

## Perceived social support from parents and teachers' influence on students' mathematics-related self-beliefs

E. A. Bofah & F. D. Ntow

### Abstract

Studies have shown that parents' and teachers' behaviors shape young people's self-beliefs and achievement in mathematics. Little research has documented the ways in which perceived social support (PSS) promotes students' self-beliefs (self-confidence and self-concept) towards mathematics in Ghana. Given the important role that students' PSS (from parents and teachers) plays in fostering children's academic interest, this paper aims to identify the empirical link between PSS and students' mathematics self-beliefs. The sample consisted of 2034 12th grade (average age = 18.49, girls = 58.20%) high-school students. The possible mediating role of students' self-confidence on the relationship between students' PSS and self-concept was examined using latent variable structural equation modeling. The results indicated that PSS statistically significantly predicts students' mathematics self-belief. Moreover, students' mathematics self-confidence was found to play a mediating role between PSS and mathematics self-concept. The proportion of the effects mediated, however, varied across the two support sources from 12% to 34%. The findings lend support to the theoretical assumptions in the literature that supportive social relationships influence students' self-beliefs.

**Keywords** social support; mathematics self-concept; mathematics self-confidence; path models; mediation analysis.

### Introduction and background

The effect of Mathematics-related affective measures on mathematics learning and achievement has long been a concern of mathematics educators and researchers (e.g., McLeod, 1992). Students' mathematics affective dispositions influence their learning of mathematics, for better or for worse (Bofah, 2015, 2016; Bofah & Hannula, 2015b; Hannula, 2015a, 2015b; Hannula, Bofah, Tuohilampi, & Metsämuuronen, 2014; Holm, Hannula, & Björn, 2016; McLeod, 1992; Wilkins & Ma, 2003; Zembylas, 2004). Zembylas, (2004, p. 716) indicated that affect (e.g., emotions, beliefs) shape learning experiences for students, and recognition of their significance merits further consideration in both learning theory and pedagogical practice. Wilkins and Ma (2003) highlighted the significance of mathematical related affective measures:

a person's mathematical disposition related to her or his beliefs about and attitude toward mathematics may be as important as content knowledge for making informed decisions in terms of willingness to use this knowledge in everyday life. (p. 52)

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Moreover, a positive mathematical disposition is a yardstick for being quantitatively literate (Wilkins & Ma, 2003). Moreover, mathematics is a highly regarded school subject, and people who are confident and competent in mathematical activities are seen as possessing some sort of superior intellect, although perhaps being perceived as a little socially inept and 'geeky' (Grootenboer and Marshman 2016, p. 1). In Ghana, mathematics has been used as a critical filter for entry into the so-called STEM (Science, Technology, Engineering, and Mathematics) programs in all levels of education. Moreover, high school mathematics ability is seen "as the means through which individuals can make sense of the world; that mathematics is an empowering force in solving life's problems" (Gates & Vistro-Yu, 2003, p. 33). It is also true that mathematicians, mathematics educators and policy-makers see mathematics as an opportunity for grappling with real-time problems while contributing to an understanding of the basic processes involved in learning and performance (Gray, 2014). The importance of the social influences on mathematics affect has long been recognized (Blömeke & Kaiser, 2015; Lee, 2009; see Hannula, 2015b for a commentary). It has been increasingly recognized in the field of education that perceived social support (PSS:from parents and teachers) has significant impacts on students' learning and developmental processes. Mathematics education researchers, for example, have devoted considerable attention to examining the role that PSS play in students' affective disposition in the learning of mathematics (Ahmed, Minnaert, van der Werf, & Kuyper, 2010; Gonzalez-Pienda et al. 2002; Rosenfeld, Richman, & Bowen, 2000). Several researchers have argue that students' self-evaluations are developed via social interactions and experiences (e.g., Eccles [Parsons] et al., 1983; Eccles [Parsons], Adler, & Kaczala, 1982; Freiberger, Steinmayr, & Spinath, 2012; Wigfield & Eccles, 2000). In light of the above, the present study set out to verify the role of PSS in students' mathematics self-beliefs—namely, confidence in oneself and in one's ability—and to examine the affective pathways through which PSS influences students' self-beliefs. In particular, the study examine how students' self-confidence in mathematics mediates the association between PSS (from parents and teachers) and self-concept. In what follows is a discussion on the empirical evidence and consequent theoretical explanations of social support and its association with self-beliefs.

### **Social Support and Self-beliefs**

Studies have shown that students' social support such as parental and teacher support predict their academic self-beliefs and attitudes towards mathematics (e.g., Stake, 2006; Strayhorn, 2010). Of particular interest to the present study are studies that dealt with the association between social support (from parents and teachers) and self-beliefs. Mathematics self-beliefs "illustrate students' subjective convictions" (Organization for Economic Co-operation and Development [OECD], 2013; p. 81) and the internal representations to which the holder attributes truth, validity, or applicability, usually stable and highly cognitive, may be highly structured (Goldin 2002, p. 61). They include one's total confidence in oneself and one's ability. They play a significant and independent role in individuals' continued growth and in the development of their mathematical skills and competencies (Bandura, 1997; OECD, 2013). Mathematics self-beliefs influence how students function when confronted with mathematical problems, influence how students perceive themselves as mathematics learners (Bong & Skaalvik, 2003; Bofah, 2016; Chaman, Beswick, & Callingham, 2014; OECD, 2013), and they affect the choices students make about educational and career paths (Wigfield & Eccles, 2000). In this study, mathematics self-beliefs is

conceptualized to include self-confidence (often referred to as competence belief: Mcleod, 1992) and self-concept. There has been considerable debate concerning the definitions, specificity and overlap between the different self-belief constructs in this area (see e.g., Bong & Skaalvik, 2003; Ferla, Valcke, & Cai, 2009; Morony, Kleitman, Lee, & Stankov, 2013; Stankov, Morony, & Lee, 2014). Although the constructs overlap considerably and share certain undistinguished similarities, they are indeed independent psychological constructs that are empirically distinct from each other (Bong & Skaalvik, 2003; Lee, 2009; Lee & Stankov, 2013; Morony et al., 2013; Wesson & Derrerr-Rendall, 2011).

