learning and other school activities including:<br>• Assisting their child's learning;<br>• Being actively involved in their child's education at school;<br>• Serving as full partners in their child's education and being included, as appropriate, in decision-making and on advisory committees to assist in the education of their child; and<br>• The carrying out of other activities such as those described in section 1118 of the ESEA" Section 9101(32).<br>(US Dept. of Education, 2004)<br><br>"Involvement' comes from the Latin, 'involvere', which means 'to roll into' and by extension implies wrapping up or enveloping parents somehow into the system" and "the implication in the word is that the person 'involved' is co-opted, brought into the act by another party" (Benson, 1999, p. 48).<br><br>Parents who are "involved" serve the school's agenda by doing the things educators ask or expect them to do – volunteering at school, parenting in positive ways, and supporting and assisting their children at home with their schoolwork – while knowledge, voice and decision-making continue to rest with the educators.(Pushor, 2001)<br><br>Comprehensive parent involvement framework is well-known and highly regarded within educational communities. The six types of parental involvement Epstein outlines include parenting, communicating, volunteering, learning at home, decision making, and collaborating with the community (Epstein, 1997, p. 15). |
| **Parent Engagement** | Engagement, in comparison to involvement, comes from en, meaning "make," and gage, meaning pledge; to make a moral commitment. (Pushor & Ruitenberg, 2005)<br><br>The word engagement is defined as "contact by fitting together… the meshing of gears". The implication is that the person 'engaged' is an integral and essential part of a process, brought into the act because of care and commitment. By extension, engagement implies enabling parents to take their place alongside educators in the schooling of their children. (University of Indianapolis, 2011)<br><br>Family engagement comprises all activities that parents undertake to help their children learn and do well in school and through life. This inclusive definition takes into account that family engagement takes place at home as well as in school and community settings, and that parents play several different roles in their children's education ( Michigan Department of Education, 2015)<br><br>Family engagement is:<br>• A shared responsibility in which schools and other community agencies and organizations are committed to engaging families in meaningful and culturally respectful ways, and families are committed to actively supporting their children's learning and development.<br>• Continuous across a child's life, spanning from Early Head Start programs to college<br>• Carried out everywhere that children learn – at home, in pre-kindergarten programs, in school, in after-school programs, in faith-based institutions, and in community programs and activities.<br>(The National Family, School, and Community Engagement Working Group, 2009) |
| **Parents as Partners** | Parents bringing their own knowledge "together" with schools, share decision making, determination of goals and outcomes (Michigan Department of Education, 2015) |

**Table 2.2**. Empirical Research in Parent Engagement (PE) and/ or STEM engagement

| Author | Yr. | Question/ Topic | Method/Theory | PE/STEM | Deficit vs. Different |
|---|---|---|---|---|---|
| Archer, DeWitt, Osborne, Dillon, Willis, & Wong | 2012 | How do families shape children's engagement and identification with science? | Semi-structured interviews<br><br>*Praxeology* | Family Habitus & Capital<br>Science Identity & Engagement | Both (international) |
| Brown, Brown, Reardon, & Merrill | 2011 | Perceptions about STEM | Survey | STEM definition | Neither |
| Coolahan, McWayne, Fantuzzo, & Grim, | 2002 | Parenting Styles of Black Parents | Survey<br>Factor Analysis | Black Parent Engagement | Different Perspective |
| Fantuzzo, McWayne, & Perry | 2004 | How does family involvement relate to children's behavioral and learning competencies? | Mixed-method | Black parent engagement | Different Perspective |
| Ing & Marsha | 2014 | Parent influence on students' persistence in STEM careers | Nationally representative longitudinal survey data | Parent engagement STEM in developmental stages | Deficit Perspective |
| James, Basham, Israel, & Maynard | 2010 | Operationalizing STEM education of all (including special education) | Application of Bronfenbrenner's ecological model | STEM implementation | Deficit Perspective |
| LaNasa, Cabrera, & Trangsrud | 2009 | Construct validity of Student engagement | Confirmatory factor analysis | [Student Engagement] to inform indirect parent engagement and STEM engagement | Neither |
| McWayne, Hampton, Fantuzzo, Cohen, & Sekino | 2004 | Multi-dimensionality of parent involvement on K5 student academic competencies | Survey<br>MANOVA | Black Parent Engagement | Different Perspective |
| McWayne, Melzi, Schick, & Kennedy | 2013 | Defining Latino Family Engagement | Mixed-Method Measurement & Development Study | Family Engagement – Black and Latino families | Different Perspective |
| Thiry, Laursen, & Hunter | 2011 | What Experiences Help Students Become Scientists? | Comparative study | STEM identity | Neither |
| Yeung, A.S. | 2010 | Parental expectation influences on student STEM self-concept | Survey & Structured Eq. Modeling (SEM) | STEM (physics) Parent STEM expectation | Neither |

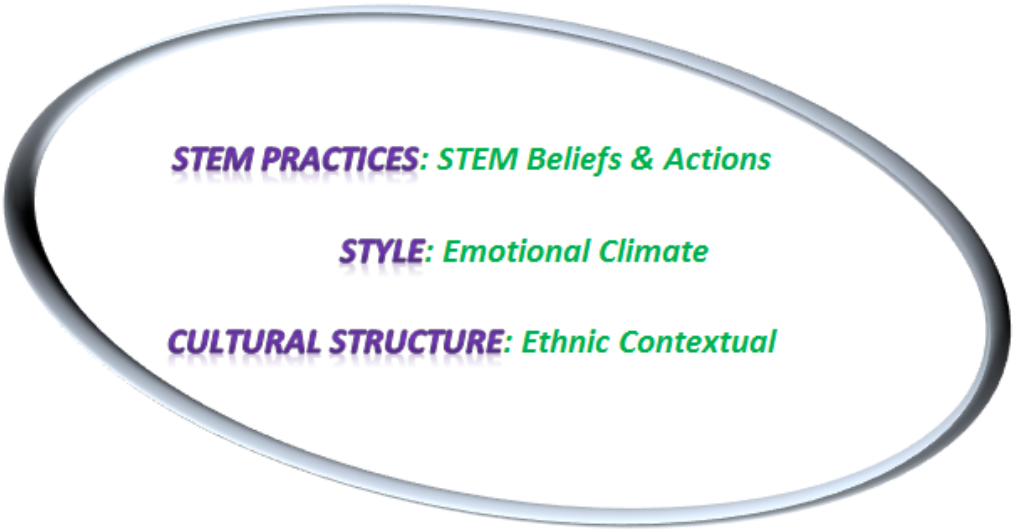


**Fig. 2.1** The Theoretical Construct of Black Parent Student Engagement (BPSE)

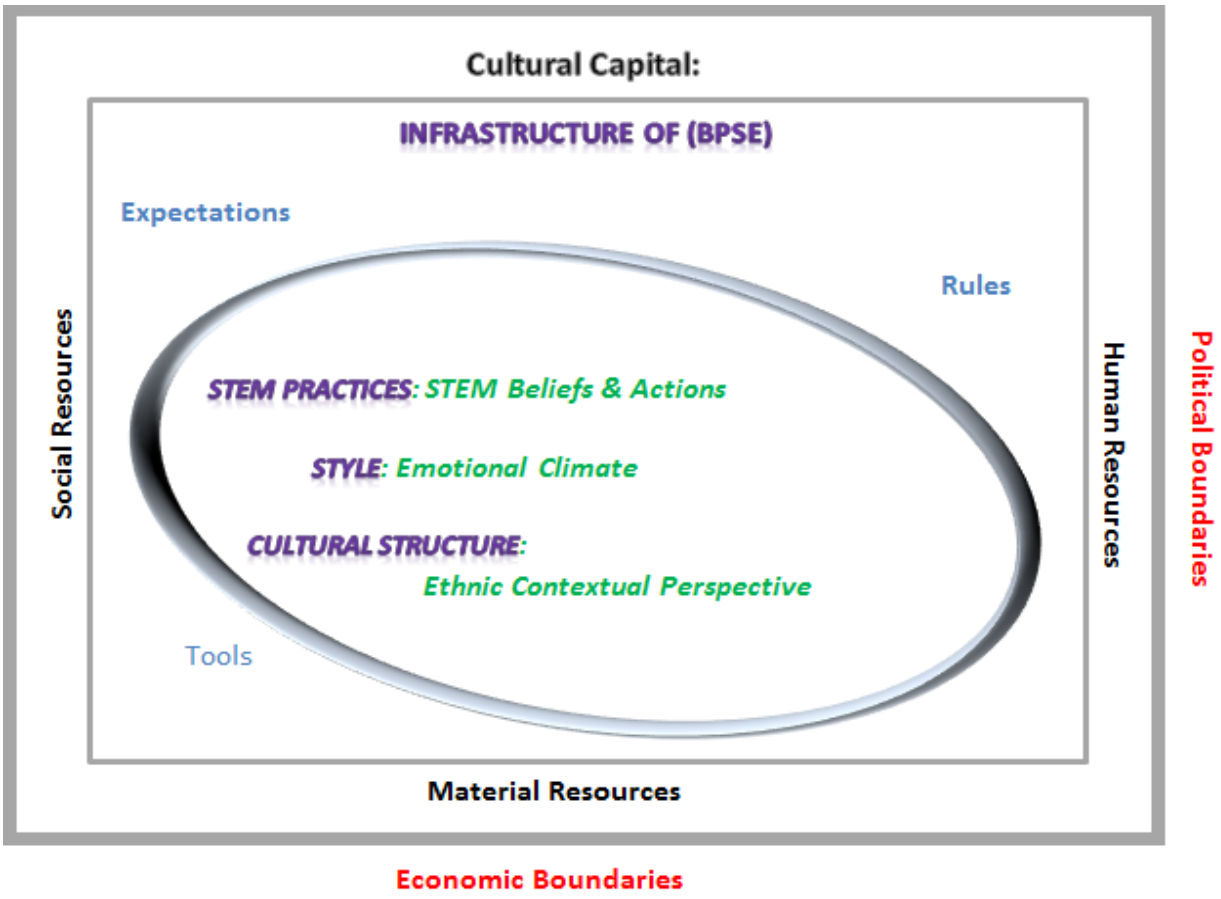


**Fig. 2.2.** Theoretical Domain: The Community/Home Space of BPSE

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# CHAPTER 3

# THE MULTIDIMENSIONAL STRUCTURE OF BLACK PARENT ENGAGEMENT IN STEM: AN INTRODUCTION TO THE BP-SEQ INSTRUMENT [2]

[2] Collins, K.H. *To be submitted to Gifted Child Quarterly*

**Abstract**

Research has shown that the parent has the most impact in the educational process of students. However, Black parents are often viewed as disconnected and unconcerned about the educational process that contributes to the success of their children in school and, consequently, the research regarding Black parent engagement is approached from a deficit model. The primary goal of this study is to address the shortcomings in the contextual examination of the dimensions of parent engagement in its role of student STEM development. Grounded in theories of ecological child development and culture as practice, a newly developed instrument, the Black Parent-STEM Engagement Questionnaire (BP-SEQ) - was used as an instrument to validate the Black parent STEM (science, technology, engineering, mathematics) engagement (BPSE) construct. Findings among parents of identified gifted and talented Black students in a STEM-focused, school-within-a-school/magnet program support the theoretical construct of BPSE which warrants a multidimensional perspective of parent engagement that includes practices, style, and cultural structure.

**Keywords**

Black parent STEM engagement questionnaire (BP-SEQ), STEM talent development, STEM identity, gifted Black students, construct validity; ecological theory of child development

According to behavioral and socio-cognitive theorists such as Bandura, Vygotsky, and Bronfenbrenner, there is a strong relationship between students' school behavior and students' performance within a socio-ecological context of learning (Whitaker, Graham, Severton, Holden

& Latimer, 2011; Woolfolk, 2010). The basic tenets of Bronfenbrenner's ecological theory of child development asserted that development occurs in nested contexts (Halgunseth, 2009; Woolfolk, 2010). As such, the home and the community represent the microsystem that is closest in terms of locality and impact to the child's development with institutionalized student development further away. The home and the community serves as socializing agents (Barton et al, 2009; Prasad, 2005) in the core of student development, which includes identity and talent development. A review of the literature has revealed, however, there are gaps in research that address a contextual examination of Black parent engagement that effectively fosters STEM identity and self-concepts for Black students who have shown significant interest, talent, and/or success in STEM disciplines. Instead, Black parents are often portrayed and reported as disconnected and unconcerned about the educational process that contributes to the success of their children in school (Fields-Smith, 2005). In addition, their cultural values and style of engagement are marginalized (Casanova, 1996; Fields-Smith, 2007) and consequently approached from a deficit model (Barton et al, 2009; Halgunseth, 2009; Radin & Kamii, 1965 as cited in Coolahan, McWayne, Fantuzzo, & Grim, 2002; Wright, 2011). This study aims to (1) confirm this new definition of Black parent STEM engagement (BPSE) that is introduced as supported by the literature and (2) validate the use of the newly constructed instrument, Black Parent STEM Engagement Questionnaire (BP-SEQ). Doing so will support an introduction of scholarship for a multidimensional examination and assessment of Black parent STEM engagement in relationship to Black students' STEM development and outcomes.

## The Ecology of Parent Engagement

Parent involvement, parents-as-partners, and parent engagement are three common terms used interchangeably to define parent engagement as it relates to their children's learning (MDOE, 2013). Based on the meanings established in the research, I contend that *parent involvement* is grounded in a framework and perspective of the school's needs, expectations, and goals for children learning (USDOE, 2008; Pushor & Ruitenberg, 2005); *parent-as-partner* acknowledges a cultural component in the process of parent involvement that values the knowledge that the parent brings to the formal educational framework (MDOE, 2013); and *parent engagement* is a distinguishable extension of the parent involvement and parent-as-partner concepts that offers a more comprehensive view of parent behavior (how and why parents do what they do) and the style in which they do it. This comprehensive view goes beyond the educational framework of parent involvement (Kluge, 2000; Barton et al, 2009; MDOE, 2013; The National Family, School, and Community Engagement Working Group, 2009; Pushor & Ruitenberg, 2005; University of Indianapolis, 2011). Halgunseth (2009) described parent engagement as meaningful collaboration in the educational process that influences student achievement and career selection by solidifying the educational identity as an extension of the student's personal self. As such, parent engagement offers the equality of leadership, authority, and development of learning objectives and student activities between the home and the school.

## Black Parent STEM Engagement

### Practices, Style, and Cultural Structure

Research has shown that a student only spends 20% of school aged years in the classroom and therefore the efforts made by institutions to influence student's STEM career

choices are ineffective. An obvious solution is to use non-school personnel and resources to teach STEM skills (National Commission on Excellence, 1983; Archer et al, 2012) and to support STEM talent development of all students (National Science Foundation, 2010). Based on the ecological framework for the earliest development at the micro level, STEM engagement that fosters STEM development between the more knowledgeable other, MKO, and the student occurs at the center of the community/home space (Vygotsky, 1977 as cited in Woolfolk, 2010). It is no wonder that "the two most influential environments in which young children develop are their homes and their early childhood education program" (Halgunseth, 2009, p. 56). As a result the focus of this study is to examine the cultural context of Black parents' engagement with their children as it related to fostering STEM competence, interest, and talent development. The Black Parent STEM engagement construct is informed by existing literature and frameworks related to Black parent engagement, multicultural gifted education , STEM talent development and, and human development. Shown in Figure 3.1 and referred to as Black parent STEM engagement (BPSE), the MKO exhibits a style of parenting by which s/he engages the student in STEM practices. Close examination of this interaction revealed beliefs and actions that define and impact STEM practices; they are "the what and why" parents do what they do, which is deeply embedded at the core of everyday social practices, or habitus.

This is comparable to what Fantuzzo et al (2002) defined as parenting behaviors and styles (Coolahan, McWayne, Fantuzzo, & Grim, 2002). I further posit that among the practices and style of Black parent STEM engagement is the influence of a unique cultural structure. A cultural environment that values extended family relationships and shared mentoring, or the "it takes a village" mentality, (Fields-Smith, C., 2009; Grantham, Scott, & Harmon, 2013; Mendez,

2010; Pearson, Hunter, Ensminger, & Kellam, 1990) is essential to the Black parent STEM engagement construct:

[Insert Figure 3.1 here]

**Operationalization of BPSE.** Extending the research of Black parent engagement and Black student identity, Black parent STEM engagement (BPSE) is consequently operationalized as the STEM specific, goal-directed, behavior and style of Black parents practiced within the cultural environment of the child (Collins, 2015). Framed within critical race theory (CRT), *The Ecologies of Parent Engagement* model (EPE; Barton, Drake, Perez, St. Louis, & George, 2009) extends Bronfenbrenner's view of ecology and goes beyond mere cultural context; it includes the beliefs and activities of everyday social practices as characteristics of the parent engagement. Therefore, behavior is further defined as activities that include beliefs, perception, values, and actions (Roth, Lawless, and Tobin, 2000), or practices, while style refers to the cultivation techniques and emotional climate by which Black parents engage with their children.

It is important to reiterate that this engagement is exhibited independently from the context or standards of formal education. Therefore, researchers, administrators and curriculum developers must consider the cultural context of parenting styles and practices in order to better understand its role in fostering STEM talent development and success of Black students. Not only is it imperative and necessary that we study the multidimensionality of Black parent STEM engagement (BPSE), it should be studied within the context of the environment of Black culture and value systems. Without this consideration, institutionalized structures of STEM efforts will continue to lack the appropriate inclusion of that most critical influence, perspective, and cultural

responsive catalyst of STEM identity development – family and community engagement. Again, this implies and supports an investigation to understand BPSE within the cultural context in which it occurs for sake of student STEM development and achievement at school as well. Studied and validated within the context of the home and community allows for identification of attributes in Black parenting style and practices that are not viewed in comparison to White, middle class parenting styles and practices or as deficits in intellectual value (Bandura, 1977 as cited in Woolfolk, 2010; Radin & Kamii, 1965 as cited in Coolahan,, McWayne, Fantuzzo, & Grim, 2002; Wright, 2011).

Validated within the cultural context of the home and community, Black parent behavior and styles, has been empirically studied and showed trends of multidimensional parenting (Fantuzzo, McWayne, & Perry, 2004; McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004; McWayne, Melzi, Schick & Kennedy, 2013). Further, the Black parent behavior and style construct, grounded in the ecological theories of Bronfenbrenner (Halgunseth, 2009; Woolfolk, 2010) and Epstein (Bowers & Griffin, 2011), was validated for low income Black families of preschool students and defined as the style (active-responsive, passive-permissive, and active-restrictive) and goal-directed behavior, or activities (supportive home learning environment, direct school contact, and inhibited involvement) of Black parents practiced within the cultural context of the child. These researchers developed the Parenting Behavior Questionnaire–-Head Start (PBQ-HS)—in which they administered to their population and concluded that the caregivers employ parenting strategies in response to the sociocultural context in which it occurs. Their findings suggested a relationship between parental circumstances (support, resources, etc.) and style of parenting (Coolahan, McWayne, Fantuzzo, & Grim, 2002). Subsequently, the multivariate relationship between Black parenting styles and the preschool students' learning

competences were examined where home-based family involvement surfaced as the strongest predictor of leaner outcomes (Fantuzzo, McWayne, & Perry, 2004).

**BPSE Theoretical Domain**

Barton, Drake, Perez, St. Louis, and George (2009) contended that parent engagement is a mediation process between space (or nested contexts, i.e. the school, community/home, etc.) and capital, or resources and tools, where parents act as authors and agents in their child's educational process. The terminology of space and capital is drawn from Pierre Bourdieu's (1977) Culture as Practice (Barton, 2009; Prasad, 2005) and the Moll's (1992) Funds of Knowledge frameworks (Amaro-Jiménez & Semingson, 2011; Moll, Amanti, Neff, & González, 1992; Tan & Barton, 2010; Wright, 2011).

So, rather than continuing in the trends of developing a model designed to remediate and make accommodations for perceived deficits of culturally diverse students, this model of Black parent STEM engagement is built on the cultural tools and experiential knowledge that have become the basis for teaching what is valued and useful within a community of practice. Barton's and Bourdieu's work offer a complex analysis of "relations between lifestyle, life chances, and material resources" (Prasad, 2005, p.9) by which to examine BPSE more validly. It is through the conceptual framework of EPE that Black parent STEM engagement (BPSE) model is oriented within its own theoretical domain as illustrated in Figure 3.2.

[Insert Figure 3.2 here]

Barton's spaces, or fields as referred to by Bourdieu (1977), are bounded by different types of environmental boundaries: social, cultural, political, economic, etc. (Barton et al, 2009; Prasad, 2005). Archer et al (2012) asserted that "The extent to which science is thinkable and can be practically supported and encouraged within families through cultural, economic, and social capital is not spread randomly across the population: It is structured by social inequalities" (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). Further, Vygotsky and other constructivists contend that all knowledge is socially constructed (Gergen, 1997; Woolfolk, 2010). Table 3.1 summaries the contextual components of BPSE domain within that space:

[Insert Table 3.1 here]

**STEM Practices.** Within these spaces are the underlying structures of everyday STEM practices such as expectations, rules, and tools (habitus; Bourdieu, 1977 as cited in Prasad, 2005) that shape actions in scope, focus, and purpose (the game; Bordieu,1977). These STEM practices are used to steer the student toward goals that the culture values and are bounded by the [cultural] capital, or resources (human, social, material, etc.) that individuals (players; Bourdieu, 1977) bring to that space. Human resources are the people in that space that act as more knowledgeable others (MKO; Vygotsky, 1978 as cited in Woolfolk, 2010). Accepting that all knowledge is socially constructed and culture creates cognition, social resources include commonly held, everyday practices (Gergen, 1997; Phillip, 1997) and interactions used to communicate knowledge, or ways of thinking and doing. Material resources are marked by the multiple representations of the knowledge. These identified and sometimes intertwined boundaries are important to consider because they determine if knowledge is internal, general,

and transferrable or bound to the time and place in which it was constructed. For example, a recreational coach (MKO/human resource) for a local community center (material resource) may incorporate STEM practices when during basketball practice (social resource) to purposefully foster STEM skill development in basic math, geometry skills, statistics, etc. and/or peek interest in STEM careers such sports analyst, sports medicine and kinesiology, design engineers (flooring, balls, score boards, etc.) as part of his coaching techniques (style).

## Research Design

The focus on this study was to design a comprehensive instrument that could be used by researchers to capture data that would lead to reliable and valid claims about BPSE. Accurately structuring and measuring BPSE is required before we can study BPSE on a larger scale to better understand its influence on students and in schools. Completing this task began first with a sound conceptual delineation of the BPSE domain and included a deliberate collection of evidence throughout the instrument design process that would support the meaning drawn from the analysis of the collected data. One of the tasks in providing evidence for construct validity for the multidimensionality of BPSE includes determining the appropriate strength of the indicators in terms of affirmative response from the participants as well as representation of the most appropriate dimension. According to the 2014 edition of Standards for Educational and Psychological Testing, construct validity can be achieved by presenting a scientifically sound argument to support the intended interpretations of the instrument's results (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 2014). Credited for the evolution and adaptation of a single concept of validity, Messick (1989) theorized construct validity as a unitary concept that represents the

degree to which the evidence of validity argument supports the intended interpretation of the results and their use (Embretson, 2007). The guiding principles of AERA, APA, and NCME's (2014) "Standards for Educational and Psychological Testing"; Embretson's (2007) "Evidence Categories in the Validity System"; and Benson's (1998) process for conducting a strong program of construct validity drawn from the "Unified Theory" of Messick (1989) stipulated a framework for providing evidence of construct validity to put forward throughout the study.

Based on these principles of instrument design, the Black Parent STEM Engagement Questionnaire (BP-SEQ) was constructed and its psychometric properties were examined in order to validate it as a suitable instrument to measure Black parent STEM engagement specific to STEM identity development in Black students that show STEM interest or STEM success. In this pilot study, I sought to answer the following research questions:

1. Does the structure of the BP-SEQ align with the research and theory on Black parent STEM engagement in the literature?
2. Is the BP-SEQ internally consistent?
3. Are the findings from the BP-SEQ related to other indicators of Black parent engagement in theoretical, expected ways?