Mathematics self-confidence refers to students' perceptions of how good they are at performing a given task (Ahmed et al., 2010), whereas self-concept is often broadly defined as one's perception of the self that is continually evaluated and reinforced by personal inferences about oneself (Lee, 2009, p. 355). That is, self-confidence refers to the anticipation of successfully mastering challenges, and to the belief that one can make things happen in accordance with one's inner wishes (Rosenberg, 1986, p. 31).

Mathematics self-concept on the other hand, refers to students' cognitive representations of their own mathematics abilities (Spinath & Steinmayr, 2012; Wigfield & Eccles, 2000). Self-concept also encompasses a comparative component in which students judge their attitudes and abilities in comparison with their peers; referred to in the literature as frame of reference effect (Bong & Skaalvik, 2003; Rosenberg, 1986). Mathematics self-concept is a "thought process" (Kloosterman, 1988) and multidimensional (Marsh, 1993). As Mcleod, (1992, pp.583-586) emphasized, "it is reasonable to think of confidence as belief about one's competence in mathematics and ... self-concept as a generalization of confidence in learning mathematics".

High mathematics self-confidence allows students to feel better about themselves, making them more interested in pursuing mathematics and its related disciplines. Hence a learner may be confident within one area of mathematics, but perhaps not another (Bong & Skaalvik, 2003; Ferla, Valcke, & Cai, 2009; Morony, Kleitman, Lee, & Stankov, 2013; Stankov, Morony, & Lee, 2014). Moreover, both self-concept and self-confidence involve the cognitive dimension of self-evaluation, as they are formulated based on either one's judgment (perception) of either oneself as a person (i.e., self-concept) or one's perceptions of how good one is at performing a particular task (i.e., self-confidence) (Lee, 2009; Ahmed et al. 2010). Shavelson, Hubner and Stanton, (1976, p. 411) noted that these perceptions are formed through experience with the environment, and are highly influenced by environmental reinforcements (e.g., perceived social support)(see also Wilkins & Ma, 2003).

Perceived social support is a distal background factor that influence affect and outcome expectations by affecting learning experiences (Lent et al. 1994, 2000; Rice et al. 2013, p. 1029). Perceived social support has also been characterized as individuals' confidence that adequate support would be available if it was needed or to characterize an environment as helpful or cohesive (Barrera, 1986, p. 417) for learning a given school domain (e.g., mathematics).

Both theoretical and empirical research studies claim the existence of a relationship between PSS and affects (e.g. self-beliefs). For instance consistent with ecological development theory (Bronfenbrenner, 1979; Murdock & Miller, 2003) and the modern expectancy-value theory (Eccles[Parsons] et al., 1982; Wigfield & Eccles, 2000), research has indicated that children have a greater sense of their affective dimensions when their parents and teachers are more involved in their education (e.g., Grolnick & Slowiaczek, 1994; Marchant, Paulson, & Rothlisberg, 2001).

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Bronfenbrenner's ecological development theory holds significant assumptions that students' background and affective traits (e.g., self-concept [microsystem]), family-level variables (e.g., parental support [mesosystem]), school-level factors (e.g., teacher support [exosystem]), and historical trends and events (e.g., cultural expectations [macrosystem]) interact and influence individual-level students' affect (Strayhorn, 2010). That is, expectations and self-beliefs develop within multiple contexts of students' lives, ranging from the macrosystem context such as cultural expectations, to more proximal microsystem contexts, or to the interpersonal relationship between students and individuals in their lives (Murdock & Miller, 2003, pp. 384-385). Moreover, Keesee (1975) conceptualized educational environment of students to include the home (family), school (teacher) and peers, and posited that these social environmental agents influence students' self-beliefs and achievements. Concerning the expectancy-value theory, Eccles[Parsons] and colleagues posit that children's self-beliefs on their mathematics competency are manifestations of their parents' and teachers' self-beliefs and perceptions (Bhanot & Jovanovic, 2009; Eccles[Parsons], Adler, & Kaczala, 1982). For instance, Eccles[Parsons] et al. (1982) found that parents who think their children are not good in mathematics, and that mathematics is difficult, turn out to have children with a low mathematics self-concept. Our focus here is on understanding the extent to which students' relationships with teachers and their parents in their education could explain the variation in their self-beliefs.

Parents' and teachers' expectations and attitudes have been found to shape student's self-concept, aspirations and expectations of success (e.g., Ormrod, 2011). Moreover, research has shown that a good mutual relationship between parents and teachers can benefit the academic success of the child (Sheldon & Epstein, 2005). Parental support or involvement has been defined in various ways in the literature; for example, parental aspirations for their children's academic achievement, parents' communication with their children about education and school matters, parents' participation in school activities, parents' communication with teachers about their children, and parental supervision at home (Fan, 2001). This inconsistency in defining the constructs underlines the multidimensional nature of parental support or involvement. In this study, we operationalized perceived parental support as parents' guiding, being aware of the importance of school and mathematics in the child's everyday life, emphasizing the importance of mathematics at home, emphasizing learning as a process, helping with homework, attitudes towards mathematics and discussing day-to-day school activities (Epstein, 2010).

Studies have indicated that when families become involved in their children's education, both at home and at school, and are supported by cordial relationships with teachers, students' self-beliefs increase, as does achievement (Hughes & Kwok, 2007). Moreover, the perceived parent-teacher relationship contributes to children's academic pursuits and positive self-perceptions (Hughes & Kwok, 2007). Perceived parental support has been positively associated with interest in school and self-beliefs (e.g., Ahmed et al., 2010; Wentzel, 1998). Moreover, Stake (2006) found parental support to be positively related to children's beliefs about science and mathematics. The parent-child relationship allows the child to explore, leading to the development of both internal and external working models that "promote exploratory competence, self-efficacy, and self-esteem" (Moss & St-Laurent, 2001, p. 83). Other studies have found that positive encouragement from teachers, peers, and parents is associated with positive self-beliefs about the social importance of

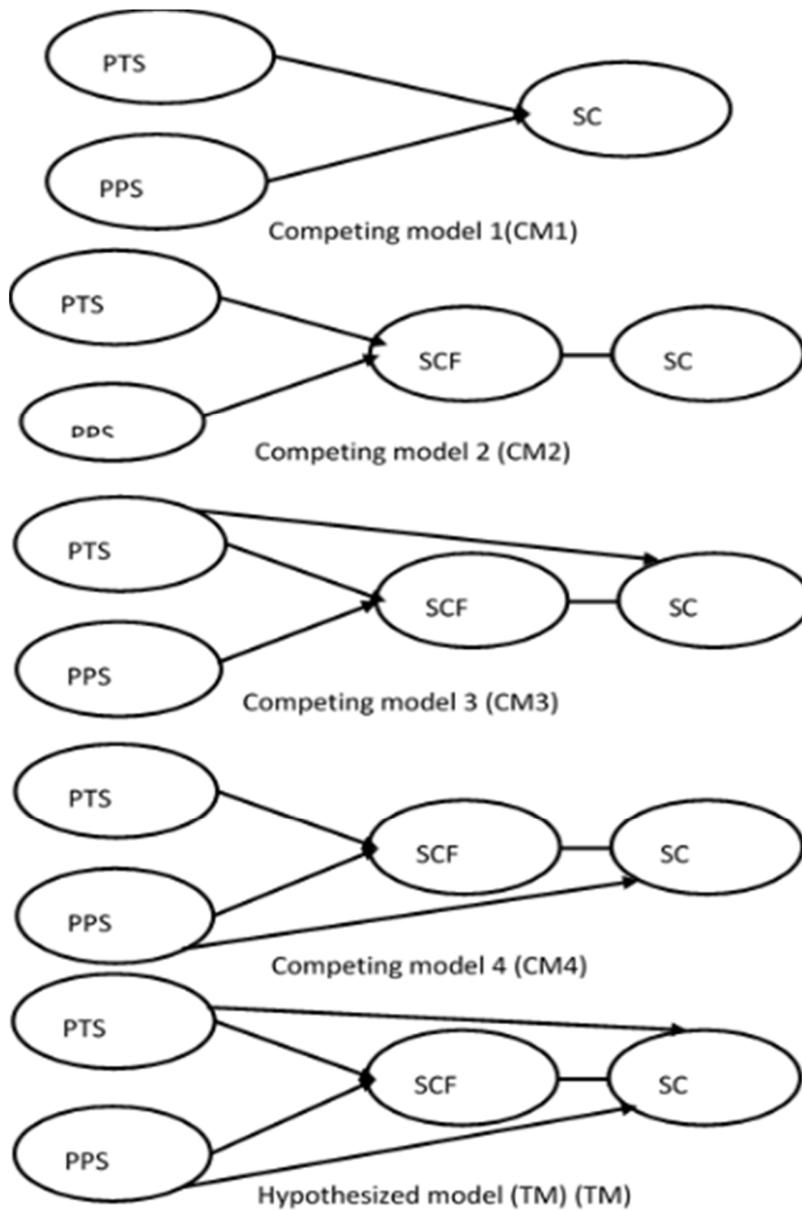
mathematics and helped to diminish the development of negative self-beliefs (e.g., Wilkins & Ma, 2003).

A positive relationship with the teacher has been found to have a positive influence on students' self-beliefs (e.g., Ahmed et al., 2010; Covington & Dray, 2002; Marchis, 2011; Murdock & Miller, 2003; Wilkins & Ma, 2003). For instance, Marchis (2011) and Murdock and Miller (2003) found that students' assessment of teacher support strongly predicts students' affect towards mathematics. Moreover, the quality of the perceived teacher-student relationship in Grade 7 has been found to predict students' self-concept in Grade 9, even after controlling for seventh-grade self-concept and achievement (Murdock et al., 2000). Other studies (e.g., Goodenow, 1993; Roeser, Midgley & Urban, 1996) have indicated that students who perceived greater teacher support felt a stronger sense of belonging in the school environment, and in turn exhibited higher self-beliefs. Wentzel (1998) found that perceiving positive teacher-student relationships predicted a positive school-related affect even after controlling for perceived parental and peer support. In the present study, perceived teacher support is conceptualized to include the students' self-reported attributes of their teacher with respect to how the teacher inspires, encourages and creates a positive and varied learning environment as well as carefully guides students through mathematics learning processes. In general, the studies support the assumption that family and teacher relationships influence the affective dispositions of students (e.g., Eccles, 2007; Wilkins & Ma, 2003). Moreover, both empirical and theoretical evidence suggest that the perceptions of available social support (from parents and teachers) influence thoughts about the self.