## Methodology

### Evidence Based on Test Content

**Logical/theoretical analysis and domain structure**. Based on a theoretical analysis and operational definition of BPSE, three (3) major dimensions – STEM specific practices, parenting style, and cultural structure - of BPSE were identified as outlined in Figure 3.1. STEM specific practices were further defined by beliefs and actions that embody these everyday STEM

practices. Figure 3.3 represents a graphical representation of the hypothesized structure for the conceptual model of BPSE. The model suggests a relationship whereby BPSE is defined by the STEM specific and goal-directed practices of the parent that are cultivated with an emotional climate, or style of parenting and culturally structured amongst the ethnic, contextual perspective of that parent-child interaction. While beliefs and actions further detail the STEM practices dimension, the graphic representation of the hypothesized structural model in Figure 3.3 does not presume any specific hierarchical structure.

[Insert Figure 3.3 here]

**Development of the BP-SEQ Instrument.** Guided by Embretson's (2007) universal system of construct validity and DeVellis' (2012) eight (8) steps in survey development, the Black Parent STEM Engagement Questionnaire, BP-SEQ, instrument was developed. With a hypothesized structural model provided, indicators that captured each dimension of BPSE were determined in order to develop the questionnaire that was used as the blueprint for specifying the BPSE domain structure and to measure the construct for the selected population.

First, the BPSE construct to be measured was determined and defined as explained above. Then a theoretical (Figure 3.2) and empirical domain (Figure 3.3) was developed and illustrated to steer the development of construct indicators. To inform the generation of the item pool, an examination of the psychometric properties of several validated instruments including but not limited to parent influence theory (Ing, 2014; Yeung, Kuppan, Foong, Wong, Kadir, and Yau, 2010); Black parent engagement (Coolahan, McWayne, Fantuzzo, & Grim, 2002; Fantuzzo, McWayne, & Perry, 2004; McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004;

McWayne, Melzi, Schick & Kennedy, 2013); student development relevant to STEM issues among Black students (Connolly, 2011; Harvey, 1981; Hernandez, Schultz, Estrada, & Chance, 2012; Perez, Cromley, & Kaplan, 2013); and the development & evaluation of measurement scales (Carter, Reschly, Lovelace, Appleton, & Thompson, 2012; Gregorich, 2006; Kopp, Zinn, Finney, & Jurich 2011;Carlson & Mulaik, 1993; LaNasa, Cabrera, & Trangsrud, 2009) was conducted.

**Report of subject matter expert ratings.** Table 3.2 outlines the process of how I developed the statements to represent each dimension with examples from the BP-SEQ included. Separated by the 4 hypothesized dimensions, the sources listed above represent relevant theories, previous studies, and sample statements I analyzed and/or adapted to fit the BPSE construct. The initial item pool included 66 statements representing all four dimensions. These 66 items were then reviewed by expert panels representing Black parent engagement experts (3), STEM educators(2), identity development scholars (2), and Black parents of former K-12 STEM students from the same sample population (4). A critical examination of the items by these experts was conducted to ensure the items measured what they were written to measure and that the construct of BPSE was fully represented on the questionnaire.

[Insert Table 3.2 here]

Table 3.3 further summarizes the evolution of the BPSE statements and the instrument development starting with the 66 generated statements, or variables, representing the multidimensionality of BPSE: beliefs (B1-B21), actions (A1-A21), style (S1-S11), and culture (C1-C13). Through this process of providing internal source of evidence for construct validity,

the original 66 items were reduced to 41 to represent the Black Parent STEM Engagement Questionnaire (BPSEQ-41). A 6–point Likert rating scale, from 1 – 6 with 1 being strongly disagree to 6, strongly agree - was determined to be the most appropriate approach to align the indicators with the construct. However, for validation purposes, the word "Black" was omitted on the actual survey distributed to participants to avoid any influence of responses.

[Insert Table 3.3 here]

Before attaining their final version, the 41 statements were also examined twice more by two different expert panels. One examination for representation of the construct was conducted through a discussion-based workshop based on the observational experiences of a selected educators' panel. This panel consisted of fifteen (15) K-12 teachers and administrative coordinators from diverse backgrounds and geographical areas. Through a rigorous application process conducted by the National Association of Gifted Children, they were selected to participate in a national professional development program for educators of gifted and magnet school programs within Title 1 school districts. As the facilitator of the workshop, I had the participants to review the statements and discuss the appropriateness of each statement as it relate to the Black parents that they work with in their respective gifted education programs. Finally, my advisory committee members (4) examined the items to ensure appropriate wording and clarification of items that represent the BPSE construct in ways that were appropriate with respect to fostering Black student STEM identity development. As a result, the final version of the BPSEQ-41 was realized representing the multidimensionality of BPSE: beliefs (B1-B8), actions (A1-A12), style (S1-S8), and culture (C1-C13). Items constructed as belief indicators

were designed to capture Black parents' beliefs regarding (1) perceived external boundaries that might limit their student's STEM access and achievement outside of the community (B1-B5); (2) their own capacity (know-how), ability (knowledge), and efforts to engage effectively in STEM development for their child (B6-B20) that also speak to their expectations and values (B10-B11); and (3) student experiences of micro-aggressions and other success inhibitors. Items constructed to represent the style dimension included indicators related to the social values (S6 – S11), communications (S2-S4), and advocacy (S1, S5) that underpin the emotional climate in which the parent-child interaction is exhibited. Cultural structure items were aimed at capturing unique cultural norms and environmental influences that are innately woven into the fabric of the home and disposition of the parents or mentors that are inherited by the student through automatic and purposeful rearing practices; indicators for these were meant to get at the common Black experiences that define sense of self (C1-C10), community (C4), and struggle (C11-C13).

## Data Collection & Analysis

### Evidence Based on Response Process

**Participant recruitment and selection criteria.** An adequate amount of research on parent engagement among gifted and highly talented students exists that has asserted the existence of a relationship between parent engagement and student's academic achievement (Grantham & Collins, 2013; Grantham & Henfield, 2011; NSF, 2010; Whiting, 2006). Thus, the presumption was made that BPSE influences the STEM self-concept and talent development of gifted and high-ability Black students as evident in their STEM persistence and achievement. The target population was a representative sample of parents of identified high school talented

and gifted students enrolled in a STEM program from a rural, Title 1 school district in Georgia. Criteria for selection to complete the pilot BP-SEQ were parents of identified high ability and gifted high school students who are 1) accepted and enrolled in a school-within-a-school enrichment program and 2) show evidence of STEM persistence or continued STEM interest in related academic interest, selection and/or achievement. Evidence of achievement is presumed by their continuance in the program which has its own criteria that includes, but not limited to, academic achievement at 85% or above in STEM courses. Because these parents had students with talents, interests, or persistence in STEM courses, they were expected to demonstrate high levels of BPSE on the questionnaire. As such, the parents served as a validation sample where high performance on the BPSE as a whole or individual items would corroborate that the instrument was measuring BPSE and low performance would flag the item(s) for review.

**Participant response analysis.** Benson warned that participant's response process could influence the relationship of test items and therefore an analysis of responses can be used as evidence based on internal structure (1998). As an incentive for participating in the study and to allow for an analysis of individual responses, parents who completed the BPSEQ-41 were invited to participate in a parent STEM awareness workshop to further discuss items that were presented in the survey. In addition to the items representing the dimensions of BPSE, common terms related to STEM as well as a mapping of their "STEM development status", similar to Archer et al family relationship to science (Archer et al, 2012), was included at the beginning of the instrument along with other demographic information. Participants were asked to reflect on the thought processes, ideas, questions, etc. that they engaged in while completing the survey.

***Demographic background.*** Of the 38 respondents to the survey, only one parent reported a race other than Black or African American. Thirty-one (31) identified themselves as mothers

and four as fathers with the other four choosing not to identify their parental role. Participants were representative of the parents in the magnet program with respect to the overall population of 115 students in grades 9 through 12. The sample population comprised of the following student population identified by parents: 5 freshmen, 10 sophomores, 12 juniors, and 8 seniors; 10 males and 25 females; 32 were identified as gifted students with 28 of those still participating in programs exclusively developed for gifted students. Recognizing common STEM terms, approximately half (53%) of the parents indicated they were familiar with the given definitions of "parent STEM engagement" and "STEM skill" while more parents indicated they had more familiarity with other terms such as "STEM concepts" (60%), "STEM career "(73%), and "STEM subject/classes" (77%). Parent demographics also revealed that 72% of respondents had graduated from college and the rest of the respondents (28%) have had at least some taken some college courses with approximately half of them reporting that the excelled in or at least found mathematics and science/health very interesting themselves. Economic considerations revealed that over half (55%) of the respondents' family income were between $80,000-$150,000 while four reported income below $40,000, 8 between $40,000-$79,999, and one over $150,000.

On average, parents reported that their children were more interested in technology and computers (27) more than any other subjects with mathematics reported as the 2nd most interested subject (26). Engineering and design were reportedly disliked the most (16) over other STEM subject such as science, the 2nd most disliked, which was significantly lower (6). However, 23 parents reported that their children had not even had a course in engineering even though they reportedly did not like engineering. Of those students that have taken an engineering or design course (7), they all made A's in the course. Of all the grades reported, only 2 students had even made a C or below, both of which were in mathematics class, the 2nd most interested

course. Developmentally speaking, parents, by far, reported that their children were being conceptually developed in STEM over practical, limited, deprived, or no development in STEM/ STEM values. Table 3.4 below summarizes the general conditions under which parents reported their engagement in developing their child's STEM talent... Almost one-half of the participants felt like their engagement practices provided their children STEM conceptual development that positively influenced the child's self-concept and identity about STEM. However, the final workshop conducted in which we further discussed what that might look like in the home, it was determined that most are not as confident that they are providing that conceptual basis to significantly influence the child's self-concept. For example, one parent noted that she chose conceptual development over practical development in the survey because she talks to her female child about how hard it will be as an [engineer] in a field with mostly white males. Most of her conversations are not about the actual skills, knowledge, and everyday practices of an [engineer] because she reported that she is not familiar with that. Another parent noted that she talks to her child about how much more money her child can make as a [scientist] compared to other fields of study but does mention things like conducting lab experiments. Based on these conversations, practical development may actually be more prevalent than reported which would be more aligned with the research and review of the literature as well.

[Insert Table 3.4 here]

## Evidence Based on Internal Structure

**Analysis logic and procedure.** The simplest form of quantitative analysis for appropriateness of items for construct validation and model fit is descriptive statistics (i.e. mean, median, variation, standard deviation, correlations, etc.). For instruments that include a Likert scale such as the BPSEQ-41, a favorable mean for each item is one that is affirmative toward the theoretical characteristics of the construct. Further, conducting a descriptive statistics analysis allows researchers to form a general idea of which items can be identified early on for appropriateness. IBM SPSS 21 was used to obtain the statistical data for the BP-SEQ instrument administered to the select population. BPSEQ-41 utilized a Likert scale ranging from 1-6, more specifically with 1-3 representing strongly to somewhat disagree and 4-6 represent somewhat agree to strongly agree. As such, a mean of five (5) or higher was desirable as a good indicator, four (4) was acceptable, and any mean less than four (4) was considered a weak indicator.

## Findings

The BPSEQ-41 instrument was systematically reduced to 33 items after a rigorous analysis of the data. The resulting statements of the BPSEQ-33 instrument are provided in Table 3.5. A summary of the items' means and their correlations within and between each dimension are provided in Table 3.7 (see appendix) and discussed below. These results provide evidence for BPSE construct validity and reliability based on criteria for retaining items that are correlated with other indicators within their hypothesized domain (Crocker & Algina, 1986; Field, 2009).

[Insert Table 3.5 here]

**Evidence of Internal Consistency/ Reliability**

**Appropriate strength of the indicators.** Table 3.6 summarizes the initial examination of the individual items of BPSEQ-41 for appropriateness as a good indicator of the construct based on the mean of that item. A preliminary examination of the data suggested that the construct could be appropriately represented by a minimum of 10 items (4 statements from the belief dimension, 1 from actions, 2 from style and 3 from cultural structures) that were the best indicators to represent the BPSE dimensions. However, there are not enough items to statistically represent the model with 3-4 dimensions. As a result, the distinct dimensionality feature would be lost. Based on best practices of factor analysis, it is recommended that at least 3 - 4 variables (indicators) converge to represent a single factor, or dimension (Mulaik, 2010). Consequently, only the items representing the current Belief and Cultural Structure dimensions would be considered reducing the model down to two dimensions that would have to be renamed based on the common theme of the statements before it could be further explored as an option.. It should be noted however, the graphic representation and hypothesized structural model of the construct illustrates Beliefs and Actions as subcategories of STEM Practices and therefore the items representing each of them separately could prove to be best modeled as a single set of variables of STEM Practices directly. Another option would be to eliminate only the 9 items that were identified as weak indicators (mean less than 4) and still appropriately represent the construct and theoretical model with 33 items. An examination of the item correlations is warranted.

**Correlation between the indicators.** A more detailed examination was conducted to evaluate the correlations of the items to each other within their specified dimension and the other dimensions. I was seeking to determine if the items within my hypothesized dimension highly

correlate with each other and do items that are not in specified dimension lowly correlate. Best practices in correlation analysis recommends that significant correlations, in terms of their absolute values, occur at .300 or higher (Mulaik, 2010). For the purpose of this study – to maximize the most appropriate indicators that best represent the construct - .4 and .5 were considered a good range and appropriate strength for correlation, while .6 and .7 were considered moderately high/strong and .8 and .9 were evaluated as indicators of very strong correlations. The inter-item correlations were examined and summarized in Tables 3.6 in the appendix.

***Inter-item correlations*.** Examining the correlation strength of each item from the BPSEQ-41 questionnaire within its own group, or dimension, additional traits about BPSE were interpreted. For example, strong indicators for belief, PB2 and PB4 (BPSEQ-41 variable name) , indicate that Black parents believe that "extra steps" on the part of the parent are necessary in order that their child succeed outside of the home community. As a result, PB2, "I believe that "extra steps" such as providing tutoring for STEM classes and repeat testing for college for entrance exams, are critical for my child to have equal access to STEM opportunities and future STEM success" (the original wording of BPSEQ-41 statement) could very well be eliminated as a duplicate of PB4, "I believe that parent engagement and learning about STEM at home are 'extra steps' that are critical for my child to have STEM success at school. On the other hand, PB2's high correlation (.416) with one of the style statement, "I set standards for my child with the expectation that my child will have to work twice as hard to have equal access to STEM opportunities" speaks to the social values of work ethic that influence the style of parenting. As a result, PB2 was regrouped as a style of parenting that is responsive to inequity issues. Likewise, the findings reveal that PB1 and PB5 should be eliminated because their correlation to other variables within the belief dimension are not as strong as the other variables (ranging from

.339-.503) and PB5 negatively correlates with PB3 (-.319). This suggested that Black parents do not believe that children teachers allow their children to perform below their academic potential without "pushing" them to achieve more (PB1). Neither do they believe that the practical applications of STEM skills are more beneficial that the advanced STEM skills learned in such classes as physics and computer programming. Yet, this item's negative correlation to PB3, "I talk to my child about what I think it might be like for him or her as a scientist, technician, engineer, mathematician, or other STEM related jobs (i.e. nurse, STEM teacher, electrician, mechanic, etc.)," indicates item behavior that would be indirectly proportionate; this contradicts the expected conceptual development at home that matches the belief of advanced STEM skill development in school. Continuing with additional detailed examinations and interpretations of inter-item correlations as provided in the example above other discussions are offered for consideration. The full scale with all statements can be found in the appendix to review the exact statements.

Regarding the action dimension, PA4 and PA9 are weak indicators of actions dimension and neither correlates with any other variable within that dimension, except PA8. PA12 is a weak indicator and it does not correlate with any other items except for PA11 which is strong enough as an indicator that PA11 could adequately represent the characteristics that PA11 is attempting to capture. While PA2, PA5, and PA10 are among the weakest indicators, they do have correlations with the majority of the other items within their group. Within the style dimension, S4 correlates with S1, S2, and S3 and S6 only correlates with S7. Lastly, the last three cultural structure items related to micro aggressions are not adequate indicators of the dimension. C11 and C12 are weak indicators without any appropriate correlations within its group. They also correlate negatively with C13 whose only other correlation is C10 (good indicator) which is also

negative. .The elimination of C11-C13 is further justified by their significant correlation among Belief indicators, PB1 and PB5 which are eliminated in the final version of the instrument along with PB7 which was a good indicator but with no strong correlation to any other variables within its group. C10 does correlate well with C8 and C9 which are also acceptable indicators.

***Compounding nature of style and cultural structure.*** Cultural structure items, C2, C3, C4, and C6 all correlated significantly with at least ½ of the variables within the Action and Style dimensions. C5 and C7 also correlated with 1/2 of the variables within the style factor as well but not with any appearance of compounding effects or high correlations among more than one dimension. Style item, S7, correlated with 4 of the remaining 6 variables for the Belief dimension with a strong correlation with PB2 which is also strongly correlated to S8. S4 and S6, which are the best indicators for Style dimension, are the only two that do not correlate with at least ½ of the variables within the Actions dimension.

**Test Consequences.** Elimination of an item did not mean that the item itself was invalid or did not independently represent the theoretical model and defined construct; it only meant that it was not the most dominate or appropriate item as an indictors in relationship to the other items within its dimension. For example, a critical review of the literature and other empirical studies have revealed that historically speaking, Black and other minority parents that are engaged with their children generally do not trust that their child are challenged appropriately to reach their potential by teachers, especially if the child exhibits the desired behavior (Vincent, Rollock, Ball, & Gillorn, 2012). However, an analysis of item PB1 representing this belief did not reveal that this is a strong belief of the parents for the pilot study and it is not a significant variable, in relationship to other indicators. Implications could be simply that is not as critical to consider when implementing STEM programs or training and engaging parents.

[Insert Table 3.6 here]

**Scale reliability**. Cronbach's alpha = .819, confirmed the scale's reliability as a whole to measure the BPSE construct (Cronbach's alpha coefficient of .76, Coolahan et al, 2002; Crocker & Algina, 1986; McWayne et al, 2004; Kline, 1993 as cited in McWayne et al, 2013). Reliability for each dimension was reported as well: belief (.721), action (.90), style (.923), and cultural structure (.781). Belief has the least number of items representing its factor and further diverged into distinct categories, beliefs about the priority on the global focus of STEM and the belief that Black students have to make up for perceived lags created by systemic boundaries from the dominant social structures and practices.

This interpretation of the coefficient is based on the traditional suggestion that 76% of the variability in observed scores is the true scores with the remainder as measurement error. The number of items in the scale and the inter-item correlation among the items affects Cronbach's alpha (Crocker & Algina, 1986) therefore the most robust factor structure should minimize inter-factor correlations (McWayne et al, 2013) and is meaningful (Benson, 1998; Messick, 1989). For the remaining items whose communality values were less than the ideal .5 (Crocker & Algina, 1986; Mulaik, 2010), if they were removed then the scale's reliability would increase to only .833 and therefore was kept for meaningfulness as determined by my criteria such as mean, correlation, etc. A communality less than .5 indicated that variance in each item explained by those extracted variables was very small.

## Conclusion

### The Structural Model of BPSE

Based on the statistical analysis performed, Black parent STEM engagement, or BPSE, is better described as a 4-dimensional model. Figure 3.4 represents the structural model of Black parent STEM engagement that best represent the empirical data collected for this study. Actual measurements of factor loading coefficients are not included within the scope of this study which focuses on validating the structure of the model.

[Insert Figure 3.4 here]

STEM practices are best represented by belief and actions as independent dimensions rather than a subset of STEM practices. The dimensions are represented as follows:

(1) Developmental Attitudes/ Beliefs by X1 - X5 representing beliefs related to a global focus on STEM and concerns related to systematic lag created by the boundaries of social dominant practices in STEM achievement;

(2) Action by X6 – X13that includes efforts to influence student's STEM interest and decisions as well as expose him or her to STEM related material, activities, and concepts;

(3) Social Values/ Style by X14-X17 and X22 – X27 represents an emotional climate that is influenced by social values and issues (i.e. humor, equity, tradition, and common-sense, competitive, and experiential learning, etc.); and

(4) Cultural Structure by X18 – X21 and X28 – X33 includes a village mentality that acts as a form of extended parenting. The strong cultural affiliations with family/community, church, and sports create another source of guidance, praise, and authoritarian, parental monitoring (Lowe & Dotterer, 2013) for Black students.

**Limitations and Directions for Future Research**

As stated earlier, one of the tasks in providing evidence for construct validity for the multidimensionality of BPSE includes determining the appropriate strength of the indicators in terms of affirmative response from the participants as well as representation of the most appropriate dimension. While this study used descriptive statistics and interactions with participants as evidence for the underlying structure of the BPSEQ, further research is needed to statistically verify the factor structure with a measurement model. The next step in this scale development research is to conduct a larger administration of the instrument in order to have the sample size to conduct a factor analysis.

Based on general guidelines for adequate structural model criteria of good model fit well-defined factors are revealed by soliciting 5 - 10 participants for every item represented in the instrument (Crocker & Algina, 1986; Mulaik, 2010). As a result, the final measurement model should be further studied with a bigger population representative of this same population. It would also be useful to include a representative sample across developmental ages and other magnet programs to include a more diverse group of parents within the same district. In addition, the factor structure can be checked for invariance across sub-samples such as parents of female and male students, parents within income and educational ranges, and different parental roles. This added rigor will validate the instrument's generalizability

**Evidence based on conceptual relationship to related variables.** Divergent evidence that is also important in validating the BPSE construct is the responses from other races. However, since only one parent indicated that she was of a different race that Black, the data for that parent was removed; there were not enough parents of this category to provide meaningful information to the study (i.e. divergent evidence or characteristic to confirm unique Black parent STEM engagement characteristics). It is also important to note that the correlation matrix as a whole for the BPSEQ-41 was not positively defined. So this should also be re-examined with the 8 items removed to form the BPSEQ-33.

Despite these limitations, the study does confirm the need to redress the gaps in the literature and begin the process toward a contextual model of research and multidimensional assessment for Black parent engagement in STEM.

**Evidence Based on Consequence of Test/ Significance**

The findings of this study set the foundation for further research into the contextual examination of Black parent STEM engagement. Findings from more in-depth study and measurement could serve to inform educational and intervention approaches for the application of effective, Black parent engagement in STEM curriculum; an approach to decrease the cultural discontinuity in the home-to-school transition of younger students that affects student STEM achievement; serve to offer improvement strategies in the quality of the overall parent and teacher collaboration; and more importantly, increase in STEM identity (competence and interest) and talent development of gifted and talented Black students that exhibit achievement in STEM disciplines in school.

**Table 3.1.** Description of the Theoretical Domain within the Community/Home Space of BPSE

| Structures | Description |
|---|---|
| ***Boundaries*** | |
| Social Boundaries | Social boundaries refer to the unequal power that people have in defining what constitutes knowledge |
| Cultural Boundaries | The value of that knowledge is determined, in part, by how well information fits into the current, accepted community of practice, or cultural boundaries. |
| Political Boundaries | Political boundaries are the systematic processes and issues that affect the meaning of knowledge. |
| Economic Boundaries | Financial situations and power that can affect the social negotiation, or communication methods of that knowledge. |
| ***Infrastructure*** | |
| Cultural Capital | Resources that individuals bring to the space (human, social, and material resources) |
| Habitus | Expectations, rules, and tools of everyday practices that become innate dispositions of the members of that space (Culture as Practice) and shape BPSE in scope, focus, and purpose |

**Table 3.2.** Sample of Statements Generated for the Original Item Pool (n = 66)

| *BPSE Factor* | Source | Original Question or Concept | BPSE Item | Author Comments/Changes |
|---|---|---|---|---|
| *Beliefs (Inhibitions)*<br><br>*B22* | McWayne et al PICE-K (2004) – U<br>Inhibited Involvement | I am concerned that I am not involved enough in school activities | My parent engagement IN STEM? at home takes the place of my engagement at school. | My academic [STEM] engagement with my child at home takes the place of my academic [STEM] engagement at the school. |
| *Actions*<br><br>*A9* | McWayne et al PICE-K (2004) – U<br>Supportive Home Learning Environment Factor<br><br>*Whiting, 2006 (Scholar Identity in Black Males: Self-awareness; Academic Self-Confidence )* | I talk to my child about what it's like for them to be a boy or a girl | I **talk** to my child about what it might be like for him or her as a scientist, technician, engineer, mathematician, or other STEM related jobs. | I talk to my child about what it might be like for him or her as a scientist, technician, engineer, mathematician, or other STEM related jobs. |
| *Actions*<br><br>*A15* | McWayne et al PICE-K (2004) – U<br>Supportive Home Learning Environment Factor<br><br>*Whiting, 2006 (Scholar Identity in Black Males: Locust of Control)* | I tell my child how I expect him/her to behave at school | I **tell** my child what I expect from him or her regarding STEM achievement in school. | |
| *Style*<br><br>*S4* | Woolfolk, 2010<br>Parenting Styles | Concept: High control, authoritarian parenting for AA yields better grades | I **communicate** very clearly my expectations to my child about his or her STEM academic success expectations. | I communicate very clearly my expectations to my child about his or her STEM academic success. |
| *Style (social Values)*<br><br>*S10* | *Frasier Identifying Traits Attitudes and Behaviors (TAB) of AA gifted students*<br><br>McWayne t al (2013) Parental Engagement for Families from Latino Backgrounds (PEFL): Supplemental Education | *Concept: Humor*<br><br>I tell stories to my child. I read stories with my child. | I often **use** humor or an entertaining approach (e.g., story-telling, role play, prose, etc.) to explain STEM concepts. | *? may load on Action also*<br><br>*I often use humor or an entertaining approach (e.g. story-telling, role play, prose, etc.) to explain STEM concepts.* |
| *Culture (Self-concept)*<br><br>*C2* | Cross, 1991 (Internalization)<br><br>*Whiting, 2006 (Scholar Identity in Black Males: Locus of Control; Need for Achievement =>need for affiliation)*<br><br>*Ford, 2013 (Female Achievement Model for Excellence: Cultural)* | **Concept**: Confident in own standard of Blackness | The skills that my family or community **value** are considered when engaging my child in STEM activities or STEM skill development. | *Values could also be an item for beliefs within practices* |

**Table 3.3.** BPSEQ-41 Instrument Development Summary

| BPSE Dimension | Item Pool/ Features | Omissions/ Combined | BPSEQ-41 | |
|---|---|---|---|---|
| **Practices** | | | | |
| ***Beliefs*** | • B1 – B5: External boundaries (5)<br>• B6-B9, B12 - B17, B20: Personal capacity, ability, efforts (11)<br>• B10-B11: Expectations & Values (2)<br>• B18, B21-B22: Microagressions/Inhibitions (3)<br>• *(B19 numbering was omitted)* | B1 combined with B10 and S1<br>B3 combined with B2<br>B5 combined with B4<br>B6 combined with B21<br>B8 combined with B7 and B9<br>B13 combined with B10<br>B14 combined with B18<br>B12, 16, 17, 20 combined with B7<br>B22 combined with C11 | PB1 (B2)<br>PB2 (B4)<br>PB3 (B7)<br>PB4 (B10)<br>PB5 (B11)<br>PB6 (B15)<br>PB8 (B21) | |
| ***Actions*** | • A1-A21(21) | A1 combined with A15<br>A2 combined with A12 and A15<br>A3 combined with A10<br>A4 combined with B18 and C7<br>A6 combined with A5<br>A7 combined with A12<br>A13 combined with S6 into S10<br>A15 combined with A16 into S4 | PA1 (A5)<br>PA2 (A8)<br>PA3 (A9)<br>PA4 (A10)<br>PA5 (All)<br>PA6 (A12) | PA7 (A14)<br>PA8 (A7)<br>PA9 (A18)<br>PA10 (A19)<br>PA11 (A20)<br>PA12 (A21) |
| **Style** | • S1, S5: Mediation/Monitor (2)<br>• S2 – S4: Communication (3)<br>• S6 – S11: Social Values (6) | S3 combined with S2<br>S6 combined with A13 into S10<br>S8 combined with S1 | S1 (S1)<br>S2 (S2)<br>S3 (S4)<br>S4 (S5) | S5 (S7)<br>S6 (S9)<br>S7 (S10)<br>S8 (S11) |
| **Culture** | • C1 – C5, C7 -10: Self-concept (9)<br>• C4: Sense of Community (1)<br>• C11-C13: Inhibitions(3) | None combined or omitted | C1 – C13 | |

**Table 3.4.** Summary of Parental Engagement Toward Student STEM Development (STEM Demographic Information)

| Student STEM Development Status | Response | % |
|---|---|---|
| **Conceptual STEM Development**<br>*PARENT engages child in STEM-related activities that influences CHILD's goal to become (or at least think of himself as) a scientist, technician, mathematician, or engineer.* | 13 | 43% |
| **Practical STEM Development**<br>*PARENT engages child in STEM-related activities BUT CHILD does not think of himself as (nor want to be) a scientist, technician, engineer, or mathematician.* | 5 | 17% |
| **Limited STEM Development**<br>*PARENT has little or no resources (money, material, knowledge, etc.) or STEM interest to support CHILD who has a high personal STEM interest* | 5 | 17% |
| **Deprived STEM Development**<br>*PARENT & CHILD has some STEM interest BUT does not consistently engage in STEM activities or adequately support STEM interest with available resources (money, material, knowledge, etc.).* | 4 | 13% |
| **NO STEM-Value Development**<br>*PARENT & CHILD has little or no STEM interest or STEM-related engagement at home.* | 3 | 10% |
| ***Total*** | *30* | |

**Table 3.5.** The Black Parent STEM Engagement Questionnaire-33 (BPSEQ-33) Instrument Development

| ITEM | BPSEQ -44 | BPSEQ -33 | Indicator Trait | X# | Statement |
|---|---|---|---|---|---|
| B2 | PB1 | N/A | **[REMOVED]** | | (B2)At school, my child is not pushed to perform at his or her academic potential in STEM classes. |
| B10 | PB4 | PB1 | **LAG** | 1 | PB1 (B10) I believe that parent engagement and learning about STEM at home are "extra steps" that are critical for my child to have STEM success at school. |
| *B11* | *PB5* | *N/A* | ***[REMOVED]*** | | *(B11) I believe that classes that teach practical STEM skills learned for everyday life (health & wellness, working on computer, accounting, etc.) will benefit my child more than classes that teach advanced STEM skills (physics, programming, data analysis, etc.)* |
| B15 | PB6 | PB2 | **Global Focus** | 2 | PB2 (B15) I believe that my level of STEM engagement will help to develop my child's STEM talent and identity for later successes. |
| B18 | PB7 | PB3 | **Global Focus** | 3 | PB3 (B18): It is important for me to engage in my child's STEM development to make sure that our values about careers, religion, ethnicity, etc. help to shape his or her positive STEM identity. |
| *B21* | *PB8* | *PB4* | ***LAG*** | *4* | *PB4 (B21): I am concerned that I do not know enough about STEM.* |
| B7 | PA3 | PA1 | **Influence** | 5 | PA1 (B7): With more information about STEM, I am confident that I can find ways at home to positively influence my child's interest and efforts in STEM. |
| A5 | PA1 | PA2 | **Influence** | 6 | PA2 (A5): When I talk to my child about his or her college or career aspirations, I promote STEM related choices. |
| A8 | PA2 | PA3 | **Exposure** | 7 | PA3 (A8): I use current events and popular/mainstream culture to discuss STEM related issues with my child on a regular basis. (e.g. news, TV, magazines, etc.). |
| A9 | PA3 | PA4 | **Influence** | 8 | PA4 (A9): I talk to my child about what I think it might be like for him or her as a scientist, technician, engineer, mathematician, or other STEM related jobs (i.e. nurse, STEM teacher, electrician, mechanic, etc.). |
| *A10* | *PA4* | *N/A* | ***[REMOVED]*** | | *(A10) I do not enroll my child in after-school and/or summer STEM learning activities because those types of programs cost too much.* |
| A11 | PA5 | PA5 | **Exposure** | 9 | PA5 (A11): I buy or bring home educational STEM materials or games for my child (e.g. flashcards, books, videos, notebooks, etc.). |
| A12 | PA6 | PA6 | **Influence** | 10 | PA6 (A12): I talk to my child on a regular basis about how important it is to learn STEM skills. |
| A14 | PA7 | PA7 | **Influence** | 11 | PA7 (A14): I make sure that my child has access to the STEM supplies s/he needs for school (e.g. calculator, Internet access, computer, etc.). |
| *A18* | *PA9* | *N/A* | ***[REMOVED]*** | | *(A18) I punish my child when his or her academic performance does NOT meet my expectations in STEM classes.* |
| A19 | PA10 | PA8 | **Exposure** | 12 | PA8 (A19): I tell stories about others that I know (historical, celebrities, personal) who have done well in STEM classes, majors, or careers to motivate my child in STEM. |
| A20 | PA11 | PA9 | **Exposure** | 13 | PA9 (A20): I encourage my child to engage one-on-one in STEM-related activities with other family, mentors, and community members. |
| *A21* | *PA12* | *N/A* | ***[REMOVED]*** | | *(A21) I try to engage my child in STEM activities that are more hands-on and how-to (e.g., building, designing, Legos, blocks) than theory-based learning (background information, definitions, equations, etc.)* |
| B4 | PB2 | PV1 | **Equity** | 14 | PV1 (B4): I set standards for my child with the expectation that he or she will have to work twice as hard to have equal access to STEM opportunities. |

**Table 3.5.** The Black Parent STEM Engagement Questionnaire-33 (BPSEQ-33) Instrument Development

| ITEM | BPSEQ -44 | BPSEQ -33 | Indicator Trait | X# | Statement |
|---|---|---|---|---|---|
| S4 | S3 | PV2 | **Style: Competitive** | 15 | PV2 (S4): I set achievement standards for my child that are competitive in nature (i.e. earn highest grades, take highest level classes, seeking out a variety of extra-curricular activities, etc.). |
| S10 | S7 | PV3 | **Humor** | 16 | PV3 (S10) I often use a visual or entertaining approach (e.g. story-telling, role play, prose, video, demonstration, etc.) to explain STEM/academic concepts to my child. |
| S11 | S8 | PV4 | **Street-wise** | 17 | PV4 (S11) I use a "common sense" approach when engaging my child in STEM activities. (real-life examples, situational learning opportunities, etc.). |
| C4 | CE1 | CE1 | **Family Pride** | 18 | CE1 (C4) STEM identity and STEM success for my child is viewed with pride as success for the family and community as well. |
| C8 | CE2 | CE2 | **Church/ Religion** | 19 | CE2 (C8): Church affiliation and/or religion play an important role in setting a foundation for my child's identity needed to succeed in STEM fields. |
| C9 | CE3 | CE3 | **Sports/ Athletics** | 20 | CE3 (C9): Successes in sporting activities and/or athletic skills play an important role in boosting my child's confidence to succeed in STEM. |
| C10 | CE4 | CE4 | **Culture: LAG Belief** | 21 | CE4 (C10): It is important for my child to understand the gaps (e.g. racial, gender, income, etc.) that exist among cultural groups in STEM in terms of their achievement, majors and careers, retention, persistence, etc. |
| S1 | S1 | (Q)S1 | **Influence** | 22 | QS1 (S1): I often encourage and discuss my child's level of motivation and efforts to help him or her to be prepared to excel in STEM subjects in school. |
| S2 | S2 | (Q)S2 | **Influence** | 23 | QS2 (S2): I communicate my beliefs about the benefits of STEM skills to my child with the clear expectation that he or she will be encouraged to develop them at school. |
| A17 | PA8 | (Q)S3 | **Parent Praise** | 24 | QS3 (A17): I praise my child as a confidence booster when his or her academic performance meets or exceeds my expectation in STEM/academic classes. |
| S5 | S4 | (Q)S4 | **Parent Monitoring** | 25 | QS4 (S5) I closely monitor my child's STEM/academic progress and success. |
| S7 | S5 | (Q)S5 | **Global Focus** | 26 | QS5 (S7) I focus on the "big picture," (e.g., STEM career awareness, general benefit of STEM major, etc.) when engaging in STEM activities with my child. |
| S9 | S6 | (Q)S6 | **Global Focus** | 27 | QS6 (S9) When engaging my child in STEM problem solving activities, I tend to focus on those with which multiple solutions are acceptable (i.e. open ended versus one correct or expected answer). |
| C1 | C1 | (Q)CN 1 | **Influence** | 28 | QC1 (C1): I provide STEM experiences for my child that I never had a chance to experience (e.g. travel, arts/ music lessons, community service, membership in organizations, etc.). |
| C2 | C2 | (Q)CN 2 | **Influence** | 29 | QC2 (C2): The skills and talents that my family or community value play an important role in how I engage in activities that support my child's STEM identity development. |
| C3 | C3 | (Q)CN 3 | **Exposure** | 30 | QC3 (C3): I promote an awareness of STEM skills and careers to my child that will enhance or benefit our community and/or family (i.e. promote connection to community, attitude of "reaching back", skills that serve, etc.). |

**Table 3.5.** The Black Parent STEM Engagement Questionnaire-33 (BPSEQ-33) Instrument Development

| ITEM | BPSEQ-44 | BPSEQ-33 | Indicator Trait | X# | Statement |
|---|---|---|---|---|---|
| C4 | C4 | (Q)CN 4 | **Experiential** | 31 | QC4 (C5): My child sees me or other family members engaged in STEM activities (e.g. nursing sick family members, fixing cars or light fixtures, problem solving TV connections, etc.). |
| C5 | C5 | (Q)CN 5 | **Communal** | 32 | QC5 (C6): My child's individual success in STEM is the result of collective efforts by supportive family members, community leaders, and/or mentors. |
| C6 | C6 | (Q)CN 6 | **Tradition** | 33 | QC6 (C7): Creating a STEM learning environment that is filled with cultural heritage is important for my child's STEM identity development. (i.e. things that represent our values, traditions, contributions, etc.). |
| *C11* | *C11* | *N/A* | ***[REMOVED]*** | | *(C11) Because my home and/or work responsibilities prevent me from volunteering at my child's school, my engagement in STEM activities with my child at home takes the place of my engagement at the school* |
| *C12* | *C12* | *N/A* | ***[REMOVED]*** | | *(C12) Going to the school, as a parent, is stressful* |
| *C13* | *C13* | *N/A* | ***[REMOVED]*** | | *(C13) I do not let my tight personal schedule prevent me from frequently visiting the school.* |

**Table 3.6** BPSEQ-41 Examination for Item Appropriateness of Good Indication of the Construct

| Dimension | Weak Indicator(s) $x < 4$ | Acceptable Indicators(s) $4 \leq x < 5$ | Good Indicator(s) $x \geq 5$ |
|---|---|---|---|
| **Beliefs** | PB1 | PB5, PB6, PB8 | PB2, PB3, PB4, PB7 |
| **Actions** | PA2*, PA4, PA5, PA9, PA10, PA12 | PA1, PA3, PA6, PA8, PA11 | PA7 |
| **Style** | *none* | S1, S2, S3, S5, S7, S8 | S4, S6 |
| **Culture** | C11, C12 | C2, C3, C4, C6, C7, C8, C9, C13 | C1, C5, C10 |