A novel contribution of this study is that the effect of both parental support and teacher support on students' self-beliefs was examined in a relatively new context (i.e., Ghana) whereby cultural, socio-economic, career-related and gender issues are substantively different (see Hannula, 2015a, 2015b, for an overview). A deeper understanding of the complex interplay between social support and mathematics self-belief is important for educational researchers, and indigenous research and theorizing that integrates understudied cultures/nations are crucial to the establishment of more useful and universal theories (van de Vijver & Leung, 2000). Moreover, all identified studies have focused on younger adolescents, in no higher than the eighth grade. Thus, the present study continues this line of research by extending the literature to encompass older adolescents in Grade 12. Also, new research in under-studied cultures/nations on self-beliefs can challenge the foundations of current theories and provide new ways of looking at the self (Chiu and Klassen, 2010, see also Bofah, 2015, 2016; Bofah & Hannula, 2015).

### *The Current Study*

The purpose of the study was to determine the extent to which students' self-concept in mathematics could be explained by students' mathematics self-confidence as well as perceived teacher and parental support in mathematics. The mechanism by which students' perceived teacher and parental support influences self-concept has attracted little attention. Heeding the call of researchers for domain specificity in assessing the relationship between perceived social support and self-beliefs (e.g., Ahmed et al., 2010), all variables in the current study are defined and assessed with regard to mathematics, a school domain being used as a critical filter for entry into STEM programs in Ghana. In brief, the current study examined the direct effects of perceived social support (from parents and teachers) on students' self-beliefs. The study also tested whether self-confidence mediates the effects of the two support sources on self-concept. The hypothesized mediation model (TM) and associated competing models tested in the present study are presented in Figure 1.



**Key**

- Perceived teacher support (PTS),
- Perceived parental support (PPS),
- mathematics self-confidence (SCF),
- Mathematics self-concept (SC) and
- Theoretical model (TM).

(To avoid cluttering, only path estimates are shown).

**Figure 1. Competing models tested in the study**

It is important to note that the literature supporting the hypothesized model (Figure 1: TM) is limited, and based mostly on research from European and American perspectives. As such, the study is exploratory in nature. However, the extant literature provides an opportunity for the study to hypothesize the possible direct and indirect relationships between students' mathematics self-concept (SC), self-confidence (SCF), perceived teacher support (PTS) and parental support (PPS).

The model flows from left to right, with the arrows representing the hypothesized causal impact of one variable on another. The model's structural component indicates that perceived teacher and family support would affect mathematics self-confidence, which would then affect mathematics self-concept. In addition, perceived teacher and family support affects mathematics self-concept directly. Although the figure suggests a causal relationship between the variables, I do acknowledge that reciprocal relationships could also be possible. Nevertheless, most of the associations are derived from existing empirical evidence as well as theoretical models that portray the relationships between the variables as depicted in the figure.

The current study hypothesized the following:

- Hypothesis 1: Perceived social support (from parents and teachers) has a positive and direct effect on mathematics self-confidence.
- Hypothesis 2: Perceived social support (from parents and teachers) has a positive and direct effect on mathematics self-concept.
- Hypothesis 3: Mathematics self-confidence has a positive and direct effect on mathematics self-concept.
- Hypothesis 4: A positive relationship exists between the two sources of perceived social support.

Based on the hypotheses above, mathematics self-confidence was expected to have mediating effects on the relationship between perceived social support (from parents and teachers) and mathematics self-concept.

- Hypothesis 5: The relationship between perceived teacher support and mathematics self-concept is mediated by mathematics self-confidence.
- Hypothesis 6: The relationship between perceived parental support and mathematics self-concept is mediated by mathematics self-confidence.

## **Methods**

### *Sample and setting of study*

The sample consisted of 2034 twelfth-grade Ghanaian students ( $M_{age}=18.49$ ,  $SD_{age}=1.25$ ; 58.2% girls). Education in Ghana follows a two-tier model with three stages of compulsory schooling (Kindergarten: two years for 4-year-olds; Primary school: six years for 7 to 12-year-olds; Junior High School: three years from age 13 to 15; and Senior Secondary School (upper-secondary): four years from age 15 to 18). In more simple terms, Ghana operates a 6-3-3 system of education. Nine senior high schools were selected from urban and rural areas in Ghana, and school rankings by the Ghana Education Service were used to select schools across performance levels, as such survey participants' demographics resembled overall educational population in Ghana. The schools included single-sex, coed, private, religious and public schools.

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### *Measure*

Participants completed a questionnaire that assessed several constructs regarding their views on mathematics (Hannula et al. 2005; Roesken et al. 2011). These measures are an abridged version of the Views on Mathematics (VOM) scale developed in Finland by Pehkonen's research team (Hannula et al., 2005; Roesken et al., 2011). There were four items on the mathematics self-confidence factor (e.g. "I know that I can do well in mathematics"; "I know that I can do well in mathematic") and 12 on the mathematics self-concept factor (e.g. "I can handle advanced mathematics tasks"; "Mathematics has been a clear and precise subject to study"), six on the teacher support factor: (e.g. "The teacher has so far been a positive example"; "Teacher explains what the studied topics are needed for"), and three on the parental support scale factor : (e.g. "My family encourages me to study mathematics"; "The importance of competence in mathematics has been emphasized at my home"). Each item was rated on a five-point Likert scale ranging from *always* to *never*. The constructs "reliability" and "validity" have been established in several studies (e.g., Bofah & Hannula, 2014, 2015a, 2016; Roesken et al., 2011). For instance, measurement invariance of the construct across student gender (Bofah & Hannula, 2014, 2016), as well as single sex and coed schools (Bofah & Hannula, 2016) has been established. The questionnaires were voluntary and students had the right to withdraw or skip any question that they did not wish to answer. There were 63 different student classrooms with an average class size of 32 students.