**results based on pairwise(n = 26, 27) exclusion but categorized at next level for listwise exclusion (n=26*)

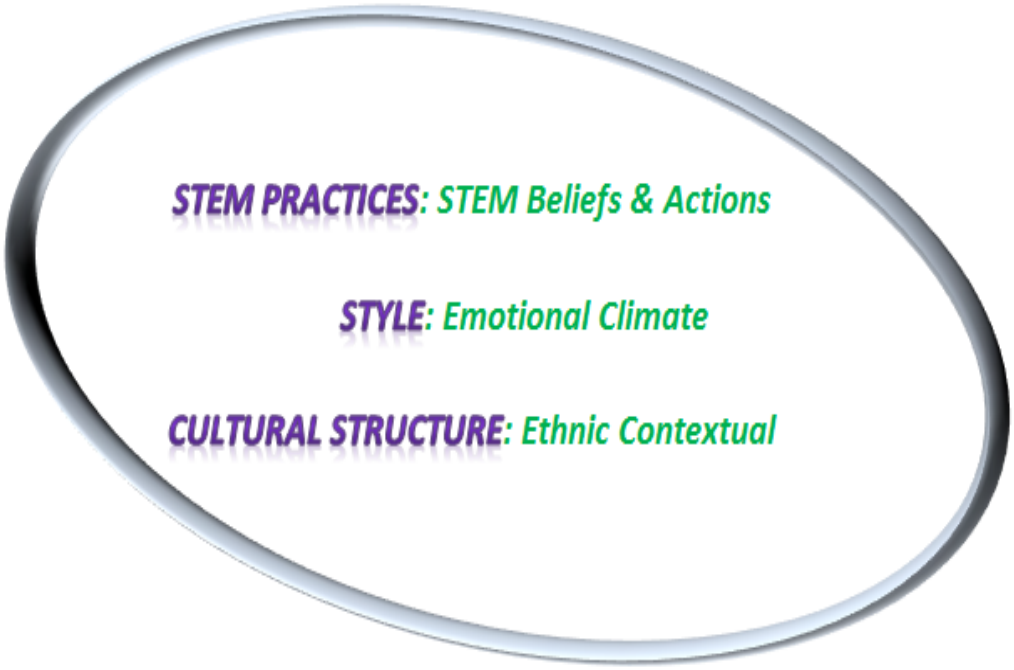


**Figure 3.1.** The Black Parent STEM Engagement (BPSE) Construct

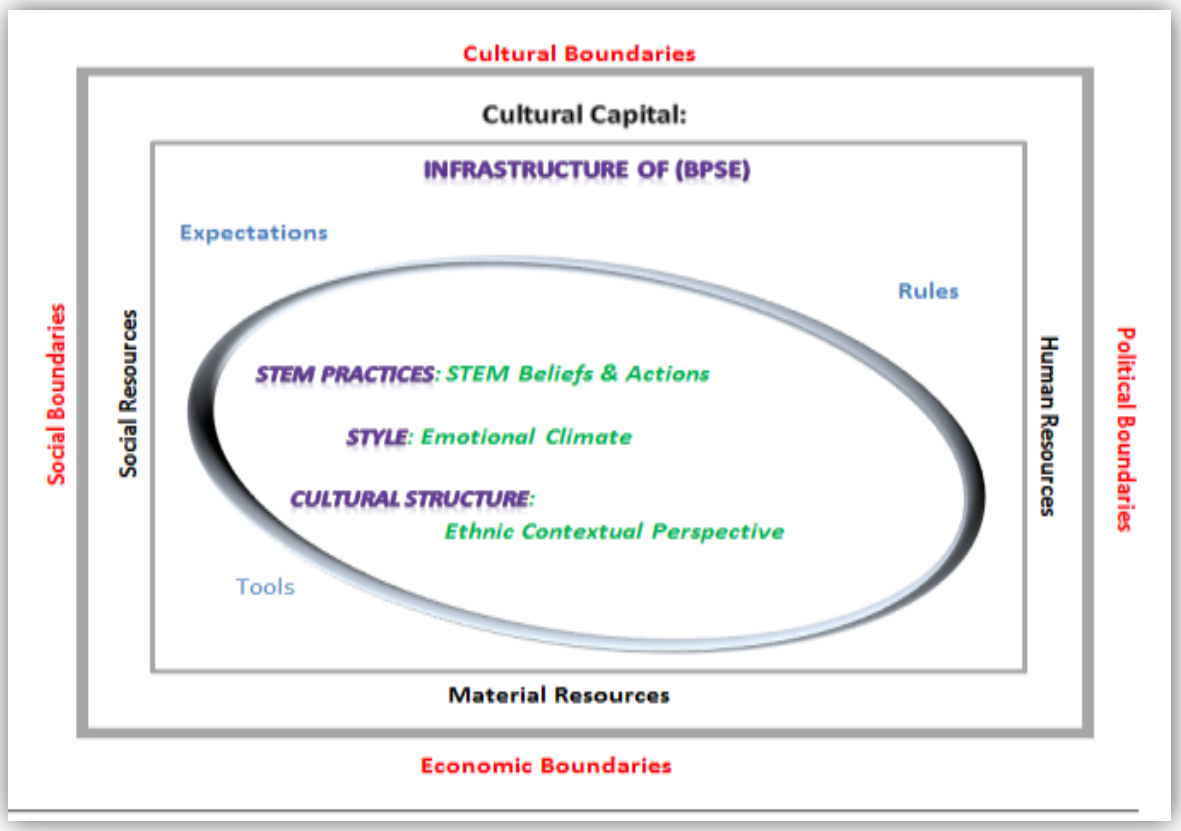


**Figure. 3.2**. Theoretical Domain of Black Parent STEM Engagement (BPSE)

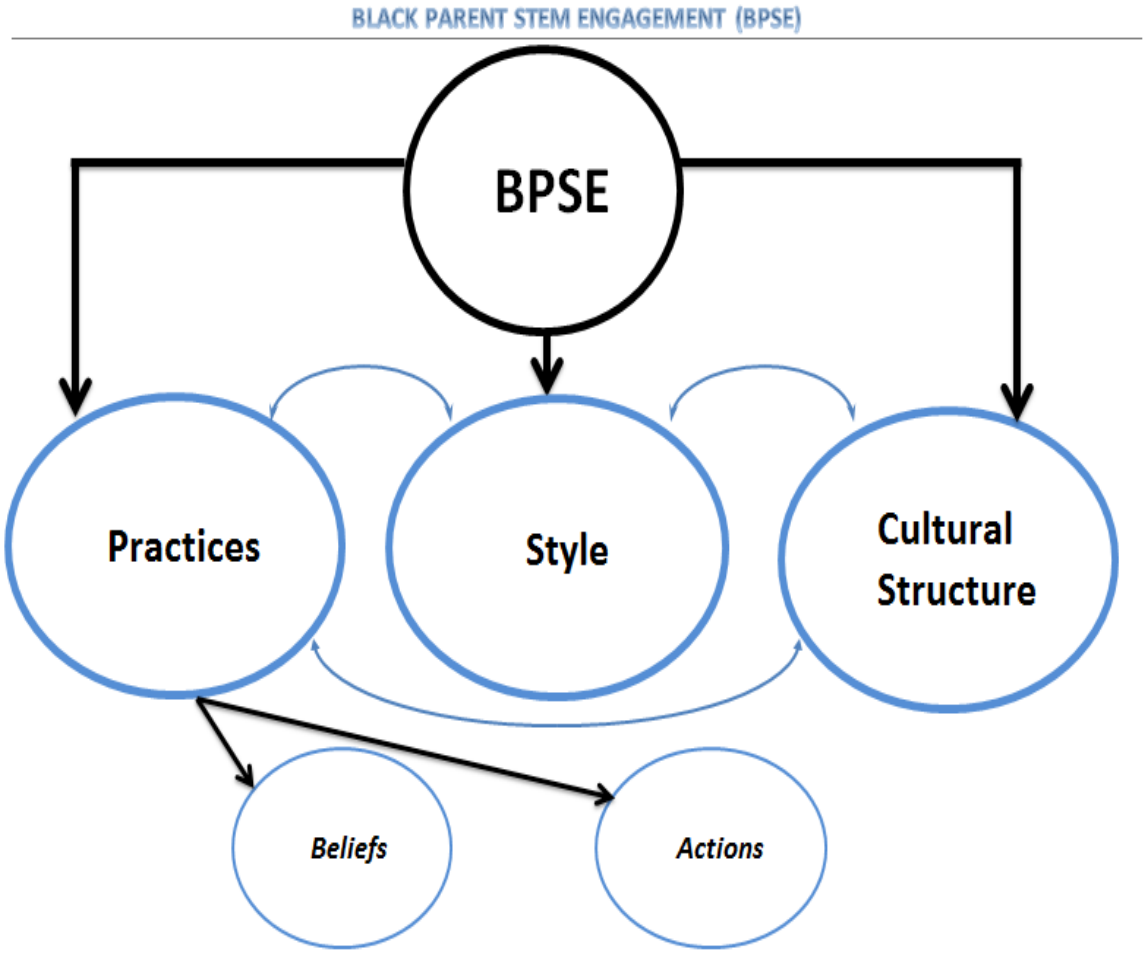


**Figure 3.3.** A Graphical Representation of the Hypothesized Structure for the Conceptual Model of BPSE

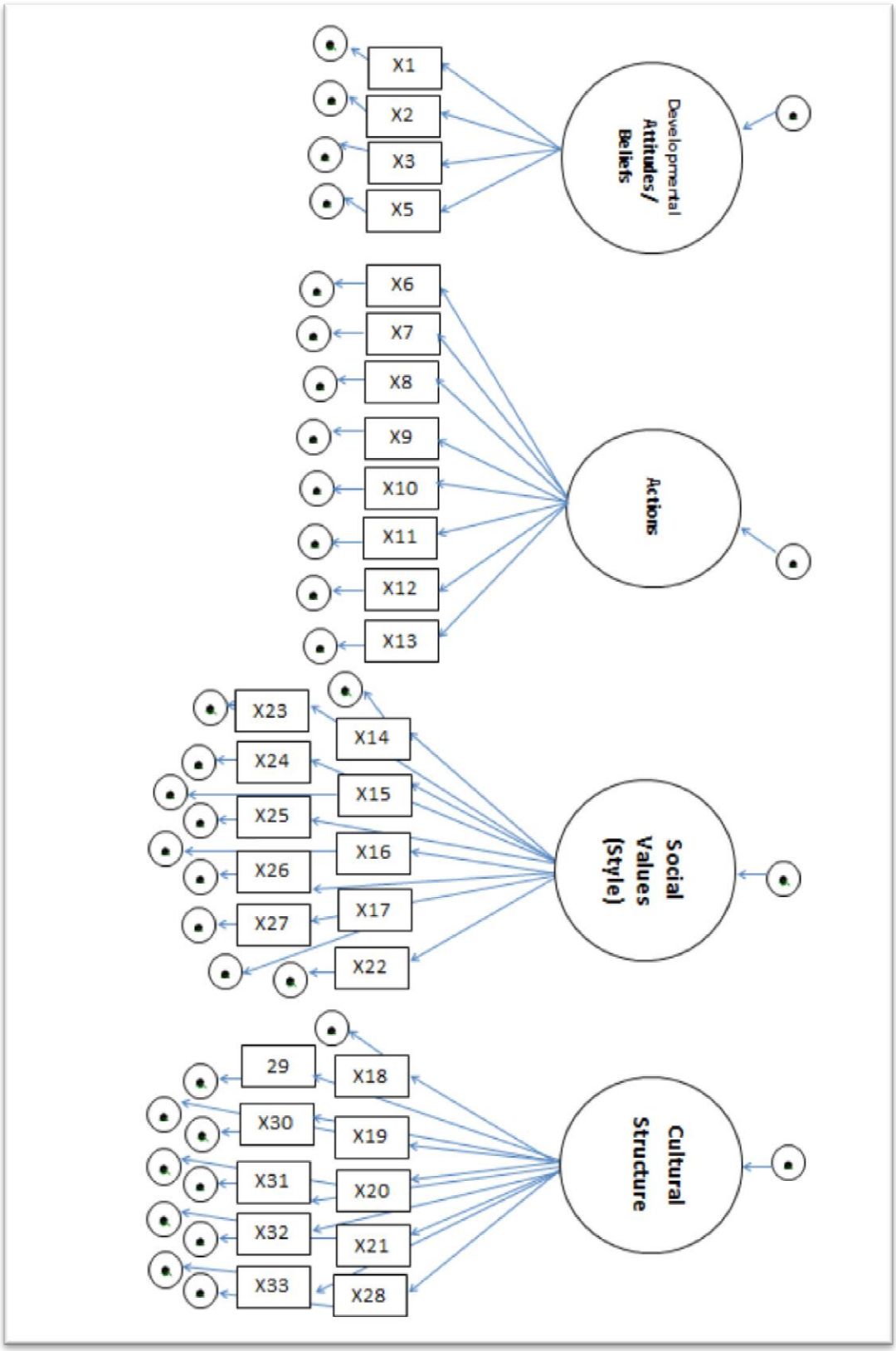


**Figure 3.4:** A priori 4-Factor Solution of BPSE, e= 1.

# Appendix

**Table 3.7a** BPSEQ-41: The Inter-item Correlation Matrix Summary (within the Dimension)*

| Item | Mean (PWE) | Mean* (LWE) | Significant Correlations (r >=.3)** | Appropriate Strength (.4<=r<.6)** | Moderately Strong (.6<=r<-.8)** | Very Strong to (.8<=r<1)** | *Sign. Neg. Correlations (-.3<=r<0)* |
|---|---|---|---|---|---|---|---|
| **Beliefs** | | | | | | | |
| **PB_1** | *3.444* | *3.423* | 2 | 1 | 0 | 0 | *0* |
| **PB_2** | **5.148** | **5.154** | 1 | 0 | 0 | 0 | *0* |
| **PB_3** | **5.370** | **5.385** | 3 | 1 | 1 | 0 | *1* |
| **PB_4** | **5.296** | **5.308** | 3 | 1 | 1 | 0 | *0* |
| **PB_5** | 4.111 | 4.115 | 0 | 0 | 0 | 0 | *1* |
| **PB_6** | 4.667 | 4.731 | 1 | 1 | 0 | 0 | *0* |
| **PB_7** | **5.333** | **5.346** | 3 | 1 | 0 | 0 | *0* |
| **PB_8** | 4.037 | 4.000 | 4 | 1 | 0 | 0 | *0* |
| **Actions** | | | | | | | |
| **PA_1** | 4.519 | 4.500 | 5 | 5 | 0 | 0 | *0* |
| **PA_2** | *3.926* | 4.000 | 6 | 4 | 1 | 0 | *0* |
| **PA_3** | 4.704 | 4.692 | 5 | 2 | 0 | 0 | *0* |
| **PA_4** | *3.741* | *3.769* | 2 | 0 | 0 | 0 | *0* |
| **PA_5** | *3.577* | *3.577* | 7 | 3 | 3 | 0 | *0* |
| **PA_6** | 4.000 | 4.000 | 7 | 5 | 2 | 0 | *0* |
| **PA_7** | **5.654** | **5.654** | 1 | 0 | 0 | 0 | *0* |
| **PA_8** | 4.500 | 4.500 | 7 | 3 | 0 | 0 | *0* |
| **PA_9** | *3.538* | *3.538* | 1 | 1 | 0 | 0 | *0* |
| **PA_10** | *3.846* | *3.846* | 8 | 5 | 2 | 0 | *0* |
| **PA_11** | 4.154 | 4.154 | 8 | 3 | 3 | 0 | *0* |
| **PA_12** | *3.731* | *3.731* | 3 | 1 | 1 | 0 | *0* |
| **Style** | | | | | | | |
| **S_1** | 4.769 | 4.769 | 4 | 4 | 0 | 0 | *0* |
| **S_2** | 4.615 | 4.615 | 5 | 4 | 0 | 0 | *0* |
| **S_3** | 4.885 | 4.885 | 5 | 5 | 0 | 0 | *0* |
| **S_4** | **5.269** | **5.269** | 2 | 2 | 0 | 0 | *0* |
| **S_5** | 4.385 | 4.385 | 1 | 1 | 0 | 0 | *0* |
| **S_6** | **5.000** | **5.038** | 2 | 1 | 0 | 0 | *0* |
| **S_7** | 4.074 | 4.038 | 5 | 3 | 1 | 0 | *0* |
| **S_8** | 4.815 | 4.769 | 3 | 2 | 1 | 0 | *0* |
| **Culture** | | | | | | | |
| **C_1** | **5.037** | **5.000** | 2 | 0 | 1 | 0 | *0* |
| **C_2** | 4.692 | 4.692 | 2 | 1 | 0 | 0 | *1* |

| Item | Mean (PWE) | Mean* (LWE) | Significant Correlations (r >=.3)** | Appropriate Strength (.4<=r<.6)** | Moderately Strong (.6<=r<-.8)** | Very Strong to (.8<=r<1)** | *Sign. Neg. Correlations (-.3<=r<0)* |
|---|---|---|---|---|---|---|---|
| **C_3** | 4.667 | 4.654 | 3 | 1 | 0 | 0 | *0* |
| **C_4** | 4.963 | 4.962 | 4 | 1 | 0 | 0 | *0* |
| **C_5** | **5.000** | **5.000** | 3 | 0 | 0 | 2 | *0* |
| **C_6** | 4.769 | 4.769 | 3 | 1 | 0 | 2 | *0* |
| **C_7** | 4.846 | 4.846 | 3 | 0 | 0 | 2 | *0* |
| **C_8** | 4.769 | 4.769 | 2 | 0 | 1 | 1 | *0* |
| **C_9** | 4.423 | 4.423 | 2 | 1 | 0 | 1 | *0* |
| **C_10** | **5.077** | **5.077** | 3 | 1 | 1 | 0 | *1* |
| **C_11** | *3.192* | *3.192* | 2 | 0 | 1 | 0 | *2* |
| **C_12** | *2.185* | *2.231* | 1 | 0 | 1 | 0 | *1* |
| **C_13** | 4.963 | 4.923 | 0 | 0 | 0 | 0 | *3* |

**listwise exclusion. Matrix not positive defined.* ***Positive Correlations*

**Table 3.7b**. Correlation Matrix Summary for Cultural Structure Items across Belief and Action Dimension

| Item | Mean (PWE) | Mean* (LWE) | Significant Correlations (r >=.3)** | Appropriate Strength (.4<=r<.6)** | Moderately Strong (.6<=r<-.8)** | Very Strong to (.8<=r<1)** | *Sign. Neg. Correlations (-.3<=r<0)* |
|---|---|---|---|---|---|---|---|
| **Belief** | | | | | | | |
| **C_1** | **5.037** | **5.000** | 1 | 1 | 0 | 0 | *1* |
| **C_2** | 4.692 | 4.692 | 1 | 1 | 0 | 0 | *1* |
| **C_3** | 4.667 | 4.654 | 2 | 1 | 0 | 0 | *0* |
| **C_4** | 4.963 | 4.962 | 0 | 0 | 0 | 0 | *2* |
| **C_5** | **5.000** | **5.000** | 1 | 0 | 1 | 0 | *1* |
| **C_6** | 4.769 | 4.769 | 1 | 1 | 0 | 0 | *1* |
| **C_7** | 4.846 | 4.846 | 1 | 0 | 1 | 0 | *1* |
| **C_8** | 4.769 | 4.769 | 1 | 0 | 0 | 0 | *0* |
| **C_9** | 4.423 | 4.423 | 0 | 0 | 0 | 0 | *1* |
| **C_10** | **5.077** | **5.077** | 2 | 2 | 0 | 0 | *0* |
| **C_11** | *3.192* | *3.192* | 3 | 2 | 0 | 0 | *0* |
| **C_12** | *2.185* | *2.231* | 3 | 2 | 0 | 0 | *0* |
| **C_13** | 4.963 | 4.923 | 0 | 0 | 0 | 0 | *1* |
| **Actions** | | | | | | | |
| **C_1** | **5.037** | **5.000** | 3 | 1 | 1 | 0 | *0* |
| **C_2** | 4.692 | 4.692 | 6 | 2 | 0 | 0 | *1* |
| **C_3** | 4.667 | 4.654 | 7 | 5 | 1 | 0 | *1* |
| **C_4** | 4.963 | 4.962 | 6 | 2 | 0 | 0 | *0* |
| **C_5** | **5.000** | **5.000** | 1 | 0 | 0 | 0 | *0* |
| **C_6** | 4.769 | 4.769 | 4 | 2 | 0 | 0 | *0* |
| **C_7** | 4.846 | 4.846 | 0 | 0 | 0 | 0 | *0* |
| **C_8** | 4.769 | 4.769 | 1 | 1 | 0 | 0 | *1* |
| **C_9** | 4.423 | 4.423 | 1 | 1 | 0 | 0 | *1* |
| **C_10** | **5.077** | **5.077** | 0 | 0 | 0 | 0 | *1* |
| **C_11** | *3.192* | *3.192* | 1 | 0 | 0 | 0 | *0* |
| **C_12** | *2.185* | *2.231* | 4 | 3 | 0 | 0 | *0* |
| **C_13** | 4.963 | 4.923 | 0 | 0 | 0 | 0 | *0* |

**listwise exclusion. Matrix not positive defined.* ***Positive Correlations*

**Table 3.7c** Correlation Matrix Summary for Cultural Structure Items across Style Dimension (8 variables)

| Item | Mean (PWE) | Mean* (LWE) | Significant Correlations (r >=.3)** | Appropriate Strength (.4<=r<.6)** | Moderately Strong (.6<=r<-.8)** | Very Strong to (.8<=r<1)** | *Sign. Neg. Correlations (-.3<=r<0)* |
|---|---|---|---|---|---|---|---|
| **C_1** | **5.037** | **5.000** | 2 | 1 | 0 | 0 | *0* |
| **C_2** | 4.692 | 4.692 | 3 | 1 | 0 | 0 | *0* |
| **C_3** | 4.667 | 4.654 | 4 | 1 | 2 | 0 | *0* |
| **C_4** | 4.963 | 4.962 | 6 | 4 | 1 | 0 | *0* |
| **C_5** | **5.000** | **5.000** | 5 | 2 | 0 | 1 | *0* |
| **C_6** | 4.769 | 4.769 | 4 | 2 | 2 | 0 | *0* |
| **C_7** | 4.846 | 4.846 | 4 | 2 | 0 | 1 | *0* |
| **C_8** | 4.769 | 4.769 | 1 | 1 | 0 | 0 | *0* |
| **C_9** | 4.423 | 4.423 | 1 | 0 | 0 | 0 | *0* |
| **C_10** | **5.077** | **5.077** | 0 | 0 | 0 | 0 | *0* |
| **C_11** | *3.192* | *3.192* | 1 | 0 | 0 | 0 | *0* |
| **C_12** | *2.185* | *2.231* | 1 | 1 | 0 | 0 | *0* |
| **C_13** | 4.963 | 4.923 | 0 | 0 | 0 | 0 | *0* |

**listwise exclusion. Matrix not positive defined.* ***Positive Correlations*

**Table 3.7d** Correlation Matrix Summary for Style Items across Belief Dimension and Action Dimension

| Item | Mean (PWE) | Mean* (LWE) | Significant Correlations (r >=.3)** | Appropriate Strength (.4<=r<.6)** | Moderately Strong (.6<=r<-.8)** | Very Strong to (.8<=r<1)** | *Sign. Neg. Correlations (-.3<=r<0)* |
|---|---|---|---|---|---|---|---|
| **Belief** | | | | | | | |
| **S_1** | 4.769 | 4.769 | 1 | 0 | 0 | 0 | *0* |
| **S_2** | 4.615 | 4.615 | 2 | 0 | 0 | 0 | *0* |
| **S_3** | 4.885 | 4.885 | 0 | 0 | 0 | 0 | *1* |
| **S_4** | **5.269** | **5.269** | 1 | 0 | 0 | 0 | *1* |
| **S_5** | 4.385 | 4.385 | 1 | 0 | 0 | 0 | *0* |
| **S_6** | **5.000** | **5.038** | 1 | 0 | 0 | 0 | *0* |
| **S_7** | 4.074 | 4.038 | 5 | 1 | 1 | 0 | *0* |
| **S_8** | 4.815 | 4.769 | 1 | 0 | 1 | 0 | *0* |
| **Action** | | | | | | | |
| **S_1** | 4.769 | 4.769 | 9 | 5 | 2 | 0 | *0* |
| **S_2** | 4.615 | 4.615 | 8 | 4 | 2 | 0 | *0* |
| **S_3** | 4.885 | 4.885 | 6 | 3 | 0 | 0 | *0* |
| **S_4** | **5.269** | **5.269** | 2 | 0 | 0 | 0 | *0* |
| **S_5** | 4.385 | 4.385 | 1 | 1 | 0 | 0 | *0* |
| **S_6** | **5.000** | **5.038** | 0 | 0 | 0 | 0 | *0* |
| **S_7** | 4.074 | 4.038 | 7 | 4 | 0 | 0 | *0* |
| **S_8** | 4.815 | 4.769 | 4 | 2 | 0 | 0 | *0* |

**listwise exclusion. Matrix not positive defined.* ***Positive Correlations*

**Table 3.7e** Correlation Matrix for Actions X Beliefs

| Mean* | | 3.423 | 5.124 | 5.385 | 5.308 | 4.115 | 4.731 | 5.346 | 4.000 |
|---|---|---|---|---|---|---|---|---|---|
| | **Item** | **PB_1** | **PB_2** | **PB_3** | **PB_4** | **PB_5** | **PB_6** | **PB_7** | **PB_8** |
| 4.500 | **PA_1** | .270 | -.086 | .336 | .107 | -.256 | -.012 | .060 | .077 |
| 4.000 | **PA_2** | .236 | .366 | .073 | -.176 | .186 | .000 | .198 | -.190 |
| 4.692 | **PA_3** | .391 | .190 | **.525** | **.522** | -.243 | .120 | .346 | **.467** |
| *3.769* | **PA_4** | .133 | .245 | -.108 | .108 | .455 | -.224 | .065 | -.197 |
| *3.577* | **PA_5** | .385 | .384 | .337 | .259 | .024 | .073 | **.505** | .209 |
| 4.000 | **PA_6** | .288 | .029 | .230 | .221 | -.136 | -.051 | .331 | .279 |
| 5.654 | **PA_7** | .086 | -.042 | **.573** | **.406** | *-.313* | -.083 | .011 | -.046 |
| 4.500 | **PA_8** | .028 | -.027 | -.140 | -.235 | .204 | -.012 | .170 | -.254 |
| *3.538* | **PA_9** | .001 | .188 | *-.335* | -.285 | -.047 | *-.477* | -.071 | -.130 |
| *3.846* | **PA_10** | .354 | -.012 | .220 | .161 | .070 | .181 | .316 | -.082 |
| 4.154 | **PA_11** | .271 | **.473** | .335 | .298 | -.098 | .189 | .176 | -.202 |
| *3.731* | **PA_12** | .155 | .549 | .087 | .377 | .260 | .067 | .050 | -.151 |

**listwise exclusion Matrix not positive defined.*

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# CHAPTER 4

# MEASURING BLACK PARENT STEM ENGAGEMENT: TOWARD A MODEL OF CONTEXTUAL RESEARCH AND MULTIDIMENSIONAL ASSESSMENT OF PARENTING PRACTICES, STYLES, AND CULTURE[3]

[3] Collins, K.H. *To be submitted to Roeper Review*

**Abstract**

Addressing the achievement gap between Black and White students in science, technology, education, and mathematics (STEM), the term STEM pipeline is increasingly being used to refer to the STEM practices and initiatives at different levels of student development and how they connect to each other. The basis for this research is framed with the perspective of parent as first teacher. As such, it posits that parent STEM engagement begins the process of fostering a STEM identity among students that is critical for further talent development in their formal educational development. To better understand the practices of Black parents that effectively foster STEM identity among their students, this study examines the STEM practices of Black parents within the context of their own culture. Findings reveal that Black parent STEM engagement (BPSE) is characterized by the beliefs and actions that make up their practices, complemented by a cultural style and environment that are very well connected and correlated. The results offer important information about culture as practice that can inform formal educational structures and STEM implementation of STEM initiatives meant to provide a culturally responsive curriculum.

*Keywords: Black parent STEM engagement questionnaire, Black student STEM development, Confirmatory factor analysis, Structured equation modeling, Culture as practice, STEM talent development*

In 2012, The Bureau of Labor Statistics projected that the 3.5 million jobs in computer and mathematical disciplines identified in 2010 with grow by an additional 778,000 new jobs by

the year 2020. They predicted, however, that there will not be enough qualified candidates to fill these positions with minorities particularly underrepresented (Hughes, 2012). There have been an abundance of calls to action and various strategies attempting to address our science, technology, engineering, and mathematics (STEM) crisis with interventions from STEM-focused grants to state-implemented school certifications to enrichment programs aimed at our most gifted and talented students.

Most educational and teacher-implemented interventions seek to promote an increase in STEM interest and aim to recruit underrepresented students in STEM. These efforts of motivation rely on the behavioral approach, which utilizes extrinsic means of incentives and rewards to motivate or influence habits or tendencies to act in certain ways. Students differ in diversity, so they also differ in their "needs, goals, interests, emotions, and beliefs" (Woolfolk, 2010, p.407) and therefore when used as a singular approach, behavioral approach is ineffective. Reflective of motivational components (Eccles, Wigfield, & Schiefele, 1998 as cited in Eccles & Wigfield, 2010) and self-concept & identity as described by Woolfolk (2010), students internalize four basic questions that influence their motivation to learn in [STEM] areas:

1. Can I succeed in [a STEM field] (competence)?
2. Do I want to succeed in [a STEM field] (value/interest)?
3. What do I need to do to succeed in [a STEM field] (ability)?
4. Do I belong in [a STEM field] (identity)?

(Woolfolk, 2010, p.408).

The answers to these questions for most Black students involve construction of an academic/scholarly identity that greatly influences the way in which they "come to understand [themselves] within and in relation to the institution of schooling" and consequently shape their

"self-perceptions of efficacy, ability, and success" (Hatt, 2012, p. 439). This construction has consequences related to Black parent engagement, "teacher expectations, student academic identity development, and schooling inequities" (p. 438).

Honing in on the parent engagement piece, Noble and Morton (2013), in their study regarding mathematical outcomes on NAEP (National Assessment of Educational Progress) as the outcomes relate to parental and individual experiences, urged that "the focus must shift away from achievement gaps to the realization of these students' academic potential" (p.35). Based on the gaps in the literature and the skewed research grounded in deficit-thinking, this study is initiated based on the conclusion that the biggest STEM issue related to Black students is the type of prevalent research that act as an intellectual position for the status of Black student STEM identity. The literature reveals a disproportionate amount of research on the deficiency of Black student achievement in comparison to Whites and Asians. These dominant research perspectives position Black children with an association of failure as a norm that perpetuates negative stereotypes (stereotype threat). Noting this as a disservice to our children in of itself, Noble and Morton (2013) contended that it would be possible to design educational policies to impact the mathematical literacy of Black students if there was a deeper understanding of the mathematical performance in relation to their interest. This, they felt, would ultimately influence "participation and achievement in advanced mathematics courses, leading to increased readiness for college and increased participation in STEM fields" (p.31).

As such, this study sought to increase awareness in Black student STEM talent development from the closest source, ecologically speaking, to the student. A critical review of the literature revealed that the home-school relationship may be one of the most underused strategies for improving student STEM achievement. Yet, findings reveal that parents, as the

student's first teacher, play a significant role in shaping the identity that supports students' STEM talent development. Empirical research has shown that effective parent engagement can bridge the gap between formal and informal learning to forge a culturally responsive curriculum and integrated learning community. Positing that the home and the community is the foundation to develop a strong Black student STEM identity, the central focus of this study is the measurement of the multidimensional attributes of Black parent STEM engagement that fosters the child's earliest and constant development of a STEM identity and talent.

## The Black Parent STEM Engagement (BPSE) Construct

In a previous study of BPSE, a critical review of the literature on the historical importance of Black family engagement, Black student STEM identity, and gifted and talent development was conducted. I sought to identify unique characteristics and factors of Black parent STEM engagement that may contribute to the development of STEM self-concept and achievement among Black students who have shown interest and/or exhibited gifts and talents in STEM discipline. The Black parent STEM engagement construct was conceptualized based on key theories related to those topics.

Illustrated in Figure 4.1, the Black parent STEM engagement construct is defined and characterized by the following theoretical domains:

(1) STEM specific, goal-directed **practices** – those specific behaviors (beliefs and actions) that foster the student STEM competence and interest.

(2) **Style** of parenting – the emotional climate in which parenting behaviors, or activities are expressed.

(3) **Cultural structure** of parenting – the environmental and ethnic, contextual perspective of the parent-child interaction.

(Collins, 2015a)

[Insert Figure 4.1 here]

**Measuring Black Parent STEM Engagement**

The measurement and findings of BPSE from the parent's point of view offers an opportunity to identify that which is valued most by the parents and inherently ingrained as distinct characteristics of Black students' STEM identity. *The Ecologies of Parent Engagement* model framed within critical race theory (CRT) and Bronfenbrenner's view of ecology (EPE; Barton, Drake, Perez, St. Louis, & George, 2009) provided a source for contextual examination and consideration of the beliefs and actions of everyday social behavior, or practices of Black parent STEM engagement. These beliefs and actions influence the decisions of what and why parents do what they do. Barton's terminology is drawn from Pierre Bourdieu's (1977) Culture as Practice framework (Barton, 2009; Prasad, 2005) and Moll's Funds of Knowledge framework (Amaro-Jiménez & Semingson, 2011; Moll, Amanti, Neff, & González, 1992; Tan & Barton, 2010; Wright, 2011). Studied empirically, this is comparable to Coolahan et al (2002) parenting behaviors and styles (Coolahan, McWayne, Fantuzzo, & Grim, 2002).

**The Black Parent STEM Engagement Instrument (BP-SEQ)**

Grounded in theories of ecological student development and culture as practice, the newly developed instrument – Black Parent-STEM Engagement Questionnaire (BP-SEQ) - was used as to confirm the Black parent STEM engagement (BPSE) construct (Collins, 2015b). The BP-SEQ utilized a 6-point Likert-scale rating, ranging from strongly disagree to strongly agree. Findings in the pilot study (Collins, 2015b) supported the theoretical construct of BPSE (Collins, 2015a) among gifted and talented Black students in a STEM-focused, school-within-a-school, magnet program that is multidimensional with cultural structures, beliefs, actions, and style of engagement.

Utilizing the Standards for Educational and Psychological Testing as a guide to provide evidence for construct validity (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1999), the BP-SEQ instrument underwent appropriate rigor to ensure internal and external validity for the purpose of confirming the theoretical domain and structure of BPSE. With an original item pool of 66 variables to represent the BPSE construct, 41 items were retained and implemented as the BPSEQ-41 (Collins, 2015b) in a pilot study to a smaller sample (n = 38) of the total population represented in this study. The smaller study focused on the high school development stage of Black students enrolled in a STEM focused, magnet program designed for gifted and talented students. STEM success and achievement was evident by their continued enrollment in the program as determined by academic achievement in STEM classes (85% or higher) and 10 hours of required parent involvement that supports the goal of the program. The BPSEQ-41 used in the pilot study was systematically reduced to 33 indicators. It is important to note that the BPSE construct was developed and examined independently from the standards of institutionalized

education; it is studied within the context of the cultural environment of Black value systems. Studied and validated within the context of the home and community removes the perceived deficits of intellectual value when compared to white counterparts (Bandura, 1977 as cited in Woolfolk, 2010; Radin & Kamii, 1965 as cited in Coolahan, McWayne, Fantuzzo, & Grim, 2002; Wright, 2011).

The BPSEQ-33 contains 33 variables, with four comprising developmental attitudes/ beliefs (Factor 1) that address parents' global focus in their STEM engagement practices while the other two were related to parent's belief about parenting influences on the student's STEM interest and perceptions of systematic lag by dominant social practices that Black students must counteract in their STEM development efforts. Eight (8) variables comprised an action component (Factor 2) with half of those related to actions parents take to influence STEM interest and the other half being actions taken to expose students to STEM. The approach for STEM practices are represented by the style factor (Factor 3) with 10 variables comprising underlying social values that favor an influential style of parenting. It encompasses constant monitoring and praise as well as learning that is commonsensical, global in nature, competitive, and visual. Concerns about inequality also influence the emotional climate in which Black parents raise their children. Lastly, cultural structure (Factor 4) that embodies the everyday practices and dispositions of Black parents. It is comprised of 10 variables that highly influence engagement due to strong affiliations (i.e. church, community, sports, etc.), family pride, value for tradition, and a history of experienced inequality. Correlations among the factors and variables are assumed. The statements from the BPSEQ-33 that represent these indicators are provided in Table 4.1.

[Insert Table 4.1 here]

## Purpose of the Study

The purpose of the study was to provide further examination of the relationship between the dimensionality of the BPSEQ-33 with a bigger population across representative developmental ages and other magnet programs to include a more diverse group of parents within the same district. Factor analysis was used to further examine the factor structure and its psychometric properties for measurement variance and invariance (fit with a sample from a bigger/different population). Confirmatory factor analysis was used to examine other possible solutions to determine the model of best fit. I only eliminated the 9 items that were identified as weak indicators (respondent mean less than 4) and/or correlated poorly with other variables within that same dimension. In addition, I sought answers for the following research questions:

1. What do Black parents' views about their STEM engagement reveal about their practices?
2. To what extent does the cultural structure of BPSE influence the practices and style of BPSE?
3. Does BPSE have characteristics distinct from other ethnic groups?

## Methods

The methodology for data collection and analysis that was implemented and rigorously validated in the pilot study for the implementation of the BPSEQ-41 instrument (Collins, 2015b) was replicated as much as appropriate. IBM SPSS 21 was used for testing the exploratory factor

analysis (EFA) and Mplus version 7 (Muthen & Muthen) was used for testing the confirmatory factor analysis (CFA).

**Participants**

Participants for this study involved a wider audience from the pilot study (Collins, 2015b) sample of high school gifted and talented students. It also included other identified gifted students and/or students who are enrolled in a parent involvement thematic school. The invitation to participate was open to all parents within the same Title 1, rural school district in Georgia. Criteria for selection included parents of high ability students identified as gifted, K-12; currently taking high school AP, and/or dual-enrollment STEM courses, 9-12; and thematic magnet programs - parent themed school, K-8; liberal arts focused magnet program, 9-12; accelerated STEM academy, 9-12; and state-endorsed STEM career pathway academy, 10-12. Criteria for selection to complete the BP-SEQ were parents of identified high ability and gifted students who were 1) accepted and enrolled in a school-within-a-school enrichment program and 2) show evidence of STEM persistence or continued STEM interest in related academic interest, selection and/or achievement. Evidence of achievement is presumed by their continuance in the program which has its own criteria that includes, but not limited to, academic achievement at 85% or above in STEM courses. These criteria for selection allowed for an examination of BPSEQ-33 factor structure across student development levels, gender, program, and ethnicity to also conduct measurement invariance studies.

As an incentive for participating in the study and to allow for an analysis of individual responses, parents who completed the BPSEQ-33 were invited to participate in a parent STEM awareness workshop to further discuss items that were presented in the survey. In addition to the

items representing the dimensions of BPSE, common terms related to STEM as well as a mapping of their "STEM development status", similar to Archer et al family relationship to science (Archer et al, 2012), was included at the beginning of the instrument along with other demographic information. Participants were asked to reflect on the thought processes, ideas, questions, etc. that they engaged in while completing the survey.

**Demographic background.** There were a total of 66 parents that participated in the online survey. Mothers represented 73% (43) of those that identified their parenting role along with 11 fathers, two legal guardians, two other (extended kinship), and one identified as a primary caregiver that did not have legal custody of the student. There were none that identified themselves as grandparents. These ranges of people who are parenting our students speak to one of the cultural structures of the BPSE domain – a value for extended parenting. Developmentally represented, 20 had children in elementary school that had either been identified as gifted or attended the parent-involvement thematic school. Three (3) completed the survey based on their interactions with their middle school child and the remaining 36 (excluding 7 unanswered) were parents of high school students with 29 of them enrolled in academic AP courses. Parents of multiple children were asked to complete the survey based on the student who exhibits the most interest and better achievement in STEM discipline and related activities. Female students accounted for 59% of the parents that participated the in the survey. Of the 35 who had students that had been identified gifted, only 14 of them still participate in programs designed exclusively for gifted student development. There were 6 parents that reported their ethnic background to be something other than Black and/or African American. Whiles their responses will not be included in measurement of the structure design and factor analysis for BPSE, the data does provide additional, comparative information.

After answering basic demographic information, parents were asked to provide information related to their familiarity with STEM prior to answering the questions regarding the specific BPSE construct. These set of questions were included to measure prior knowledge but also to provide participants with a description of key terms that they would read as they finished the survey. Across all developmentally levels and consistently so, a little over 50% of the parents were familiar with terms such as parent STEM engagement, STEM skills, STEM concepts STEM classes and STEM careers. Choosing a status by which to identify themselves and their child, parents also self-selected the STEM identity status that best described them and their child. Lastly, they were asked to the best definition that generally described type of STEM practices they feel they engage in at home.

It is important to reiterate that these questions are three-fold in purpose; they provided some background information on the participants that can also be used as evidence of construct validity because the questions give insight into respondents process (Benson, 1998) of thinking the for actual survey. In addition, as outlined in Table 4.2, they provide some awareness and explanation to some key STEM terms for the reader as it relate to identity and development. The majority (43%) of the parents that completed this part of the survey reported that they are engaged in conceptual STEM development with their children.

[Insert Table 4.2 here]

**Data Collection & Analysis**

Most of the selected parents were invited to participate in the study by an email invitation to their dedicated distribution list for the qualifying program or class in which their child was

enrolled. Others were contacted through posted fliers at the various schools, dedicated social media sites that targeted parents of local gifted and STEM students, word of mouth by parents that knew each other in their program, and/or during STEM workshops that were conducted during the period of time that the related study was underway.

**Analysis logic and procedure.** Descriptive statistics (i.e. mean, median, variation, standard deviation, correlations, etc.) was used for initial examination of items as appropriate indicators of the BPSE construct and for internal consistency. With a Likert scale ranging from 1 -6, strongly disagree to strongly agree, a favorable mean for items for the BPSEQ-33 is one that is affirmative toward the theoretical characteristics of the BPSE construct. As such, a mean of 5 or higher was desirable as a good indicator, 4 was acceptable, and any mean less than 4 was considered a weak indicator.

Structured equation modeling (SEM), a multivariate statistical technique, was used to examine the 4-factor model revealed in the pilot study (Collins, 2015b). SEM is a scientific model that is both structural and measurable to support the quantitative aspects the BPSE construct and its variables. It is an appropriate approach to examine the (assumed) linear relationships between variables, to examine the internal structure, and for the small sample size. SEM allowed for the combined analysis of factors and the path of the observed variables linked to those factors (Benson, 1998; Crocker & Algina, 1986). In addition, confirmatory factor analysis (CFA) using Mplus 7.0 (Muthen & Muthen) served as a method to test other empirical models to ensure goodness of fit and to identify any sources of construct irrelevancy (systematic variability not related to the theoretical domain; Benson, 1998). In addition to the chi-squared test of model it, several indicators of fit were used to determine goodness of fit for the most appropriate model; they included the comparative fit index (CFI), Tucker-Lewis fit index (TFI) –

also known as the non-normed fit index (NNFI), standardized root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), and information criteria (akaike, AIC and Bayesian, BIC). Information criteria were used for non-nested model comparison only.

According to best practices for confirmatory factor analysis, tests of model fit are recommended to meet the following parameters: (1) a low chi-square test which is more indicative of the null hypothesis or test currently being tested; otherwise the model is saturated. For a relative chi-square divided by the degrees of freedom, a value of 3.0 or less signifies a good fit as a rule of thumb (2) information criteria (AIC/ BIC) for comparison purposes, the smaller the better; and (3) indices for a)RMSEA close to model when less than .05, reasonable between .05 and .08 and bad fit for values greater than .1; b) SRMR indicates a good fit with value less than .08 and a perfect fit at zero; c) CFI/TLI indicates an acceptable model for values between .90-.95 with confidence interval preferred percentage of 95%-97%. These criteria were used to evaluate and compare results.

## Results

### Descriptive Statistics

In addition to the participant demographic information provided above, individual responses were also examined based on income levels and developmental levels. Generally speaking, the school district from which the participants' children are enrolled has been established as a Title 1 school, which means that the majority of its population receives free or reduced lunch. This information implies that most of the community members are low income citizens. In addition, parent engagement varies at a child's different developmental stages. An

elementary child depends more on their parents as it relate to communication and involvement with day-to-day academic activities that may lessen as the child grows and reaches middle and/or high school. I wanted to report any variances that might be associated with income and developmental stages that are not considered in the BPSE model. Extracted only responses from parents that self-identified themselves Black or African American, Table 4.3 summaries the means for each statement provided in the BPSEQ-33 instrument.

[Insert Table 4.3 here]

Overall, respondents who reported their income to be less than $40,000 and had children in elementary school (ES) exhibited STEM engagement practices that were least like those identified in previous empirical studies and in expected theoretical ways. Their overall mean was 3.94 (below the agreement ratings) while all other parents with ES students at higher reported income levels were greater than 4 (somewhat agree). Parents with an income level greater than $150,000 had the highest mean at 5.41. However, for developmental stage without any consideration for income, elementary school parents responded, on average, in more expected ways (mean = 4.93). It should be noted that the middle school data is reported but only 7 parents identified themselves with children at this developmental stage and therefore may not be representative in comparison to the number of elementary and high school parents that participated in the study. Only one statement (X4 in Table 4.1, DontKnowSTEM) consistently had means that were not favorable as a representation of BPSE for this population; findings revealed that these parents were not concerned with their own knowledge of STEM as a deficit and issue related to fostering STEM interest. Yet, they did consistently report that they believed

if they had more information about STEM they could positively influence their children's STEM interest and talent development. Therefore, this statement (X4) was removed from the final BPSE model.

**Exploring the Factor Structure of BPSE**

The purpose of the factor analysis was to explore the observed factor structure revealed from the responses to the BPSEQ-33 by the participants to see if it matches the theoretical factor structure in expected ways. I ran an analysis of the data utilizing the principle component extraction method. Based on the eigenvalues greater than zero (0), seven factors represented approximately 79% of the total variance. Extracting the sum of squared loadings, Factor 1 accounted for a most of the variance (46.7%) along with Factor 2 (8.6%), Factor 3 (6.6%), and Factor 4 (5.7%), to account for 67.7% of the cumulative variance. A rotation (promax method with Kaiser normalization) of the factors for the purpose of optimizing the structure yielded seven factors also, but with the first factor now accounting for only about approximately 13.6% of the total variance. This occurs as the rotation tries to equalize the identified factors (Crocker & Algina, 1986; Field, 2009) with Factor 2 (11.3%) and Factor 3 (10.6%). Factor 4 only accounted to 5.7% of the variance. Further investigation of the scree plot, as shown in Figure 4.2 below, reveals points of inflexion, or stabilization at 3 and 5 with slight drops in eigenvalues representing instability of the curve at Factor 2 and Factor 4. Based on this, there was justification for retaining only Factors 1 - 4 as theorized (beliefs, actions, style, and cultural structure) and found in the pilot study. Thus, all items except variable, X4, that were correlated with other indicators within their hypothesized domain (Crocker & Algina, 1986; Field, 2009) and with factor loadings greater than .30 (Boyle, 1985 as cited in McWayne et al, 2013) were

retained. X4 was related to the parent's lag belief that s/he was afraid that s/h did not know enough about STEM was removed, and this was not the case for this population (overall somewhat agreement mean of 3.92).

[Insert Figure 4.2 here]

After interpreting the factor structure based on the eigenvalues and the scree plot, I reran the data using the same method but this time restricting the factor solution to 1, 2, and 3-factor solutions to further compare the factor structures to the theorized 4-factor solution. Based on this analysis, only the 1-factor solution seemed as feasible as the 4-factor solution. For the 1-factor solution, all variables loaded favorably onto the factor. As shown in table 4.4, the items also held a high inter-correlation and mean for the variables, suggested However, as shown in Table 4.4, several of the items held low communality scores (less than .5) which indicated variance in each item explained by those extracted variables was very small.

[Insert Table 4.4 here]

The pattern and structural and structural matrices were also considered. Factor loadings for the 3 factor restriction did not load very well in comparison to the 2-factor and 4-factor solution. The pattern matrix for the 2-factor, shown in table 4.5, solution loaded fairly well but did not match the suggested variable loadings of the 2-factor solution, 10 variable option based on favorable means and correlations as offered in the pilot study(Collins, 2015b).

[Insert Table 4.5 here]

**Testing a Priori Factor Structure of BPSE**

As a result, I ran the 4-factor hypothesized model (Figure 4.3) and 1-factor model simple solution (Figure 4.4) for comparison of best fit using confirmatory factor analysis (CFA).

[Insert Figure 4.3]

[Insert Figure 4.4]

Subsequently, several variations of the 4-factor solution model were also tested as model fit indices were interpreted. Of these six models, model 3 (chi-square=1577.319, df =443, p=.000, RMSEA = .197) and model 6 (chi-square=1340.293, df =420, p=.000, RMSEA = .182) showed the better fit among them. Table 4.6 provides CFA results of estimates for both. A summary for models 1-6 are outlined in Table 4.5 and further explained.

**Model 1.** Model 1 (chi-square=1910.647, df =462, p=.000, RMSEA = .218) was the 4-factor solution model with all four factors standardized at error = 1 without the X4 statement, "I am concerned that I do not know enough about STEM" because it is not indicative of the beliefs of this population. The style indicator, X14, that is influenced by beliefs regarding equity issues, "I set standards for my child with the expectation that he or she will have to work twice as hard to have equal access to STEM opportunities" was restricted to Factor1, the belief factor.

**Model 2**. Model 2 (chi-square=1874.458, df =462, p=.000, RMSEA = .215) was the 4-factor solution as described in Model 1 with the only difference being that X14 was restricted to load onto the style factor. Even though the statement is based on perceived injustices that the

child will face, this statement is considered a style indicator because of the expectation to obey and carry out an explicitly stated rule or standard without further instruction or reminder. This style of communication has social relevance and coincides with other inequalities that parents are concerned with as it relates to their child interacting outside of the home and the community. As one parent noted in one of the STEM workshops that I held for participants, they have to have the whole child in mind when they are setting standards of behavior and academics. Others agreed with another parent noting that it could mean life or death for their children, so she does not have time to negotiate with them regarding what she knows is best for them; when they say it, they mean it and expect them to do it – no questions asked.

**Model 3**. Model 3 (chi-square=1577.319, df =443, p=.000, RMSEA = .197) contains the 4-factor solution similar to Model 2 without X4 (lag belief of parent knowledge) and with X14 (manner of engagement that is situated around the equity issues that Black people face) regressed on the Style Factor, but distinct from Model 2 in that it included select correlations among observed variables as recommended in the CFA output. Including these correlations reduced the chi squared value from 2013.234 to 1991.309, indicating an increase in model-data fit.

**Model 4.** Since the 1-factor solution emerged as feasible option, I wanted to examine the model as a derivation of both models with the belief and actions dimension regressed onto practices as an identified factor at the same level of style and cultural structure. Each of these three was then regressed on a single factor, BPSE. This proved to be the least fitted model with the highest value for chi-squared (chi-square=2091.880, df =464, p=.000, RMSEA = .231).

**Model 5.** As another variation of Model 2 as recommended in the CFA output, model 5 (chi-square=1842.793, df =434, p=.000, RMSEA = .222) standardized the factors at error =1 and restricted correlation between the style and cultural structure factor.

**Model 6**. Using simple structure, model 6 (chi-square=1340.293, df =420, p=.000, RMSEA = .182) included 1-factor model solution with Black parents STEM engagement (BPSE) as the single factor on which all of the variables converged.

[Insert Table 4.6 here]

[Insert Table 4.7 here]

## Discussion

Strictly speaking, the p values (p=.000<.05) of the model fit test for model 3 and model 6 suggest that the tested structure should be rejected. However, based all of the information from the analysis that was taken into consideration, both of these structures for the BPSE construct do offer insight into the dimensionality of BPSE. Based on the nature of the variables and the close association of social and cultural structures, it was expected that the variables were strongly correlated but no correlations were presumed in the model for the CFA. This information does provide some relevant information for further study to refine the dimensionality of BPSE, suggesting how items are correlated above and beyond the hypothesized factors.

With behavior (belief and actions) and style already validated as dimensions of Black parent engagement through the documented work of Fantuzzo and his colleagues (Fantuzzo, McWayne, & Perry, 2004; McWayne, Hampton, Fantuzzo, Cohen, & Sekino, 2004; McWayne, Melzi, Schick & Kennedy, 2013), it was my goal to be able to confirm these dimensions along with the cultural structures, through factor analysis, for Black parent STEM engagement as determined by the literature and previous empirical studies. In addition, I expected to use CFA for the added benefit of its model fit indices and suggestions in the output. Based on the

suggested restrictions, I could interpret the extent to which variables and factors have influence on other variables and dimensions. These are given in terms of suggested correlations and regressions.

**Conclusion**

Ultimately model 3, the 4-factor solution and model 1, the single factor solution, were determined to be feasible models to explain the contextual nature of Black parent STEM engagement. While model 6, as a unidimensional model, fit better in a statistical sense, it is model 3, the multidimensional model, that provides evidence that is one step closer to understanding the multidimensionality of BPSE. Most likely, there are other factors influencing BPSE not yet known. If those factors were included, the model may fit better than the unidimensional model. Figure 4.5 illustrates model 3 with significant correlations among the variables included. Table 4.7 provides the factor correlations. These correlations provide some insightful information for further study to refine the dimensionality of BPSE, suggesting how items are correlated above and beyond the hypothesized factors.

[Insert Figure 4.5 here]

[Insert Table 4.7 here]

Findings from this study have confirmed that, contextually speaking, the practices, style and culture exist as influential dimensions of Black parents in their STEM engagement. It cannot be defined by how many times the parent visit the school or to what extent the parent supports school-related initiatives. Black parents are connected and effectively engaged in the academic

and STEM development of their children. It is done within the cultural context of their surroundings with their values, expectations, and cultural tools. Understanding more about the context of Black parent engagement, schools can be sure to extend that STEM pipeline into their educational structures. Effective parent STEM engagement, especially those of culturally and linguistically different students, should be implemented within a synchronized, supportive context as a standard component of school and STEM teaching strategies.

## Limitations and Further Research

**Model of best fit.** While not feasible, an infinite number of CFA test could be run to continue to search for model of better fit than what was selected in this study. For example, in the initial examination of the individual items of BPSEQ-41, the data suggested that the construct could be appropriately represented by a minimum of 10 items that were the best indicators (respondent mean greater than or equal to 5 [out of 6]) to represent the BPSE dimensions. However, the distinct dimensionality feature would be lost based on best practices of factor analysis that recommends at least 3 - 4 variables (indicators) converge to represent a single dimension, or factor (Mulaik, 2010); only the items representing the beliefs and cultural structure factors would remain to create a dual-dimensional model.

Additional divergent evidence that is important in validating the BPSE construct is the responses from other races. However, since only 6 parents indicated that they were of a different race other than Black, the data for that parent was removed; there were not enough parents of this category to provide meaningful information to the study (i.e. divergent evidence or characteristic to confirm unique Black parent STEM engagement characteristics).

**Repeated measures & predictability.** It would be helpful but is not feasible for this study to conduct a longitudinal study of the same kids across developmental stages to further investigate the transformation of BPSE as well as any confounding variables from other experiences of the child. Further research could examine the validity of BPSEQ-33 independently at various stages of child development as a predictor of student STEM persistence which would inform and strengthen the STEM pipeline.