### *Data Analysis*

All analyses in the present study were conducted using Mplus 7.4 (Muthén & Muthén, 1998-2015). The analyses were based on the Mplus robust maximum likelihood estimator (MLR). The Mplus MLR procedure permits test-of-fits that are robust for non-normality. Because of the design with students clustered within schools, we used the Mplus complex survey design option to control the clustered design and adjust standard errors. Class was used as the clustering variable as it is used to uniquely identify the sampled classrooms. Missing data were handled with the Mplus feature of full information maximum likelihood (FIML), allowing us to make use of the full sample size (although there were four cases with missing data on all variables and these were not included in the analysis). The research model is depicted in Figure 1. For a well-fitting model, and since method effects have been found to be associated with the negatively worded items in the construct (the six negatively worded items on the mathematics self-concept construct and the three negatively items on the teacher support construct) (Bofah & Hannula, 2015b), correlated uniqueness relating these negative items were incorporated into the model in order to control for the method effect associated with negatively worded items in the two scales (not shown on the diagram). Similar procedures can be found in several studies (e.g., Distefano & Motl, 2009; Marsh, 1994).

Bootstrapping procedures adjusted by bias-correction (BCa) were used to determine the statistical significance of the indirect path coefficient as recommended in the literature (Cheung, 2009; MacKinnon, Lockwood, & Williams, 2004; Preacher & Hayes, 2008; Preacher, Rucker, & Hayes, 2007). Bootstrapping has been found to be the most powerful and reasonable method for obtaining confidence limits for specific indirect effects under most conditions (Preacher & Hayes, 2008; Williams & MacKinnon, 2008). Bootstrapping is a resampling technique that draws a large (e.g., 5000) number of subsamples from the original data with replacement and estimates models for

each subsample; the results are aggregated to obtain parameter estimates, and standard errors estimates to assess statistical significance without relying on distributional assumptions (Hair Jr, Hult, Ringle, & Sarstedt, 2013). If the confidence interval includes zero, then no definitive evidence exists of an indirect relationship, but if the confidence interval does not include zero, this leads to the inference of an indirect relationship.

The analyses examined the hypothesized measurement model and structural pathways (hypotheses 1 to 6) among latent constructs in the model based on a number of structural equation modeling global fit criteria. These involve Chi-square Difference Testing using a Satorra-Bentler Scaled Chi-Square test statistic ( $SBS\Delta\chi^2-MLR\chi^2$ ) (Satorra & Bentler, 2001). A Chi-square is commonly used as an indicator of good fit (non-significant) but is very sensitive to large sample sizes. Hence, the Comparative Fit Index ( $CFI > .90$ ) and Root Mean Square Error of Approximation ( $RMSEA < .06$ ), which is less sensitive to sample size and model parsimony, were used in combinations (West, Taylor, & Wu, 2012).

The mediation effect was examined on two levels: using the chi-square difference tests to examine the overall changes in model fit, and indirect effects to examine the mediation effects of the individual pathways. Mediation exists when a predictor affects a dependent variable indirectly through at least one intervening variable, or mediator (Preacher & Hayes, 2008, p 879). To determine the best-fitting model as well as to support our mediating analysis, four competing models were compared in addition to the theoretical model (see Figure 1). Competing Model 1 (CM1) represents the models whereby perceived social support (from parents and teachers) predicts students' mathematics self-concept without the mediator (mathematics self-confidence). Competing model 2 (CM2) is CM1 with the mediator (mathematics self-confidence). Competing model 3 (CM3) represents the theoretical model without the linkage from parental support to mathematics self-concept. Competing model 4 (CM4) represents the theoretical model without the linkage from teacher support to mathematics self-concept. If CM2 shows a significantly better model fit than CM1, it indicates that mathematics self-confidence completely mediates the relationship between each of the two support sources and mathematics self-concept. If CM3 exhibits a significantly better model fit than CM2, it indicates that mathematics self-confidence plays a partly mediating role between teacher support and mathematics self-concept. If CM4 exhibits a significantly better model fit than CM2, it is an indication that self-confidence partly mediates the relationship between parental support and mathematics self-concept. Moreover, if the theoretical model (TM) exhibits a significantly better model fit than CM2 (and also CM3 and CM4), this would suggest that self-confidence plays a partly mediating role between the two support sources and self-concept.

## **Findings**

Figure 2 includes the unique relationships between the variables based on the structural equation modeling. The error covariances of the six negatively worded items on self-concept and three on teacher support were allowed to covary, to account for the method effect associated with negatively worded items (not shown). Two models, one with and other without the correlated uniqueness between the negatively worded items were tested, to show that including the correlated uniqueness in the model improved the model.

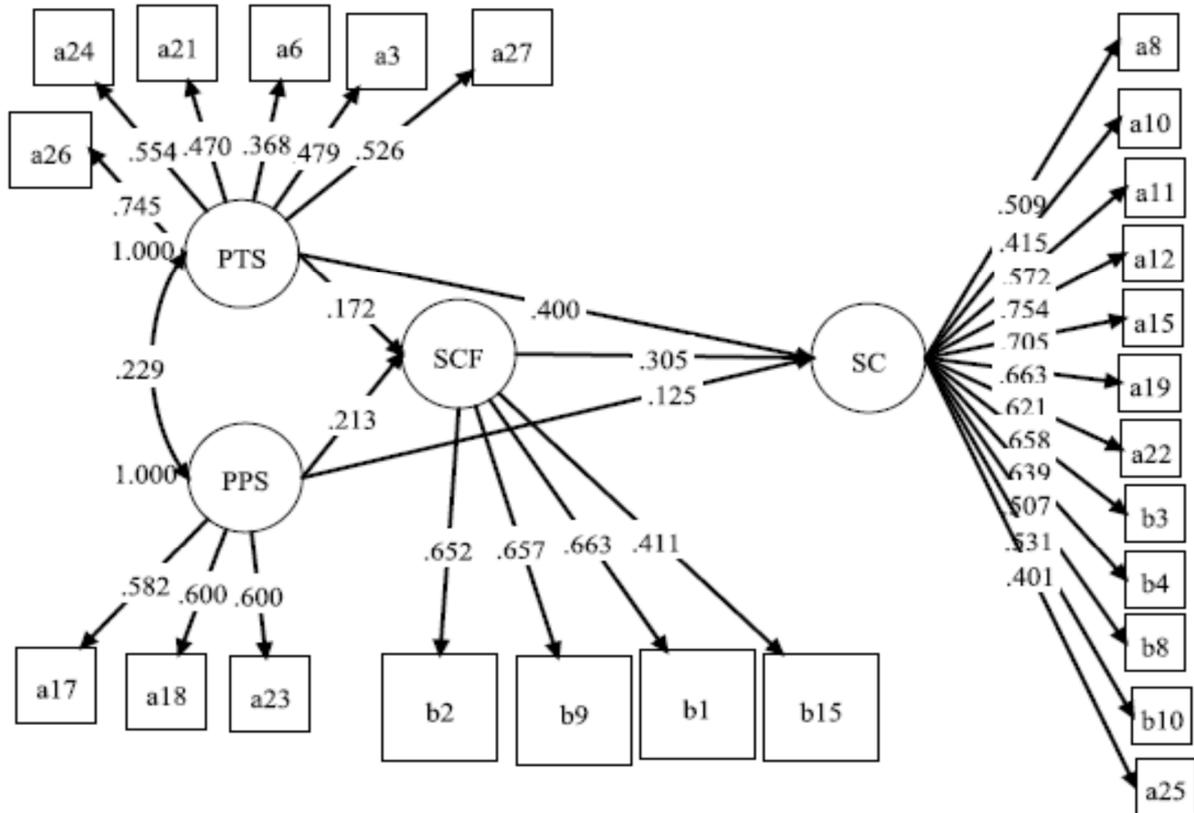


Figure 2 Estimate of the hypothesized model

PTS = perceived teacher support,  
 PPS = perceived parental support,  
 SCF = mathematics self-confidence,  
 SC = mathematic self-concept.

All estimates are statistically significant at  $p < .001$ . To avoid cluttering, correlated uniqueness for the negatively worded items are not shown. For item wording, see supplementary documents.

Fit indices  $MLR\chi^2 = 626.44$ ,  $df = 233$ ;  $CFI = .96$ ;  $RMSEA = .03$  [90% CI .03-.03].

The correlation analysis (Table 1) shows that students' self-concept was positively related to students' self-confidence, as well as teacher and parental support. Furthermore, self-confidence was positively related to teacher and parental support. Finally, teacher support was positively related to parental support.

#### Assessing the Structural Model

The fit indices and the Satorra-Bentler Scaled Chi-Square test statistic ( $SB\Delta\chi^2 - MLR\chi^2 = 514.09$  and  $\Delta df = 36$ ) indicated that the model with the correlated uniquenesses ( $MLR\chi^2 (233) = 626.44$ , scaling correction factor for MLR = 1.179;  $CFI = .961$ ,  $RMSEA = .029$ ) provided a significantly better fit to the data than the model without the correlated uniquenesses ( $MLR\chi^2 (269) = 1142.35$ , scaling correction factor for MLR = 1.181;  $CFI = .914$ ,  $RMSEA = .040$ ), thus supporting our earlier

argument that achieving an acceptable model fit requires controlling for the method effects associated with the combined use of negatively and positively worded items in our data set.

Consequently, this theoretical model was adopted for the study (estimates represented in Figure 2). The factor loadings ranged between .401 and .754 for mathematics self-concept, .368-.745 for teacher support, .582-.600 for parental support, and .411-.657 for mathematics self-confidence. The model accounted for 36.40% and 9.20% of the variability (proportions of explained variance) in self-concept and self-confidence, respectively.

#### *Direct Effects*

Hypotheses H1 to H4 were all supported. Specifically, perceived parental support was found to have a statistically significant positive and direct effect on mathematics self-concept and self-confidence. Moreover, perceived teacher support had a direct and statistically significant positive effect on mathematics self-confidence and self-concept. Self-confidence had a statistically significant positive direct effect on mathematics self-concept. In fact, the relationship between perceived parental support and self-concept was considered weak after controlling for perceived teacher support and self-confidence. The results show that teacher support was the most influential predictor of students' self-concept followed by students' self-confidence based on the magnitude of the  $\beta$  value. The weakest predictor of students' self-concept was students' perceived parental support.

#### *Indirect Effects*

The magnitude and statistically significant pathways that represent the indirect (i.e., mediated effect) effects of teacher and parental support on self-concept (via self-confidence) were evaluated. These are hypotheses H5 and H6. Following the guidelines for mediating hypothesis testing (e.g., Preacher & Hayes, 2008), the mediating effect of self-confidence on the perceived parental support construct was tested, and was found to be statistically significant (standardized:  $\beta = .063$ , 95% BCa bootstrap CI (.035, .101)). These results indicate that the relationship between parental support and students' self-concept was mediated by students' self-confidence. The Variance Accounted For (VAF), which determines the size of the indirect effect, was .306. This implies that almost 30.60% of the parental support effect on self-concept is mediated. The VAF determines the size of the indirect effect in relation to the total effect—proportion mediated. This value is normed between 0 and 1 (or 0% to 100%). Higher results indicate a stronger mediation. As such, self-confidence can be said to have been a partial mediator between parental support and students' mathematics self-concept. The total effect of the parental support on self-concept variates was (standardized:  $\beta = 0.206$ , 95% BCa bootstrap CI [.130 .281]).