**Validity and reliability.** Perceived and potential threats to the validity of the research conclusions include limited number of respondents which weakens generalizability. In addition, consideration of any cofounding variables was disregarded. Further study and consideration would help to determine if the data presented are indeed a result of BPSE and not some other phenomenon or some covariate such as school development affect, other influences, etc. Due to the nature of shifting social and cultural conditions (Benson, 1998), on-going and periodic validation studies are recommended to reestablish the validity of these claims.

## Recommendations for Parents and Teachers

Translating the findings from this study as practical components for curriculum development, the TARGET approach for reporting frames the discussion for the findings of the study. TARGET components include tasks, authority, recognition, grouping, evaluation, and time (Carole Ames, 1992 as cited in Eccles & Wigfield, 2010; Eccles, 1983 as cited in Woolfolk, 2010; Epstein, 1995 as cited in Pushor & Ruitenberg, 2005). It is commonly used within the context of school and academic spaces, and therefore allows the research to be discussed in a familiar manner to better inform the approaches for application and effective parent STEM engagement within STEM curriculum. TARGET-principle approach has proven to the crucial

characteristics of any instructional practices (Eccles & Wigfield, 2010), in the home and at school, to motivate and foster student STEM talent development.

**Tasks (ACTIONS).** Tasks should be reasonably challenging and interesting to the student. BPSE offers a continuum of innate dispositions that regulate the interests and values of the student that also influence the student's identity and interest in STEM. STEM development activities that require the student to utilize service-learning not only benefit his community but also provide authentic learning within the cultural context in which the student lives and learns.

**Authority (STYLE).** Authority in the classroom should be shared. When STEM curriculum does not represent the diversity in which it serves, it disenfranchises the learner that is marginalized. Allowing Black parents and other members of the Black student's community to contribute to the community empowers all stakeholders and provide leadership skills needed to support the development of a Black student STEM identity that is more likely to foster persistence in STEM when the student is faced with an environment that does not support his values. In addition, this gives the Black student an opportunity to see a reflection of self that extends beyond his community when parents and other member of his community are given an opportunity to contribute to the school environment in the same way he would in his own cultural context.

**Recognition (CULTURAL STRUCTURE).** Results for learning and effort should be provided. Given a style of parenting that include parent monitoring and praise to increase motivation in STEM achievement for the student, the same must be done in the institutional setting that is not in comparison to a standard or other student's performance. This promotes an incremental approach to learning for the Black student that fosters a desire to learn with the understanding that talent is not static but can be developed over time.

**Grouping (CULTURAL STRUCTURE).** Grouping should be diverse. Strong cultural affiliations are important in the context of the Black community's infrastructure. It is also encouraged and fostered through BPSE. It is because of this cultural structure that Black students work better in groups. The "It Takes A Village" mentality is a deep-rooted innate disposition of the Black community that serves and influences the way that Black students learn and develop.

**Evaluation (BELIEFS).** Evaluation of progress and mastery is essential and preferred over evaluation on *outcomes alone.* Talents and gifts are manifested in many ways for students, and this is especially so with Black students whose cultural infrastructure value creativity and novelty. If the environment in which the student is being evaluated is not a welcoming environment that also values the way his gifts and talents are manifested, the student is less likely to reveal his potential and thus is inaccurately evaluated. Group dynamics that are valued within the Black community focuses more on interconnectedness of the group. This fosters a continual evaluation of process over direct outcomes. The style of BPSE also solidify this formative style of evaluation that process and mastery offers, In addition, mastery level of evaluation allows for reflective evaluation that is important in the development of a positive self-concept for Black students interested in STEM.

**Time (BELIEFS).** Time should be set and allotted in order that students may master various tasks. It is important that efforts to provide ample time for mastery is not driven by a deficit (lag) mindset but a mindset of mindfulness and delayed decision making which also provides additional opportunities to enhance STEM skill development and creativity. BPSE that focuses on the process or open-ended questions rather than absolute answers provide an environment for creativity and exploration as well as a global focus for learning.

## Additional Implications for Learning

Effective Black parent STEM engagement can bridge the gap between formal and informal learning to forge a culturally responsive and integrated educational community. Parents are children's first teachers, and they can help to shape the social, academic, and career identity that supports students' STEM awareness. Educators must prioritize awareness of the cultures represented in their classes; it is important that they learn what motivates parents from all backgrounds to effectively and harmoniously engage in their child's educational process. More specifically, schools need effective STEM parent engagement programs to help Black STEM students navigate threats to their multiple identities as scholars who are smart, Black, who have shown great potential for success in STEM fields.

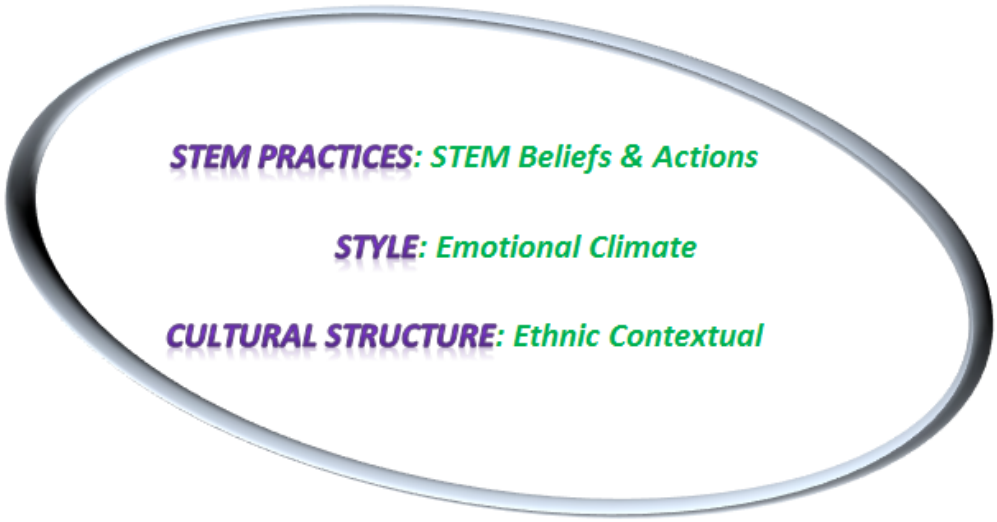


**Fig.4.1** The Theoretical Construct of Black Parent STEM Engagement

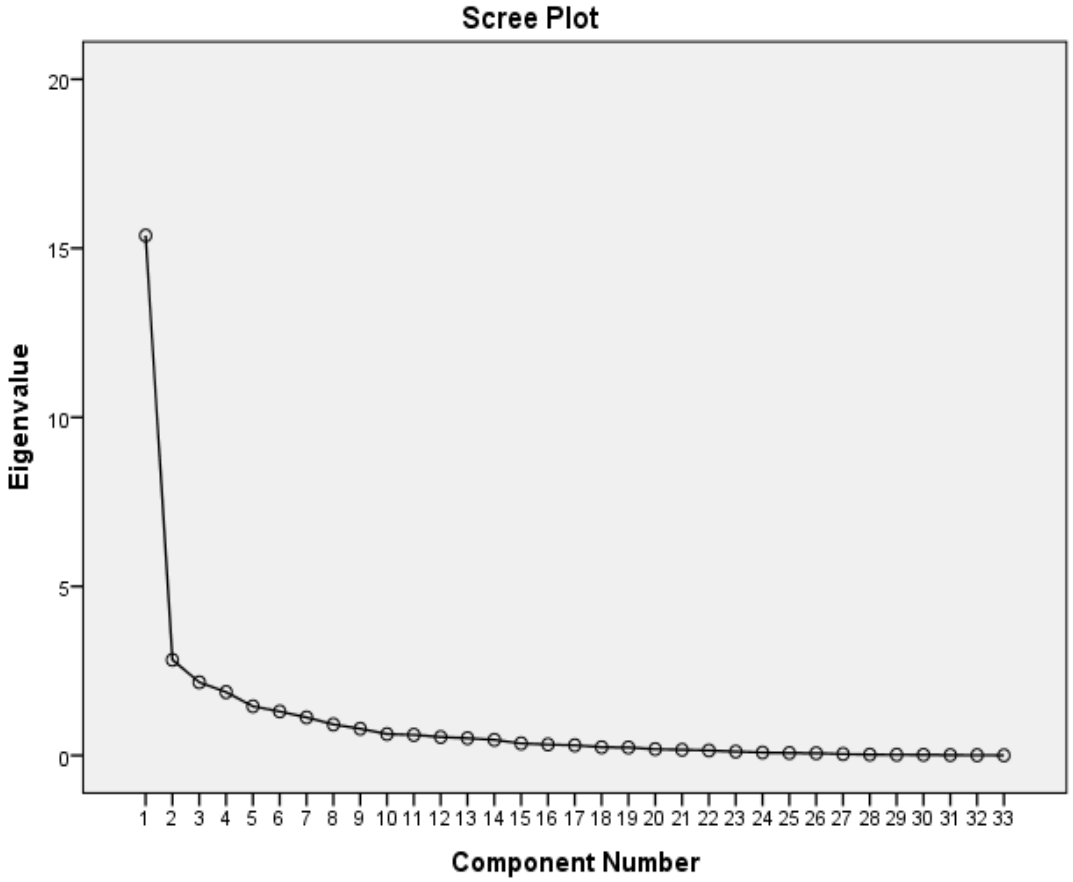


**Figure 4.2.** Scree Plot of Observed Components for BPSEQ-33

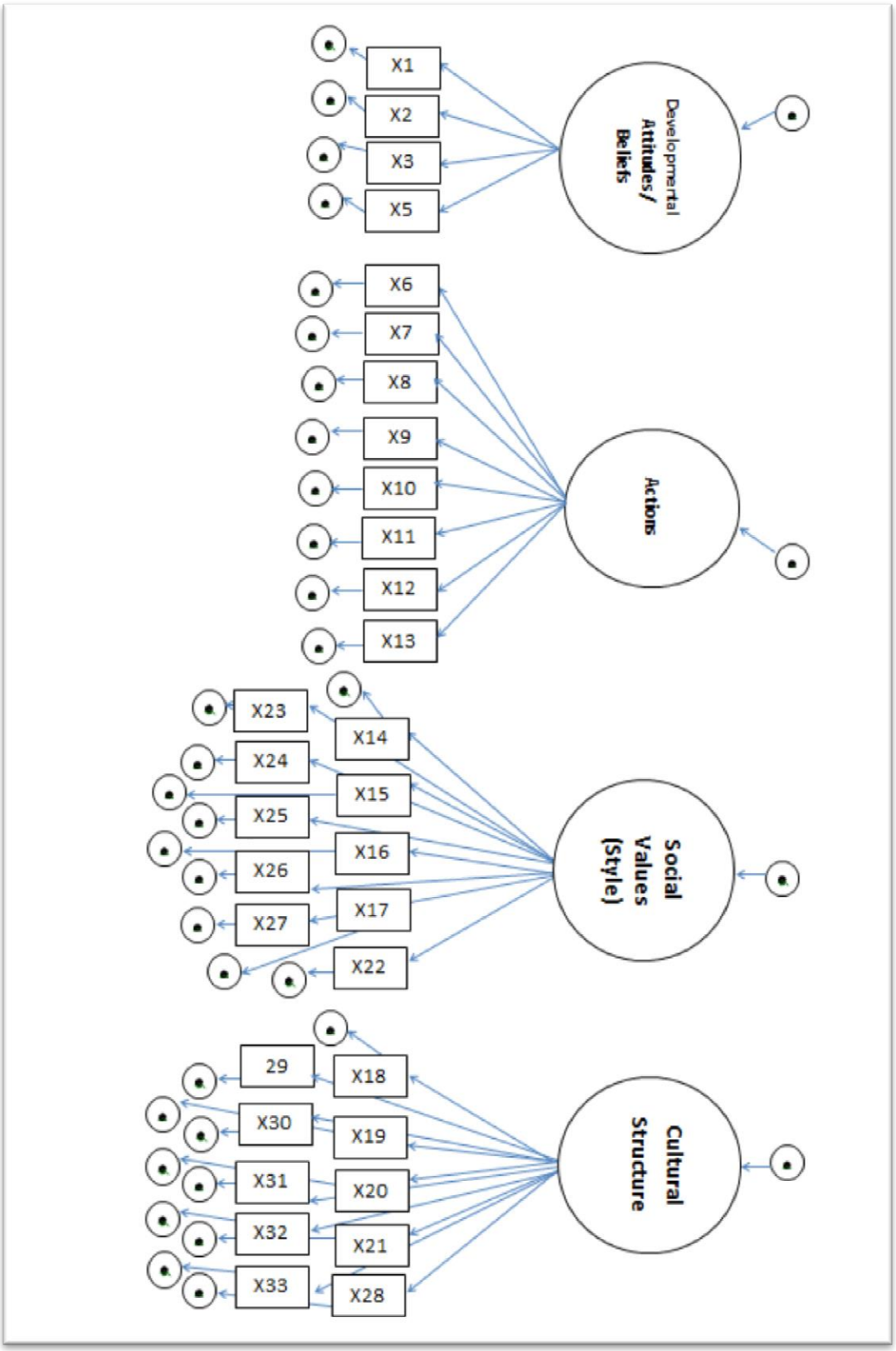


**Figure 4.3.** A priori 4-Factor Solution of BPSE, e= 1.

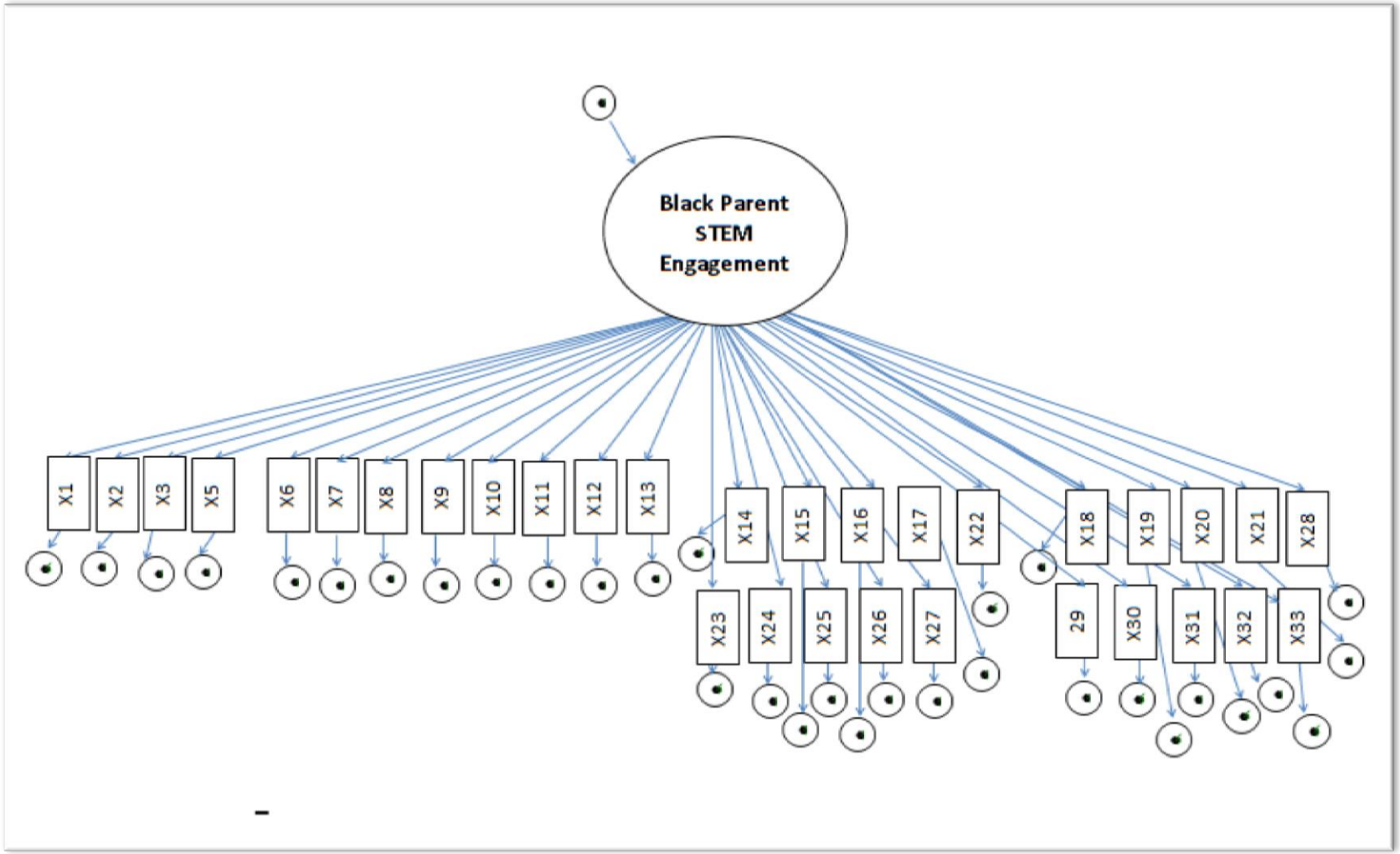


**Figure 4.4.** 1-Factor Solution of BPSE from CFA Model Fit Results. e= 1. Factor loading and correlations are listed separately.

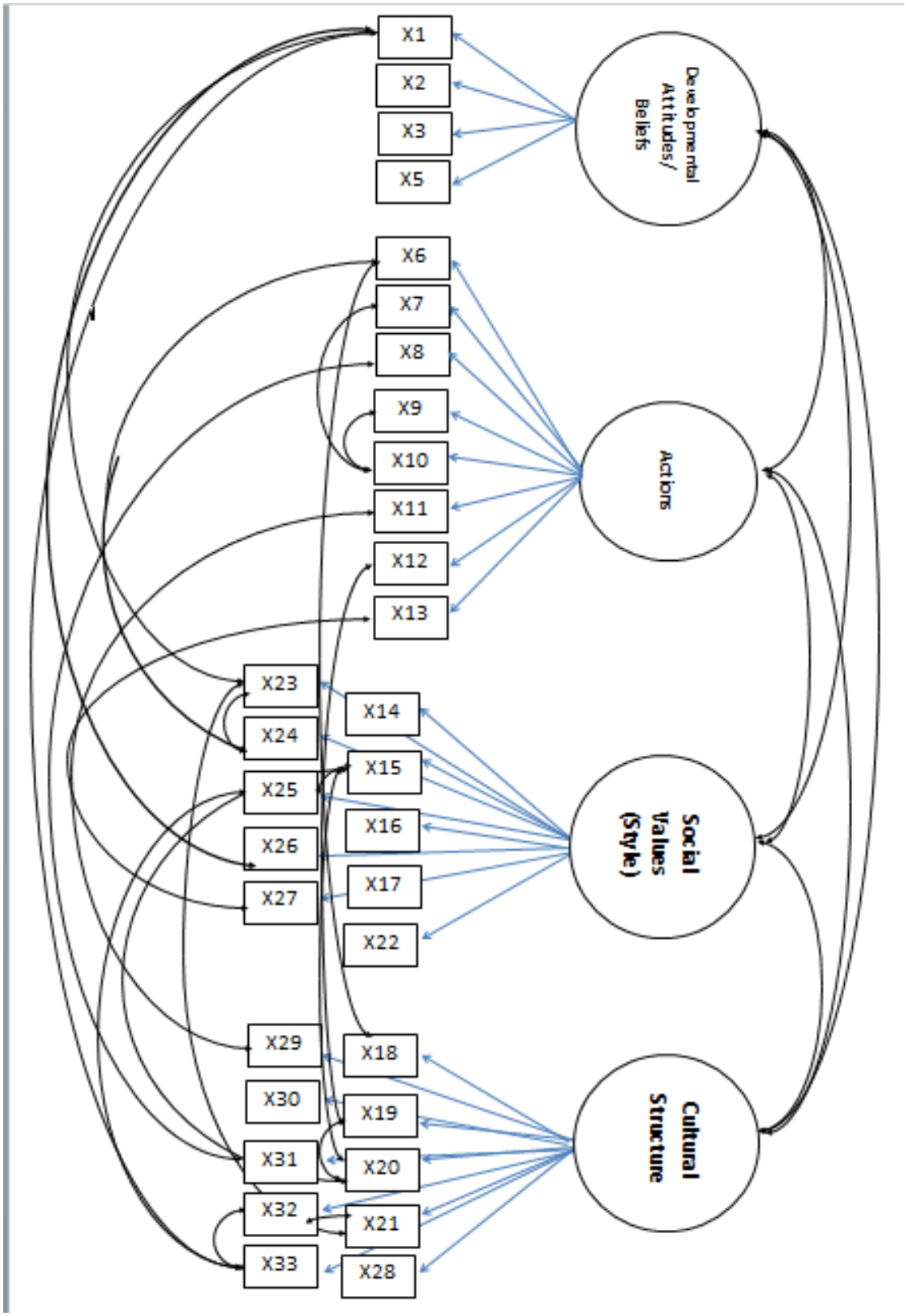


**Figure 4.5:** 4-Factor Solution of BPSE from CFA Model Fit Results with Significant Variable Correlations Illustrated. e= 1.