The total effect of the teacher support variate on the self-concept variate was (standardized:  $\beta = .432$ , 95% BCa bootstrap CI (.310, .441)). The indirect effect of self-confidence on the teacher support construct was found to be statistically significant (standardized estimate of  $\beta = .054$ , 95% BCa bootstrap CI (.030, .084)). This indicates that self-confidence partly mediated between teacher support and mathematics self-concept. The examination of the proportion of effects mediated showed that 12.50% of the effect of teacher support on self-concept was mediated by the self-confidence construct.

A pairwise contrast of the two indirect effects was examined, to test whether the two indirect effects—with respect to their magnitudes—differed significantly. The defined contrast estimate

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was -.016 with BCa 95% CI of [-0.03, 0.06]. Because zero is contained in the interval, the two indirect effects could not be distinguished in terms of magnitude.

**Table 2 Path coefficients and indirect effects on the direct and mediation models**

Model	To SCF	To SC	$\beta$	Bootstrap 95% CI	Test
From teacher support	.172 (H1)	.400(H2)			Accepted
From parental support	.213 (H1)	.123 (H2)			Accepted
From self-confidence		.305 (H3)			Accepted
Specific indirect: PTS →SCF→SC (H5)			.054	[.030, .084]	Accepted
Total			.432	[.363, .495]	
Specific indirect: PPS→SCF→SC (H6)			.063	[.035, .101]	Accepted
Total			.206	[.130, .281]	

Note. Standardized path coefficients. CI= confidence interval; PTS= Perceived teacher support; PPS = perceived parental support; SCF = self-confidence, SC = self-concept, H1- H6 = Hypothesis 1 to hypothesis 6; all estimates are statistically significant at  $p < .001$ .

*Competitive Models*

Next, the theoretical model (TM) presented in Figure 1 was tested (and analyzed in the previous section) against several competing models that are simpler than the theoretical model. Table 3 presents the statistical indices for the theoretical model and the competing models. The  $SBS\Delta\chi^2$ - $MLR\chi^2$  for models CM2 and CM1 was 373.26 (with  $df = 85$ ,  $p < .001$ ), indicating a significant difference between the two models. However, all other fit indices indicated that model CM1 fit better than model CM2. This shows that model CM1 was significantly better than model CM2, indicating that self-confidence does not completely mediate the relationship between the two support sources. Moreover, the  $SBS\Delta\chi^2$ - $MLR\chi^2$  for the comparison between models CM2 and CM3 was 144.89 (with  $df = 1$ ,  $p < .001$ ), and between models CM2 and CM4 was 26.04 ( $df = 1$ ), an indication that the models are different but that CM3 and CM4 have a better model fit than CM2, as indicated in all other fit indices. This suggests that self-confidence partly mediates the relationship between the two support sources (from parents and teachers) and self-concept, supporting our early findings.

**Table 3 Fit Indices for the competing models**

Competing Models	$\chi^2$	df	S	CFI	RMSEA	AIC	BIC
TM	626.44	233	1.180	.961	.029	151665.51	152322.56
CM1	461.72	150	1.142	.967	.032	135075.02	135647.83
CM2	841.81	235	1.183	.941	.036	151917.98	152563.79
CM3	640.68	234	1.181	.960	.029	151680.80	152332.23
CM4	797.87	234	1.179	.945	.034	151864.96	152516.39

Note. Theoretical model (TM), see Figure 1; CM1 = models with parental support → self-concept, and teacher support → self-concept; CM2 = model including students' self-confidence as a predictor of students' self-concept and a mediator between parental support and teacher support; CM3 = CM2 with an additional path from teacher support to self-concept; CM4 = CM3 with an additional path from parental support to self-concept. S = Scaling Correction Factor, CFI = Comparative fit index, RMSEA = Root Mean Square Error Of Approximation, robust maximum likelihood estimator (MLR), df = degrees of freedom, Akaike (AIC), Bayesian (BIC).

Moreover, the  $SBS\Delta\chi^2-MLR\chi^2$  for models TM and CM2 was 167.48 (with  $df = 2, p < .001$ ), indicating that models CM2 and TM were significantly different. The  $SBS\Delta\chi^2-MLR\chi^2$  for models TM and CM3 was 2.83 (with  $df = 1, p > .05$ ), indicating that models TM and CM3 were not significantly different. The  $SBS\Delta\chi^2-MLR\chi^2$  for models TM and CM4 was 212.99 (with  $df = 1, p < .001$ ), indicating a significant difference between models TM and CM4. However, the theoretical model (TM) yielded a better model fit than CM2, CM3 and CM4 in terms of other fit indices. This suggests that TM was significantly better than CM2, CM3 and CM4. As a result, the partly mediating role of mathematics self-confidence between the two support sources (from parents and teachers) and mathematics self-concept was supported.

Although it was not a purpose of this study, other models to determine if gender moderated all of the significant paths were examined. The results showed that gender did not moderate any of the paths in our model

### Discussion

The analysis presented here focused on the predictors of students' mathematics self-confidence and self-concept. Specifically, the present study investigated how students' perceived social support (from parents and teachers) might relate to self-confidence and self-concept. In addition, the study examined whether mathematics self-confidence might mediate the relationship between perceived social support and self-concept. The results of the study support the expectation that social support activities influence student affects in their mathematics self-concept. Moreover, the study indicates that mathematics self-confidence statistically significantly predicts mathematics self-concept, although students' self-confidence plays a mediating role between perceived social support and mathematics self-concept. However, whereas the magnitude of the unique effects of perceived social support on self-concept varies across the two support sources, the two indirect effects, as well as the unique effect of the two support sources on the mediator cannot be distinguished in terms of magnitude. The study shows that teacher support is the most influential predictor of students' self-concept. This is in line with the literature (e.g., Marchis, 2011; Murdock

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& Miller, 2003; Wentzel, 1998) and contradicted studies that indicate parental support as the strongest predictor of students' self-concept (Gonzalez-Pienda et al., 2002).

The results showed that the students' perceived support (from parents, and teachers) influenced their self-confidence, which, in turn, enhanced their self-concept. First, the findings indicate that students who described their parents as supportive appeared to report higher self-beliefs. Such students in general feel confident in mathematics learning, which in turn influences their self-concept. The results affirm the significance of social support in terms of students' academic affective disposition (e.g., Ahmed & Minnaert, 2010; Parsons et al. 1982; Roeser et al. 2000; Wilkins & Ma, 2003). Moreover, the results demonstrated that the self-confidence mediator uniquely accounted for significant proportions of the variance in the mediated effect of parental support.

Finally, the results indicated that students who perceived their teacher as supportive tended to show higher self-confidence, which, in turn, is related to their self-concept. That is, the perception that mathematics teachers are supportive may influence students' self-beliefs in mathematics learning and instruction. With respect to teacher support being the most significant predictor, it could be argued, similarly to Ahmed and Minnaert (2010), that students' perceived teacher support is an indication that they can access an authoritative resource in times of need relating to their self-belief in mathematics learning and instruction. This provides them with a sense of security in the classroom, which in turn boosts their self-beliefs.

The closer relationship between perceived teacher support and mathematics self-concept may be because students who have strong support from their parents come to school with more positive attitudes, thus inducing a better teacher-student relationship resulting in a higher self-concept. Moreover, students who have reached the final grades in high school have a highly static outlook towards secondary education, and their affective dimension may have reached equilibrium (Kaplan, Harik, & Hotchkiss, 2001). At that point also, parental support in education seems to decline, as research has shown that parents become less involved in their children's education as they progress further (Henderson, Mapp, Johnson, & Davies, 2007). In Ghana, mathematics is used as a selection criterion for entry into higher education. As such, a healthier teacher-student relationship is needed in order to build students' self-concept and self-confidence, which would help students to succeed.

Policy-makers should consider implementing measures that might help improve the teacher-student relationship and parental support in Ghanaian schools. The present study supports the findings of Sheldon (2002), which suggests that parents and teachers are socio-actors with varied social networks that can significantly influence children's education. The relationship between students' self-concept and parent's and teacher's support is also supported in the literature (e.g., Eccles[Parsons] et al., 1982). However, the findings from this study suggest that the impact of teachers, and parents was different for the two affective dimensions (Wilkins & Ma, 2003). Moreover, since mathematics self-confidence and self-concept have been found to be significant predictors of students' achievement and since this study has shown that teachers and parents are significant predictors of students' mathematics self-confidence and self-concept schools might exploit and foster such parental and teacher resources by providing parents and teachers with strategies for affective support. However, more research is needed in order to understand the

underlying processes that influence the pathways from parental support and teacher support to the affective dimensions.

The study's findings support both the ecological development and expectancy value theory in that they support the view that students' self-belief is affected by the multiple contexts of their lives, although this is not conclusive (Murdock & Miller, 2003). The results indicated that teachers and parents contribute to students' self-beliefs, suggesting what Murdock and Miller (2003) term the "additive-effect," whereby the strengths in one construct might compensate for weaknesses in another. These results add to the growing support for the notion that students benefit most when there is congruence between the values of home and school (Eccles[Parsons] et al., 1982; Keesee, 1975; Murdock & Miller, 2003; Stake, 2006). This congruence was empirically supported by the strong relationship found here between the two support sources.

However, interpretation of the current findings should be made with several limitations in mind. First, the measures were self-reports and thus subject to socially desirable biases. For instance, because the findings are based on student self-reports alone, there is no way of knowing whether student perceptions of teacher support coincide with the actual support provided by the teachers (Kunter et al., 2008; Long & Hoy, 2006). Furthermore, the study used only one source to gauge parental support and teacher support, and the findings might differ depending on how these constructs are obtained (directly from parents or teachers). However, other studies have indicated that support reported by parents was not significantly different from perception reported by children (e.g., Patrikakou, 1997). Second, the study did not address the possible reciprocal relations between the constructs. The opposite direction of influence is at least equally, if not more, likely. The cross-sectional design of the study and the methodological challenges prevents reciprocal causal claims. This is important because, for instance, the mediation models that were tested assume that the independent variables (i.e., parental support and teacher support) cause the mediator (i.e., mathematics self-confidence) and that the mediator causes the dependent variable (i.e., mathematics self-concept), as opposed to the dependent variable causing the mediator. Such causal relationships are best investigated using longitudinal data sets. Third, is the issue of "same-source bias or general method variance" normally associated with self-report instruments whereby respondents are asked to provide accounts of their attitudes, beliefs, perceptions. It is assumed that common method bias may inflate or deflate relationships between variables measured by self-reports (Conway and Lance 2010). However, we argue that although the level of bias is a cause for concern it does not affect our research findings because our constructs were very concrete and have undergone extensive psychometric evaluation and therefore less sensitive to the effects of common methods variance. Moreover, studies have shown that suspected biasing factors including social desirability and negative affect do not have strong, consistent effects in decreasing construct validity (Conway and Lance 2010, p.327)..

The findings have uncovered an interesting relationship among these constructs, which are known to have an effect on students' achievement. Nevertheless, the strength of the study could have been greater if controls for background variables such as achievement, students' mathematics attitudes, socio-economic background and social support prior to secondary school entry (junior secondary school) were available. In summary, the findings from this study are: 1) perceived social support statistically significantly predicts students' mathematics self-belief; 2) mathematics self-confidence mediates the role between perceived social support and mathematics self-concept, and 3) Method effect is associated with negatively worded items.

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