**Table 4.1.** The Black Parent STEM Engagement Questionnaire-33 (BPSEQ-33) Instrument

| Indicator Trait | Var | Statement |
|---|---|---|
| LAG | X1 | PB1 (B10) I believe that parent engagement and learning about STEM at home are "extra steps" that are critical for my child to have STEM success at school. |
| Global Focus | X2 | PB2 (B15) I believe that my level of STEM engagement will help to develop my child's STEM talent and identity for later successes. |
| Global Focus | X3 | PB3 (B18): It is important for me to engage in my child's STEM development to make sure that our values about careers, religion, ethnicity, etc. help to shape his or her positive STEM identity. |
| ***LAG*** | *X4* | *PB4 (B21): I am concerned that I do not know enough about STEM. [REMOVED FROM MODEL]* |
| Influence | X5 | PA1 (B7): With more information about STEM, I am confident that I can find ways at home to positively influence my child's interest and efforts in STEM. |
| Influence | X6 | PA2 (A5): When I talk to my child about his or her college or career aspirations, I promote STEM related choices. |
| Exposure | X7 | PA3 (A8): I use current events and popular/mainstream culture to discuss STEM related issues with my child on a regular basis. (e.g. news, TV, magazines, etc.). |
| Influence | X8 | PA4 (A9): I talk to my child about what I think it might be like for him or her as a scientist, technician, engineer, mathematician, or other STEM related jobs (i.e. nurse, STEM teacher, electrician, mechanic, etc.). |
| Exposure | X9 | PA5 (A11): I buy or bring home educational STEM materials or games for my child (e.g. flashcards, books, videos, notebooks, etc.). |
| Influence | X10 | PA6 (A12): I talk to my child on a regular basis about how important it is to learn STEM skills. |
| Influence | X11 | PA7 (A14): I make sure that my child has access to the STEM supplies s/he needs for school (e.g. calculator, Internet access, computer, etc.). |
| Exposure | X12 | PA8 (A19): I tell stories about others that I know (historical, celebrities, personal) who have done well in STEM classes, majors, or careers to motivate my child in STEM. |
| Exposure | X13 | PA9 (A20): I encourage my child to engage one-on-one in STEM-related activities with other family, mentors, and community members. |
| Equity | X14 | PV1 (B4): I set standards for my child with the expectation that he or she will have to work twice as hard to have equal access to STEM opportunities. |
| Style: Competitive | X15 | PV2 (S4): I set achievement standards for my child that are competitive in nature (i.e. earn highest grades, take highest level classes, seeking out a variety of extra-curricular activities, etc.). |
| Humor | X16 | PV3 (S10) I often use a visual or entertaining approach (e.g. story-telling, role play, prose, video, demonstration, etc.) to explain STEM/academic concepts to my child. |
| Street-wise | X17 | PV4 (S11) I use a "common sense" approach when engaging my child in STEM activities (real-life examples, situational learning opportunities, etc.). |
| Family Pride | X18 | CE1 (C4) STEM identity and STEM success for my child is viewed with pride as success for the family and community as well. |
| Church/ Religion | X19 | CE2 (C8): Church affiliation and/or religion play an important role in setting a foundation for my child's identity needed to succeed in STEM fields. |
| Sports/ Athletics | X20 | CE3 (C9): Successes in sporting activities and/or athletic skills play an important role in boosting my child's confidence to succeed in STEM. |
| Culture: LAG Belief | X21 | CE4 (C10): It is important for my child to understand the gaps (e.g. racial, gender, income, etc.) that exist among cultural groups in STEM in terms of their achievement, majors and careers, retention, persistence, etc. |
| Influence | X22 | QS1 (S1): I often encourage and discuss my child's level of motivation and efforts to help him or her to be prepared to excel in STEM subjects in school. |
| Influence | X23 | QS2 (S2): I communicate my beliefs about the benefits of STEM skills to my child with the |

**Table 4.1.** The Black Parent STEM Engagement Questionnaire-33 (BPSEQ-33) Instrument

| Indicator Trait | Var | Statement |
|---|---|---|
| | | clear expectation that he or she will be encouraged to develop them at school. |
| Parent Praise | X24 | QS3 (A17): I praise my child as a confidence booster when his or her academic performance meets or exceeds my expectation in STEM/academic classes. |
| Parent Monitoring | X25 | QS4 (S5) I closely monitor my child's STEM/academic progress and success. |
| Global Focus | X26 | QS5 (S7) I focus on the "big picture," (e.g., STEM career awareness, general benefit of STEM major, etc.) when engaging in STEM activities with my child. |
| Global Focus | X27 | QS6 (S9) When engaging my child in STEM problem solving activities, I tend to focus on those with which multiple solutions are acceptable (i.e. open ended versus one correct or expected answer). |
| Influence | X28 | QC1 (C1): I provide STEM experiences for my child that I never had a chance to experience (e.g. travel, arts/ music lessons, community service, membership in organizations, etc.). |
| Influence | X29 | QC2 (C2): The skills and talents that my family or community value play an important role in how I engage in activities that support my child's STEM identity development. |
| Exposure | X30 | QC3 (C3): I promote an awareness of STEM skills and careers to my child that will enhance or benefit our community and/or family (i.e. promote connection to community, attitude of "reaching back", skills that serve, etc.). |
| Experiential | X31 | QC4 (C5): My child sees me or other family members engaged in STEM activities (e.g. nursing sick family members, fixing cars or light fixtures, problem solving TV connections, etc.). |
| Communal | X32 | QC5 (C6): My child's individual success in STEM is the result of collective efforts by supportive family members, community leaders, and/or mentors. |
| Tradition | X33 | QC6 (C7): Creating a STEM learning environment that is filled with cultural heritage is important for my child's STEM identity development. (i.e. things that represent our values, traditions, contributions, etc.). |

**Table 4.2.** Summary of Parental Engagement Toward Student STEM Development (STEM Demographic Information)

| Student STEM Development Status | Response | % |
|---|---|---|
| **Conceptual STEM Development**<br>*PARENT engages child in STEM-related activities that influences CHILD's goal to become (or at least think of himself as) a scientist, technician, mathematician, or engineer.* | 19 | 41% |
| **Practical STEM Development**<br>*PARENT engages child in STEM-related activities BUT CHILD does not think of himself as (nor want to be) a scientist, technician, engineer, or mathematician.* | 8 | 17% |
| **Limited STEM Development**<br>*PARENT has little or no resources (money, material, knowledge, etc.) or STEM interest to support CHILD who has a high personal STEM interest* | 7 | 7% |
| **Deprived STEM Development**<br>*PARENT & CHILD has some STEM interest BUT does not consistently engage in STEM activities or adequately support STEM interest with available resources (money, material, knowledge, etc.).* | 8 | 17% |
| **NO STEM-Value Development**<br>*PARENT & CHILD has little or no STEM interest or STEM-related engagement at home.* | 4 | 9% |
| ***Total*** | *46* | |

**Table 4.3.** Responses by Household Income and Student Developmental Stage

| | Less than $40K | | | $40K - $79K | | | $80K - $150K | | | Greater than $150K | | | | *DEVELOPMENTAL SGTAGES ONLY* | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ES | HS | TOT | ES | HS | TOT | ES | HS | TOT | ES | *MS* | HS | TOT | ES | *MS* | HS | TOT |
| ExtraSteps | 4.00 | 4.71 | **4.63** | 5.67 | 5.00 | **5.15** | 4.50 | 5.29 | **5.00** | 6.00 | *6.00* | 5.00 | **5.75** | 5.10 | *6.00* | 5.00 | **5.06** |
| LaterSuccess | 4.00 | 4.57 | **4.50** | 5.67 | 4.20 | **4.54** | 5.75 | 5.29 | **5.45** | 6.00 | *6.00* | 6.00 | **6.00** | 5.60 | *6.00* | 4.68 | **4.97** |
| ShapeSTEMID | 3.00 | 4.57 | **4.38** | 6.00 | 5.10 | **5.31** | 5.75 | 5.29 | **5.45** | 5.50 | *6.00* | 5.00 | **5.50** | 5.50 | *6.00* | 5.00 | **5.17** |
| *DontKnowSTEM* | *3.00* | *5.14* | ***4.88*** | *5.33* | *3.20* | ***3.69*** | *2.75* | *3.14* | ***3.00*** | *4.50* | *6.00* | *6.00* | ***5.25*** | *3.90* | *6.00* | *3.84* | ***3.92*** |
| InfolfluenceSTEM | 4.00 | 5.14 | **5.00** | 6.00 | 5.00 | **5.23** | 5.75 | 5.14 | **5.36** | 6.00 | *5.00* | 6.00 | **5.75** | 5.70 | *5.00* | 5.12 | **5.28** |
| PrmoSTEMchoice | 4.00 | 4.71 | **4.63** | 4.33 | 4.00 | **4.08** | 5.25 | 4.57 | **4.82** | 5.00 | *6.00* | 6.00 | **5.50** | 4.80 | *6.00* | 4.44 | **4.58** |
| MainstreamSTEM | 4.00 | 2.86 | **3.00** | 4.00 | 3.30 | **3.46** | 4.75 | 4.71 | **4.73** | 5.00 | *6.00* | 4.00 | **5.00** | 4.50 | *6.00* | 3.60 | **3.92** |
| TalkBeingSTEM | 4.00 | 4.00 | **4.00** | 4.33 | 4.60 | **4.54** | 5.00 | 4.86 | **4.91** | 5.50 | *6.00* | 5.00 | **5.50** | 4.80 | *6.00* | 4.52 | **4.64** |
| BringSTEMhome | 4.00 | 3.43 | **3.50** | 3.33 | 3.50 | **3.46** | 4.50 | 3.14 | **3.64** | 5.00 | *6.00* | 3.00 | **4.75** | 4.20 | *6.00* | 3.36 | **3.67** |
| TalkSTEMSkill | 4.00 | 3.86 | **3.88** | 4.33 | 3.00 | **3.31** | 4.50 | 4.29 | **4.36** | 4.50 | *6.00* | 2.00 | **4.25** | 4.40 | *6.00* | 3.56 | **3.86** |
| AccessSTEMsupp | 4.00 | 4.71 | **4.63** | 4.67 | 4.20 | **4.31** | 5.75 | 5.00 | **5.27** | 6.00 | *6.00* | 6.00 | **6.00** | 5.30 | *6.00* | 4.64 | **4.86** |
| StoriesSTEMPeop | 4.00 | 3.43 | **3.50** | 4.00 | 3.30 | **3.46** | 4.00 | 3.57 | **3.73** | 4.50 | *6.00* | 3.00 | **4.50** | 4.10 | *6.00* | 3.40 | **3.67** |
| EncrSTEMmentor | 4.00 | 3.57 | **3.63** | 4.00 | 3.50 | **3.62** | 4.75 | 4.29 | **4.45** | 4.50 | *6.00* | 2.00 | **4.25** | 4.40 | *6.00* | 3.68 | **3.94** |
| STDunequalSTEM | 4.00 | 5.14 | **5.00** | 4.00 | 4.80 | **4.62** | 6.00 | 4.86 | **5.27** | 4.50 | *6.00* | 5.00 | **5.00** | 4.90 | *6.00* | 4.92 | **4.94** |
| STDSTEMcompe | 4.00 | 4.86 | **4.75** | 4.33 | 5.10 | **4.92** | 6.00 | 5.14 | **5.45** | 5.50 | *6.00* | 6.00 | **5.75** | 5.20 | *6.00* | 5.08 | **5.14** |
| VisualSTEM | 4.00 | 4.14 | **4.13** | 4.33 | 3.80 | **3.92** | 5.00 | 4.57 | **4.73** | 5.50 | *6.00* | 3.00 | **5.00** | 4.80 | *6.00* | 4.08 | **4.33** |
| CommSenseSTEM | 4.00 | 4.71 | **4.63** | 4.33 | 4.80 | **4.69** | 5.00 | 4.86 | **4.91** | 5.50 | *6.00* | 5.00 | **5.50** | 4.80 | *6.00* | 4.80 | **4.83** |
| FamSTEMPride | 4.00 | 4.86 | **4.75** | 4.33 | 4.10 | **4.15** | 5.50 | 4.86 | **5.09** | 5.00 | *6.00* | 6.00 | **5.50** | 4.90 | *6.00* | 4.60 | **4.72** |
| ChrchSTEMfound | 4.00 | 4.86 | **4.75** | 4.67 | 3.40 | **3.69** | 3.50 | 4.71 | **4.27** | 5.50 | *6.00* | 5.00 | **5.50** | 4.30 | *6.00* | 4.24 | **4.31** |
| SportsSTEMConfi | 4.00 | 3.86 | **3.88** | 3.67 | 3.40 | **3.46** | 4.25 | 5.14 | **4.82** | 5.50 | *6.00* | 5.00 | **5.50** | 4.30 | *6.00* | 4.08 | **4.19** |
| STEMGaps | 4.00 | 4.86 | **4.75** | 5.67 | 4.60 | **4.85** | 5.75 | 5.57 | **5.64** | 5.50 | *6.00* | 6.00 | **5.75** | 5.50 | *6.00* | 5.00 | **5.17** |
| DiscusMotivSTEM | 4.00 | 5.29 | **5.13** | 4.33 | 4.70 | **4.62** | 5.50 | 5.00 | **5.18** | 5.00 | *6.00* | 6.00 | **5.50** | 4.90 | *6.00* | 5.00 | **5.00** |
| CommExpctSTEM | 4.00 | 5.14 | **5.00** | 5.67 | 4.40 | **4.69** | 5.00 | 4.43 | **4.64** | 5.00 | *6.00* | 5.00 | **5.25** | 5.10 | *6.00* | 4.64 | **4.81** |
| PraiseBoostSTEM | 4.00 | 5.57 | **5.38** | 5.67 | 5.30 | **5.38** | 6.00 | 5.29 | **5.55** | 6.00 | *6.00* | 6.00 | **6.00** | 5.70 | *6.00* | 5.40 | **5.50** |
| MnitrSTEMprgres | 4.00 | 5.00 | **4.88** | 4.67 | 4.70 | **4.69** | 5.00 | 4.71 | **4.82** | 6.00 | *6.00* | 6.00 | **6.00** | 5.00 | *6.00* | 4.84 | **4.92** |
| FocusBigPicSTEM | 4.00 | 5.14 | **5.00** | 4.00 | 4.70 | **4.54** | 5.00 | 4.86 | **4.91** | 5.50 | *6.00* | 5.00 | **5.50** | 4.70 | *6.00* | 4.88 | **4.86** |
| FcusnonAbsSTEM | 4.00 | 4.57 | **4.50** | 4.00 | 4.30 | **4.23** | 5.25 | 4.57 | **4.82** | 5.00 | *6.00* | 4.00 | **5.00** | 4.70 | *6.00* | 4.44 | **4.56** |
| NewSTEMExp | 4.00 | 5.00 | **4.88** | 4.33 | 4.40 | **4.38** | 5.75 | 4.71 | **5.09** | 5.50 | *6.00* | 6.00 | **5.75** | 5.10 | *6.00* | 4.72 | **4.86** |
| CommValSTEMID | 4.00 | 4.29 | **4.25** | 4.33 | 4.10 | **4.15** | 5.50 | 4.43 | **4.82** | 5.00 | *6.00* | 5.00 | **5.25** | 4.90 | *6.00* | 4.28 | **4.50** |
| AwrSTEMConnec | 4.00 | 4.86 | **4.75** | 4.33 | 4.60 | **4.54** | 5.50 | 4.29 | **4.73** | 5.50 | *6.00* | 6.00 | **5.75** | 5.00 | *6.00* | 4.64 | **4.78** |
| SeeMeSTEMActiv | 4.00 | 4.57 | **4.50** | 4.33 | 4.70 | **4.62** | 6.00 | 4.43 | **5.00** | 6.00 | *6.00* | 4.00 | **5.50** | 5.30 | *6.00* | 4.56 | **4.81** |
| CollEffSTEMSuccs | 4.00 | 4.86 | **4.75** | 5.67 | 4.50 | **4.77** | 5.75 | 4.57 | **5.00** | 6.00 | *6.00* | 5.00 | **5.75** | 5.60 | *6.00* | 4.64 | **4.94** |
| CultHerSTEMID | 4.00 | 5.14 | **5.00** | 5.67 | 4.9 | **5.08** | 6.00 | 4.71 | **5.18** | 5.50 | *6.00* | 6.00 | **5.75** | 5.60 | *6.00* | 4.96 | **5.17** |
| **TOTAL MEAN** | **3.94** | **4.59** | **4.51** | **4.67** | **4.28** | **4.37** | **5.16** | **4.68** | **4.85** | **5.35** | ***5.97*** | **4.97** | **5.41** | **4.93** | ***5.97*** | **4.50** | **4.66** |

ES – Elementary School, MS – Middle School, HS – High School

**Table 4.4.** Means and Factor Loadings for 1-Factor Solution BPSEQ-33 Indicators

| Indicator (BPSEQ-41 Item #) | Scale (BPSEQ-33 Item #) | BPSE Traits | | | |
|---|---|---|---|---|---|
| | | Mean | Std. Deviation | BPSE Factor | Communality Extraction |
| ***Simple Indicators*** | | | | | |
| PSEQPB_6 | **Global Focus (PB2)** | .4.97 | 1.253 | **.430** | **.184*** |
| PSEQPB_7 | **Global Focus (PB3)** | .5.17 | ..941 | **.498** | **.248*** |
| PSEQS_5 | **Global Focus (S5)** | 4.86 | 1.397 | **.755** | **.570** |
| PSEQS_6 | **Global Focus** (S6) | 4.56 | 1.182 | **.837** | **.701** |
| PSEQPB_4 | **LAG (PB1)** | 5.06 | 1.040 | **.464** | **.215*** |
| PSEQPB_8 | **LAG** (PB4) | 3.92 | 1.697 | *-.085* | .007* |
| PSEQPB_3 | **Influence (PA1)** | 4.64 | 1.376 | **.480** | .231 |
| PSEQPA_1 | **Influence(PA2)** | 3.67 | 1.549 | **.859** | .738 |
| PSEQPA_3 | **Influence (PA4)** | 4.86 | 1.457 | **.695** | .483* |
| PSEQPA_6 | **Influence (PA6)** | 3.94 | 1.492 | **.687** | .472* |
| PSEQPA_7 | **Influence** (PA7) | 4.94 | 1.241 | **.809** | .654 |
| PSEQS_1 | **Influence (S1)** | 5.00 | 1.195 | **.866** | .750 |
| PSEQS_2 | **Influence (S2)** | 4.81 | 1.238 | **.691** | .477* |
| PSEQC_1 | **Influence (CN1)** | 5.17 | 1.082 | **.801** | .651 |
| PSEQC_2 | **Influence** (CN2) | 5.00 | 1.192 | **.825** | .651 |
| PSEQC_3 | **Influence (CN3)** | 4.81 | 1.238 | **.893** | .680 |
| PSEQPA_2 | **Exposure (PA3)** | 3.86 | 1.588 | **.355** | .126* |
| PSEQPA_5 | **Exposure** (PA5) | .3.67 | .1.549 | **.617** | .380* |
| PSEQPA_10 | **Exposure** (PA8) | 5.14 | 1.099 | **.810** | .654 |
| PSEQPA_11 | **Exposure (PA9)** | 4.33 | 1.331 | **.773** | .656 |
| PSEQPB_2 | **Equity (PV1)** | **4.94** | 1.241 | **.611** | .374* |
| PSEQS_7 | **Humor** (PV3) | **4.33** | 1.331 | **.700** | .491* |
| PSEQS_8 | **Street-wise** (PV4) | **4.83** | 1.207 | **.856** | .491* |
| PSEQC_5 | **Experiential** (CN4) | **4.81** | .1.305 | **.787** | .619 |
| PSEQC_6 | **Communal** (CN5) | **4.94** | 1.194 | **.681** | .680 |
| PSEQC_7 | **Tradition** (CN6) | **5.17** | 1.000 | **.621** | .385* |
| PSEQC_4 | **Family Pride** (CE1) | 4.72 | **1.365** | **.910** | .828 |
| PSEQC_8 | **Church/ Religion** (CE2) | 4.31 | **1.670** | **.340** | .115* |
| PSEQC_9 | **Sports/ Athletics** (CE3) | 4.19 | **1.082** | **.379** | .143* |
| PSEQPA_8 | **Parent Praise (S3)** | 5.50 | **.775** | **.484** | .477* |
| PSEQS_4 | **Parent Monitoring (S4)** | 4.92 | **1.156** | **.682** | .234* |
| ***Compound Indicators*** | | | | | |
| PSEQS_3 | Style: Competitive (PV2) | **5.14** | 1.099 | .569 | **.324*** |
| PSEQC_10 | **Culture: LAG (CE4)** | 5.17 | 1.0082 | .763 | .582 |

***Note***: The table is formatted to emphasize the structure of the factors for the simple and compound variables. ; Cronbach's alpha = .958
*Items with communality value (variance in each item explained by the extracted factors) < .5

**Table 4.5.** 2-Factor Solution Pattern Matrix

**Pattern Matrix[a]**

| | Component | |
|---|---|---|
| | 1 | 2 |
| ExtraSteps | -.184 | **.824** |
| LaterSuccess | -.365 | **1.007** |
| ShapeSTEM | -.275 | **.982** |
| DntKnoeSTEM | -.352 | .331 |
| InfolfluenceSTEM | -.213 | **.881** |
| PromoSTEMchoices | **.775** | .134 |
| MainstreamSTEM | .495 | -.163 |
| TalkBeingSTEM | **.727** | -.016 |
| BringSTEMhome | **.566** | .084 |
| TalkSTEMSkill | **.609** | .121 |
| AccessSTEMsupp | **.582** | .311 |
| StoriesSTEMPeop | **.506** | .407 |
| EncourSTEMmentor | **.562** | .290 |
| STDunequalSTEM | **.774** | -.183 |
| STDSTEMcompe | **.784** | -.248 |
| VisualSTEM | **.538** | .226 |
| CommSenseSTEM | **.847** | .040 |
| FamSTEMPride | **.790** | .181 |
| ChurchSTEMfoundation | **.649** | -.375 |
| SportsSTEMConfi | **.653** | -.329 |
| STEMGaps | .403 | **.476** |
| DiscussMotivateSTEM | **.957** | -.085 |
| CommExpectSTEM | **.446** | .329 |
| PraiseBoostSTEM | .094 | **.503** |
| MonitorSTEMprogress | **.584** | .145 |
| FocusBigPicSTEM | **.959** | -.229 |
| FocusnonAbsSTEM | **.718** | .177 |
| NewSTEMExp | **.714** | .144 |
| CommValSTEMID | **.716** | .163 |
| AwareSTEMConnec | **.775** | .177 |
| SeeMeSTEMActivities | **.742** | .083 |
| CollEffSTEMSuccess | .262 | **.547** |
| CultHerSTEMID | .342 | **.369** |

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

a. Rotation converged in 3 iterations.

**Table 4.6.** Goodness-of-fit CFA Results for Model Comparison (n=66), maximum likelihood estimator

| Model | $\chi^2$ df | $\chi^2$ /df | CFI TFI | RMSEA | SRMR | AIC | BIC |
|---|---|---|---|---|---|---|---|
| 1. 4-factor Solution, f @1, w/o X4, X14 ON Factor 1 | 1910.647 462 | 4.1356 | .484 .447 | .218 .000 | .220 | 4698.088 | 4842.606 |
| 2. Model 1, with X14 ON Factor 3 | 1874.458 462 | 4.0573 | .497 .460 | .215 .000 | .202 | 4661.869 | 4806.386 |
| **3. Model 2 with suggested/select variable correlations** | **1577.319 443** | **3.561** | **.596 .548** | **.197 .000** | **.172** | **4402.730** | **4588.850** |
| 4. Model 2, 2nd-order, 3-factor solution converged onto BPSE | 2091.880 464 | 4.5083 | .421 .381 | .231 .000 | .345 | 4875.291 | 5015.428 |
| 5. Model 2, f@1, with suggested correlations:F3 with F4only | 1842.793 434 | 4.246 | .461 .422 | .222 .000 | .518 | 4664.813 | 4800.572 |
| **6. 1-factor solution with select variable correlations, f@1** | **1340.293 420** | **3.19** | **.672 .613** | **.182 .000** | **.309** | **4211.704** | **4108.181** |

*P=.000<.05*

**Note: A warning is given that the latent variable covariance matrix (psi) is not positive definite. This could indicate a negative variance/residual variance for a latent variable, a correlation greater or equal to one between two latent variables, or a linear dependency among more than two latent variables.(This occurs if F1-F2 converges onto Practices without converging practices, style and cultural structure onto BPSE as a single factor).*

**Table 4.7.** Best Fit Model CFA Results for Factor Loadings Estimates (Maximum Likelihood), p=000

| | Indicator | | | Solutions for Models of Best Fit | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | 4 –FACTORS | | | | 1-FACTOR |
| *Observed* | BPSEQ-44 BPSEQ-33 | | CFA Code (CFA Variable) | BELIEF | ACTION | STYLE | CULTURE | F2 |
| LAG | PSEQPB4 | PB1 | *Extra Steps* (x1) | 1.00 | | | | 1.00 |
| Global Focus | PSEQPB6 | PB2 | *Later Success* (x2) | .862 | | | | .673 |
| Global Focus | PSEQPB7 | PB3 | *Shape STEM ID* (x3) | .947 | | | | .766 |
| Influence | PSEQPB3 | PA1 | *Info/Influence STEM* (x5) | .749 | | | | .515 |
| Influence | PSEQPA1 | PA2 | *Promo STEM choices*(x6) | | 1.00 | | | 1.037 |
| Exposure | PSEQPA2 | PA3 | *Mainstream STEM* (x7) | | .342 | | | .402 |
| Influence | PSEQPA3 | PA4 | *Talk/Being STEM* (x8) | | .751 | | | .824 |
| Exposure | PSEQPA5 | PA5 | *Bring STEM home* (x9) | | .670 | | | .751 |
| Influence | PSEQPA6 | PA6 | *Talk/ STEM Skill0* (x10) | | .711 | | | .776 |
| Influence | PSEQPA7 | PA7 | *Access/STEM supplies* (x11) | | .883 | | | .981 |
| Exposure | PSEQPA10 | PA8 | *Stories/STEM People* (x12) | | .886 | | | .948 |
| Exposure | PSEQPA11 | PA9 | *Encour/STEM mentor* (x13) | | .830 | | | .907 |
| Equity | PSEQPB2 | PV1 | *STD/unequal STEM* (x14) | | | 1.00 | | .734 |
| Style (Competitive): | PSEQS3 | PV2 | *STD/ STEM competence* (x15) | | | .653 | | .725 |
| Humor, | PSEQS7 | PV3 | *Visual STEM* (x16) | | | .735 | | .849 |
| Street-wise, | PSEQS8 | PV4 | *CommSense STEM* (x17) | | | 1.001 | | 1.080 |
| Family Pride | PSEQC4 | CE1 | *Fam/STEM Pride* (x18) | | | | 1.00 | 1.121 |
| Church/ Religion, | PSEQC8 | CE2 | *Church/STEM foundation* (x19) | | | | .365 | .439 |
| Sports/ Athletics | PSEQC9 | CE3 | *Sports/STEM Confidence* (x20) | | | | .379 | .483 |
| Culture (Belief of LAG): | PSEQC10 | CE4 | *STEM Gaps*(x21) | | | | .785 | .886 |
| Influence | PSEQS1 | S1 | *Discuss/Motivate STEM* (x22) | | | 1.035 | | 1.092 |
| Influence | PSEQS2 | S2 | *Comm/Expect STEM* (x23) | | | .753 | | .418 |
| Parent Praise | PSEQPA8 | S3 | *Praise/Boost STEM*(x24) | | | .395 | | .593 |
| Parent Monitoring | PSEQS4 | S4 | *Monitor/STEM progress* (x25) | | | .753 | | .821 |
| Global Focus | PSEQS5 | S5 | *Focus/BigPic STEM* (x26) | | | .988 | | .946 |
| Global Focus | PSEQS6 | S6 | *Focus/nonAbs STEM* (x27)` | | | .959 | | .997 |
| Influence | PSEQC1 | CN1 | *New/STEM Ex* (x28) | | | | .941 | .996 |
| Influence | PSEQC2 | CN2 | *CommVal/STEM ID* (x29) | | | | .953 | 1.011 |
| Influence | PSEQC3 | CN3 | *Aware/ STEM Connect* (x30) | | | | .974 | 1.097 |
| Experiential | PSEQC5 | CN4 | *SeeMe/STEM Activities* (x31) | | | | .869 | .916 |
| Communal | PSEQC6 | CN5 | *CollEff/STEM Success* (x32) | | | | .711 | .772 |
| Tradition | PSEQC7 | CN6 | *CultHer/STEM ID* (x33) | | | | .695 | .732 |
| ***LAG*** | *PSEQPB8* | *PB4* | *Don't Know STEM (x4)* | *REMOVED* | | | | *REMOVED* |

| Table 4.8. Latent Variable Correlations for the 4-factor Solution, CFA Results (ML) | | | | |
|---|---|---|---|---|
| | F1 | F2 | F3 | F4 |
| Beliefs (F1) | 1.00 | | . | |
| Actions (F2) | .579 | 1.00 | | |
| Style (F3) | .404 | .944 | 1.00 | |
| Cultural Structure (F4) | .500 | .991 | .944 | 1.00 |

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# CHAPTER 5

# CONCLUSION

An important part of STEM pedagogy includes parent STEM engagement that fosters and solidifies the infrastructure of Black students' STEM motivation. Parents as first teachers must engage in the conversation, responsibility, and development of Black student's STEM identity and talent. This document represents a critical examination of the multidimensional characteristics of Black parent STEM engagement from a contextual perspective that prioritizes the cultural values, beliefs, attitudes, actions, and style of parents. Embedded in an overall research agenda, the study on Black parent STEM engagement represents the researcher's goal to redress the research and practices surrounding the STEM pipeline. In an attempt to change the deficit narrative that monopolizes the conversations about STEM achievement among Black students, this study approaches the topic from an ecological point of view with the standards of parent and community practices taken as face value and sufficient for positive influence in Black student STEM development. The findings of this study reveal a carefully crafted developed instrument used to identify the structures and measurement of Black parent STEM engagement that confirms Black parent STEM engagement which fosters a STEM self-concept in Black students in an effective and culturally responsive manner that has merit as an appropriate way to confront the gaps in STEM interest, talent development, and persistence that exists among Black students.

## Summary

A review of the literature not only revealed gaps in the literature as it relate to contextual examination of parent engagement in the development of student STEM identity, but it also allowed for a critical analysis of research related to parent engagement, identity development, STEM persistence, and best practices in contextual research. This in-depth analysis lead to (1) the introduction of a newly defined construct - Black parent STEM engagement (BPSE), (2) a supporting instrument – the Black Parent STEM Engagement Questionnaire, BP-SEQ - to measure the construct, and (3) a model to guide further research and curriculum development related to Black student STEM talent development.

The empirical studies that followed the review of the literature were designed not only to develop an instrument to confirm the theoretical concept of Black parent STEM engagement, but also served as an example to follow for providing evidence of construct validity throughout the research process. Discussion of the findings is presented in practical, integrated ways that include recommendations and practical examples of implementation. It provides an effective way to reach all stakeholders of Black student STEM talent development – the researcher, parents, educational institutions, and the students.

## Discussion

Closing gaps in Black student STEM achievement begins with the establishment of a home-school partnership that includes an exchange and translation of knowledge and skills between the STEM student, parent, educator, and researcher. A critical review of the literature on Black parent STEM engagement has confirmed that Black student's self-perception and talent development is situated within motivation that is culturally contextualized by cultural, social,

material, and human capital. Whereby this capital is not valued or is met with micro-aggressions from the dominant culture, boundaries are formed that hinder Black student STEM achievement. It is important to understand context of Black student STEM talent development and achievement to inform STEM pedagogy that will reduce non-cultural responsive STEM curriculum, ineffective STEM teaching practices, and a non-inviting STEM environment.

The study of relationships within the "field" or "space" (Bourdieu, 1977 as cited in Prasad, 2005; Calabrese et al, 2009) is "particularly well suited for the study of cultural and institutional arrangement" (Prasad, 2005, p. 203); it provides a successful legitimation of unequal and oppressive social arrangements (Bourdieu, 1977) . Inquiry and analysis are grounded in the existence of social practice with an emphasis on some struggle with a cultural limitation of choice, competence, and/or action (Prasad, 2005).Thus, the validation for use of this instrument, based on the interpretation of its results, is supported by the theory of action for these uses which may include but is not limited to obtaining an accurate depiction of Black parent STEM engagement and Black students' STEM development in context (Barton et al, 2009; Connolly, 2011),

**Translating cultural practices of Black parent STEM engagement.** An examination of the literature regarding BPSE suggested that the identifiable "causal mechanisms" (Maxwell, 2004, p.6) within the structures of BPSE contribute to distinguished Black students' STEM identity development and STEM success among Black students, and should be exchanged and [knowledge] translated. Knowledge translation involves more than a transfer of knowledge; it implies that the end-user is engaged with the knowledge gained in an operational manner that includes awareness, acceptance, adoption, and adherence (Ranne, 2011) as soluble interventions

within the structures of formal educational settings. This suggests that contextual STEM knowledge translation is critical for development of STEM identity in students.

**Integrating BPSE in school.** Effective implementation of BPSE takes on an operational perspective that is distinguished by the type of activities Black parents are engaged in. Categorization of STEM development status in the home has similar characteristics when transferred into the school. Based on the parent involvement research of Lamb (2000), Black parent STEM engagement within institutionalized structures can be divided into three operationalized categories of engagement: direct STEM engagement, STEM accessible, and STEM responsibility (Collins, Curry, Marks, and Grantham, 2013) as described in table 5.1.

[insert table 5.1 here]

***Nurturing Black parent STEM engagement in schools.*** For students engaged in STEM disciplines, the school's role is to also nurture parent STEM engagement. In order to achieve school reform that syncs the Black STEM student's ability, interest, academic achievement, and cultural identity, school practices must first advance along the continuum from parent involvement to parent STEM engagement that is supported through enforced district policies, programs, and plans designed to maximize academic potential and STEM talent development. This type of school reform must begin with STEM education and training for teacher on how to effectively work with culturally different parents as collaborative partners. Next, STEM training and education programming specifically for parents and extended family members of students must take place. The school must host STEM programs and STEM related projects that consider, welcome, and include specific Black parent STEM engagement components such as a 'parents as

STEM mentors' program, for example. Lastly, district and school support for Black parent STEM engagement is key.

***Guidelines for effective BPSE.*** Considering the cultural values and traditions of Black family engagement integrated within the work of Epstein (2001), Halgunseth et al (2009), and Bowers and Griffin (2011), six features of effective Black parent STEM engagement emerge as "continuous, reciprocal, and strength-based "(Halgunseth et al, 2009, p.56). These features contribute to STEM self-concept development and successful STEM student achievement are offered as BPSE guidelines:

1. Black parents of students who show interest and/or promise in STEM disciplines act as the "first teacher" for early childhood STEM exposure and talent development.
   *This can be as simple as strategic selection in the toys that include some aspect of STEM development.*
2. Black parents of STEM students, advocating as partners in STEM program decision-making opportunities, are provided opportunities to collaborate and exchange STEM knowledge with other STEM parents as well as teachers of STEM students in order to influence the establishment of student STEM learning goals.
   *When establishing, maintaining, or evaluating STEM curriculum and programs, the parent should be included in all aspects as close as possible to its inception.*
3. Culturally contextual STEM goals and culturally responsive STEM teachings at the home and school are kept consistent through bidirectional communication and facilitated through multiple forms of programming options that are culturally responsive to unique Black parenting values and traditions.

*The home and the school should be an interdependent and seamless. extension of each other.*

4. STEM curriculum emphasizes and includes experiential and problem-based STEM activities that sustain learning within the Black student's community and home.

   *Authentic, community based problem-finding and problem-solving practices that allow for autonomous learning and leadership on part of the student in conjunction with an appropriate mentor from the community should be encouraged.*

5. Black parents purposefully engaged in STEM student development are aware of state and school-based STEM curricula in order to foster a home environment that is conducive to STEM learning that also extends the school's STEM curriculum based on the home and community cultural values.

   *There should be an awareness of the connectedness of STEM learning that naturally occurs at home and how it fits into the school curriculum that is explicitly communicated to the student by the parents.*

6. STEM evaluation programs that fully engage Black parents are dynamic and comprehensive systems that promote Black family engagement through ongoing STEM program leadership, teacher STEM training, and parent STEM capacity building.

   *As the demographics of the student population change within the school, so should the curriculum by which STEM is taught; the STEM curriculum should appeal to teaching of the whole child.*

## Research Imperatives

**Teachers' communication influences STEM self-concept and motivation in Black STEM students**. At the heart of the teaching process is communication (Powell & Powell, 2010). Effective cross-cultural communication depends first on understanding the variation of culture and learner characteristics in the classroom. Knowledge is constructed subjectively and often by a dominant culture that ties schooling to this official knowledge, which also allows that culture to maintain control of the 'truths' that govern student learning (Howard, 2006). The pedagogy involved in communicating the official knowledge within any discipline can serve as a motivational (or de-motivational) tool to influence Black students' identity, self-perception, and interest in their chosen field of study, especially in STEM fields where gaps in diverse representation is prevalent.

Teachers often reveal in their practices their personal connection to the dominant culture including its notion of smartness or implicit intelligence which causes students to connect themselves through natural order rather than to education within academic groups/disciplines. Such connections and self-assignment by students influence their everyday practices in the classroom and correlate their beliefs about whether they have anything worth contributing, their authority in context, and their reflective behavior. If negatively influences, the long term effect on self-concept can lead to low achievement, lack of motivation, and low social/career positioning. Sense of ability to succeed in any field, thus, becomes not about capacity but a cultural practice used to inject meaning of self in others (Hatt, 2012).

Teachers must commit to gaining the cultural knowledge and exhibiting cultural sensitivity in order to effectively communicate in a way that fosters STEM motivation of Black students and their parents. For example, STEM curriculum development and implementation should

highlight contributions of African Americans within the specific content and context that they occurred, not as special topic or just during Black History Month. For Black and other culturally and linguistically different (CLD) students this development and empowerment invariably influence their secondary identity (athlete, mathematician, scientist, engineer, artist, etc.) which directly affects their post-secondary/career trajectory.

## Recommendations

### Addressing the Achievement Gap

As the gap in under-representation of Black students in STEM, gifted, and advanced placement education widens, there is a growing concern and critical focus of multicultural gifted education among researchers. In the preface of her text, *Multicultural Gifted Education* (2011), Ford cited the American Association of Colleges for Teacher Education (AACTE) in its acknowledgment of existing difficulties for cultural and linguistic diverse (CLD) students to integrate their world views, or manifestation of racial identity, and the implications for cultural competent teachers to provide a culturally responsive learning environment (Ford, 2011).

Situated in the literature surrounding Black student identity and studies regarding STEM issues among Black students, there exists a common theme of cultural awareness and value. "To develop equitable outcomes, we need more knowledge than just the correct cultural interpretation … it is also necessary to gain an appreciation of the value of the learner" (McAnany, 2009, p.7). Educators and parents, alike, can address the inequitable achievement gap between Black and White students in STEM disciplines by first examining the underlying issues (causes, traits, reactions, etc.) regarding Black Students' STEM identity development (i.e. attitudes toward STEM self-concept and sense of belonging in STEM field, perception of STEM

cognitive ability, and decisions to pursue STEM interests). As cited in Gary Howard's (2006) book, *We Can't Teach What We Don't Know: White Teacher, Multiracial Schools*, it is important that teachers understand the context in which identity is developed and create an educational environment that acknowledges and values the cultural strengths [of its Black students, and fosters Black parent STEM engagement that is culturally responsive].

### Role of Mentorship to Foster A Sense of Belonging Among Black STEM Students

Critical in the development of a STEM identity for Black students is a sense of belonging in the STEM fields of study, including the classroom and the STEM workforce. Mentoring is a very influential factor in general (Jernigan, 2012) and for the STEM discipline (Hernandez, Schultz, Estrada, Chance, 2012) as it relate to Black student achievement (Goff & Torrance, 1999; Grantham & Ford, 2003; Whiting, 2009). Taken within the context of the STEM discipline, this study confirms the importance of careful match and selection of mentors for Black students throughout their educational and beginning career endeavors. This includes structural conditions of the mentor-student relationship. Noy and Ray (2012) referenced the need for students' ideas to be validated because it shapes students' perceptions of ability. In addition, concluded as an extension of this discussion, STEM fields dominated by White males may also play a role in Black students' perception of belonging and ability, especially Black female students. So it is important that, whenever possible, established, competent, and confident STEM mentors are of the same race or share multiple similarities with STEM students.

## Final Thoughts

This study of Black parent STEM engagement redresses the shortcomings in contextual Black parent engagement by its intentional investigation of the dimensions of Black parent

STEM engagement with a sample of parents of Black STEM students. The goal of this study was to contribute to the literature by providing evidence to validate effective and cultural responsive parenting style and practice. Sound construct validity that integrated various strands of validity evidence ensured that this goal was met with integrity and reliability. Since validated, the multivariate relationship between Black parent STEM engagement and Black student STEM identity (competence and interest) can be explored.

**Table 5.1.** BPSE Within the Home & Institutionalized Structure

| Home/ Contextual Status of BPSE | Institutionalized Structure of BPSE | Impact |
|---|---|---|
| **Conceptual STEM Development**<br>*PARENT engages child in STEM-related activities that influence CHILD's goal to become (or at least think of himself as) a scientist, technician, mathematician, or engineer.* | **Direct BPSE**<br>includes parent-led STEM initiatives and direct interaction with child's learning in school and home (Collins et al, 2013) | What is most important is that Black parents represent the type of involvement they are able to lead and interact directly with their children. |
| ***Translated**: BPSE may include, but not limited to, educators allowing parents to (1) facilitate problem based activities associated with the STEM curriculum or STEM content unit, (2) serve as guest speakers on a specific STEM topic or career field ,and (3) plan an STEM enrichment activity or fieldtrip.* | | |
| **Practical STEM Development**<br>*PARENT engages child in STEM-related activities BUT CHILD does not think of himself as (nor want to be) a scientist, technician, engineer, or mathematician.* | **BPSE Responsibility**<br>category of involvement that includes parents' efforts to meet their child's basic STEM needs (Collins et al, 2013) | The parent's focus for their role in this school-home relationship will be child's academic, social, and emotional well-being in the home, and consequently, at school |
| ***Translated**: For the school, Black parents may take on a more "silent partner" role in terms of communication and presence at school. Parents delegate and expect more responsibility on part of the child, holding them accountable for what they need to do to succeed in the STEM discipline or career field.. Yet, the educator can still effectively engage this parent as a resource for STEM related information. They should be utilized to find community-based STEM resources, programs, and enrichment activities.* | | |
| **Limited STEM Development**<br>*PARENT has little or no resources (money, material, knowledge, etc.) or STEM interest to support CHILD who has a high personal STEM interest.* | | |
| **Deprived STEM Development**<br>*PARENT & CHILD have some STEM interest BUT do not consistently engage in STEM activities or adequately support STEM interest with available resources (money, material, knowledge, etc.).* | **BPSE Accessible**<br>include parents ensuring proximal accessibility of themselves, other parents, and/or formal education to their children. (Collins et al, 2013) | For Black parents, this type of support solidifies the "it takes a village" and community-based rearing of the child. |
| **NO STEM-Value Development**<br>*PARENT & CHILD have little or no STEM interest or STEM-related engagement at home.* | | |
| ***Translated**: Teachers should invite parents to volunteer for regular or special STEM program activities that allow the parent to offer a sense of STEM accessibility to their child. This may also include them acting in non- or indirect-STEM roles such as room parent , coordinating roles for other parents to play in an STEM activity, or facilitating STEM information distribution to other parents* | | |
| ***Adapted from Archer et al (2012) Family Relationship with Science Interview Mapping*** | | |

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# APPENDIX

## Additional Information/ Notes

**Table A1.**

Guiding Principles & Framework for Providing Evidence of Construct Validity: Internal Source of Evidence

| ***The Standards*** *AERA, APA, NCME (2014)* | **Universal System of Construct Validity** *Embretson (2007)* | **Unified Theory & Stages of Construct Validity** *Messick (1989) & Benson (1998)* | **Possible Procedures & Sources of Evidence*** |
|---|---|---|---|
| ***Evidence based on Test Content:***<br><br>How well does the test content represent the content domain? | *Internal Source of Evidence (Meaning)*<br>**Logical/Theoretical Analysis** - Theory of the subject matter content, specification of areas and their interrelationships.<br>**Domain Structure** - Specification of content areas and levels, as well as relative importance and interrelationships.<br>**Test Specifications** - Blueprints specifying domain structure representation, constraints on item features, specification of testing conditions. | **Content-** Do test items appear to be measuring the construct of interest?<br><br>**Substantive-** Is the theoretical foundation underlying the construct of interest sound?<br><br>**Substantive Stage: Definition of the Theoretical and Empirical Domains of the Construct** – scientific theory, previous research, and observations surrounding the traits of the construct as well as the set (and measurable ways) of observed variables that operationalize the construct. | **Procedure**<br>• Define theoretical domain to include all of the dimensions and subtleties of the construct based on dominant and relevant theoretical perspectives;<br>• Provide an operational definition, or construction, representative of the construct within the empirical domain<br>• DeVellis' (2012) eight (8) steps in scale development<br>**Evidence**<br>• Reports of subject matter expert ratings<br>• Observations of behaviors |
| ***Evidence based on Response Process:***<br>**What Cognitive processes do test-takers (or raters/judges) engage in during the test (or when evaluating)?**<br>**Neither of these frameworks provided address this standard separately but Benson (1998) warns that participant's response process could influence the relationship of test of test items and therefore an analysis of responses can be used as evidence based on internal structure** | | | **Procedure** – Item response theory (IRT) can also be used to determine how well a set of items fit the theoretical structure (internal structure)<br>**Evidence**<br>• Analyze individual responses<br>• Question test-takers about performance strategies/responses<br>• Electronically monitor revisions (e.g., writing task)<br>• Eye movements or response times |
| ***Evidence based on Internal Structure***<br><br>Are relationships between test items or test components consistent with the construct the test is intended to measure?<br><br>***(Internal Consistency)*** | *Internal Source of Evidence (Meaning)*<br>**Latent Process Studies** - Studies on content interrelationships, impact of item design features on psychometric properties and response time, impact of various testing conditions, etc.<br>**Item Design Principles** - Formats, item context, complexity, and specific content as determining relevant and irrelevant basis for item responses<br>**Scoring Models** - Psychometric models and procedures to combine responses within and between items, weighting of items, item selection standards, relationship of scores to proficiency categories, etc.<br>***Psychometric Properties*** **-** Item interrelationships, DIF (differential item functioning), reliability, relationship of item psychometric properties to content and stimulus features, reliability<br>***Practical Constraints*** **-** *Available test administration methods, scoring mechanisms (raters, machine scoring, computer algorithms), testing time, locations, etc.* | **Structural**- Do the interrelationships of dimensions measured by the test correlate with the construct of interest and test scores?<br><br>**Structural Stage: Internal Relations Among Observed Variables** – Internal domain studies of the observed variables to determine the extent to which they co-vary among themselves and with the intended structure | **Procedure**<br>• Use statistical methods for conducting construct validity to determine how well items fit structure of theoretical domain;<br>• Use generalizability theory to determine how well items represent empirical domain and how adequately the number of items capture distinct features of theoretical domain;<br>• Use Multi-trait, multi-method matrix (MTMM, *Campbell and Fiske, 1959)* - this internal (convergence of similar constructs) and external (divergence of different constructs) focused design bridges the structural and external stages; it is used to establish (a) discriminant validity and (b) the relative contributions of the trait or method specific variance<br>**Evidence**<br>• Single dimension of behavior/ convergence of the observed variables with the theory<br>• Several theoretical domains of the construct, expected to be related but distinct/ divergence of observed variables in accordance with the theory<br>• Positive results from structural stage studies (necessary condition) |

**Table A2.**

Guiding Principles& Framework for Providing Evidence of Construct Validity: External Source of Evidence

| ***The Standards*** *AERA, APA, NCME (2014)* | **Universal System of Construct Validity** *Embretson (2007)* | **Unified Theory & Stages of Construct Validity** *Messick (1989) & Benson (1998)* | **Possible Procedures & Sources of Evidence*** |
|---|---|---|---|
| ***Evidence based on [Conceptual] Relationship to Other [Related] Variables:***<br><br>Assuming the test measures a particular construct, do test scores relate to the external variables that we would expect them to?<br><br>**External Validity** | *External Sources of Evidence (Significance)*<br><br>**Utility** - Relationship of scores to external variables, criteria, and categories<br><br>**Other Measures** - Relationship of scores to other tests of knowledge, skills, and abilities (KSA's) | **External**- Does the test have convergent, discriminant, and predictive qualities?<br><br>**Generalizability**- Does the test generalize across different groups, settings and tasks?<br><br>**External Stage: Relations Among Constructs** – construct co-varies in theoretical ways with different constructs or characteristics of the subject and is meaningful (significance) as it relate to other variables | **Procedure**<br>• Group differentiation – studying the construct in the presence of known group differences or creating group differences by experimental manipulation of the construct<br>• Correlation of tests – correlate a measure of the construct with a measures of other constructs<br>**Evidence**<br>• Test-Criterion Relationships<br>~Relationship to criterion the test is supposed to predict<br>~Measure of some attribute or outcome<br>~Can also be measured concurrently<br>• Convergent Evidence - Relationship to other test scores measuring the similar constructs<br>• Divergent Evidence - Relationship to other test scores measuring unrelated construct<br>• Rival hypotheses testing |
| ***Evidence Based on Consequence of Test*** | *External Sources of Evidence (Significance)*<br>• **Impact** - Consequences of test use, adverse impact, proficiency levels, etc.<br>• Validation is to indicate whether these specific benefits are likely to be realized<br>• Decisions about test use are appropriately informed<br>• Consequences that are unintended – Test score interpretation for a given use may result in unintended consequences | **Consequential**- What are the potential risks if the scores are, in actuality, invalid or inappropriately interpreted? Is the test still worthwhile given the risks? | **Procedure**<br>• Consideration of praxeology research tradition components<br>• Use Item response theory (IRT) to evaluate the consequences of test use through differential item functioning (DIF):<br><br>**Evidence**<br>• Claims made about testing use that are/ are not directly based on test score interpretations<br>• Validity of test score interpretations depend on the claims that underlie the theory of action for these uses |