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Perceived responsibility for learning, self-efficacy, and sources of self-efficacy in mathematics: a study of international baccalaureate primary years programme students

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Abstract The purpose of this study was to assess the interrelationship of elementary students' perceived responsibility for learning, self-efficacy, and sources of self-efficacy in mathematics, and differentiation as a function of gender and grade level. Participants in this study included 442 third-, fourth-, and fifth-grade students from U.S. International Baccalaureate schools. Self-report measures were used to assess key study variables. Students in grade five reported higher levels of mathematics self-efficacy and perceived responsibility for learning than those in grade three. Grade four students also reported higher levels of perceived responsibility than grade three students. In addition, regression results revealed that mastery experience, vicarious experience, social persuasion, and physiological state accounted for a significant amount of variance in students' mathematics self-efficacy, with social persuasion being the strongest predictor. Educational implications for practice within the context of International Baccalaureate schools are discussed.

Keywords Self-regulation · Self-efficacy · Sources of self-efficacy · Developmental and gender differences · Mathematics · Elementary students

1 Introduction

Researchers for decades have been interested in understanding how self-regulatory processes influence human functioning and behavior (Bandura 1997; Bembenutty et al. 2013; Zimmerman 2008). According to the social cognitive perspective, self-regulation refers to the degree to which students are "metacognitively, motivationally, and behaviorally active participants in their own learning process"

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(Zimmerman 1986, p. 308). Self-regulated learning involves controlling one's cognition, motivation, and behavior; thus, self-regulation and motivation are viewed as interdependent constructs. Among the key motivation constructs that have been studied in connection with self-regulation (e.g., self-efficacy, goal-setting, task interest), self-efficacy has been shown to play an especially important role (Pajares and Schunk 2001). Self-efficacy refers to beliefs that students hold about their ability to perform and execute a learning task under specified conditions (Bandura 1986). Bandura (1997) hypothesized that self-efficacy beliefs are developed as students interpret information from four sources: mastery experience (i.e., interpretation of one's performance), vicarious experience (i.e., observing the actions of similar others provides information regarding one's capabilities), social persuasions (i.e., verbal persuasion of capability), and physiological states (i.e., interpretation of one's physiological state as indicator of capability).

Students' self-efficacy beliefs about their learning processes affect their perceptions of personal responsibility for learning (Kitsantas and Zimmerman 2009; Zimmerman 1994). Perceived responsibility refers to student's perceptions of how responsible he or she is for their academic learning (Zimmerman and Kitsantas 2005). Self-efficacious students are more likely to view themselves, rather than their teachers, as responsible for academic learning outcomes (Kitsantas and Zimmerman 2009). One indicator of perceived responsibility for learning is students' causal attributions regarding their learning processes and outcomes. Research evidence indicates that students who self-regulate their goals and self-monitor their progress are more likely to attribute learning outcomes to specific strategies versus external sources such as teachers, than students who fail to self-regulate their goals and self-monitor (Zimmerman and Kitsantas 1999). These self-regulatory behaviors are malleable, teachable, and highly correlated with student achievement (Kitsantas 2002; Kitsantas and Zimmerman 2009).

To date, research on self-regulation, self-efficacy, and the sources of self-efficacy has primarily focused on middle school, high school, and college students (e.g., Kitsantas 2002; Pintrich and De Groot 1990; Usher and Pajares 2008; Zimmerman and Martinez-Pons 1990). Far less is known about elementary school students' perceived responsibility, self-efficacy, and sources of self-efficacy. The primary objective of this study is therefore to examine the interrelationships among students' perceived responsibility, self-efficacy, and sources of self-efficacy, and differences as a function of gender and grade level.

1.1 Grade level and gender differences in student self-regulation

Research has shown developmental differences in self-regulation in promoting learning and school achievement across grade levels (Eme et al. 2006; Pajares and Cheong 2003; Zimmerman and Martinez-Pons 1990). For instance, Eme et al. (2006) found differences in elementary school students' metacognitive evaluation capabilities (in relation to reading comprehension) between 3rd and 5th grade students with older students displaying more nuanced metacognitive evaluative abilities. In general, research supports the notion that the sophistication of students' self-regulatory functioning increases over broad developmental periods (e.g.,

middle school to high school) as they accumulate experience and knowledge about learning strategies. In a study of 5th, 8th, and 11th grade students, Zimmerman and Martinez-Pons (1990) examined grade-level differences for 14 self-regulatory learning strategies. The findings revealed a direct relationship between grade level and key variables; specifically, 11th grade students displayed greater, more adaptive use of self-regulation strategies and self-efficacy beliefs than those in 8th grade, who in turn demonstrated greater use than those in 5th grade.

Further, research shows that females display greater self-regulation than do males: females tend to employ goal-setting, environmental structuring, self-monitoring, record keeping, and help seeking more often than males (Zimmerman and Martinez-Pons 1990). Similarly, meta-analytical studies have shown that females exhibit greater motivation and ability to regulate their behaviors than males (Cross et al. 2011; Else-Quest et al. 2006; Silverman 2003). For example, a meta-analysis of 741 effect sizes from 277 studies found women to have to greater impulsivity control than males (Cross et al. 2011), whereas a meta-analysis of 189 studies that examined temperamental differences found females (ages 3 months–13 years) to have greater effortful control than males (Else-Quest et al. 2006). Despite the aforementioned evidence for gender differences, literature suggests that girls and boys do not differ in certain aspects of self-regulation (DiBenedetto and Zimmerman 2010; Pintrich and De Groot 1990; Zimmerman and Kitsantas 2014). Pintrich and De Groot (1990) found no gender differences in students' cognitive strategy use, metacognitive strategies, and intrinsic interest for learning in science and English classes. Whether gender differences exist in elementary students' ability to self-regulate their learning, remains unclear. As a result, attention to students' self-efficacy and sources of self-efficacy is needed, given its importance in learning and facilitating use of self-regulatory strategies.

1.2 Mathematics self-efficacy, sources of self-efficacy and gender differences

The self-efficacy beliefs that students hold about themselves and their academic competence influence their academic performance and level of engagement in learning and help determine what they do with the knowledge and skills they possess (Bandura 1997). There is research showing that boys and girls differ in self-efficacy across context (Joët et al. 2011; Pajares et al. 2007). For example, boys typically report higher self-efficacy in mathematics (Joët et al. 2011) and science, whereas girls report higher self-efficacy in writing (Pajares et al. 2007). Others have found no significant gender differences (Kiran and Sungur 2012; Usher and Pajares 2006).

Bandura (1997) hypothesized that self-efficacy beliefs are developed as students interpret information from four sources. The first and most powerful source has to do with one's own personal experience, or *mastery experience*. Students interpret and evaluate information about their academic competence when they complete an academic task. Personal experience with success or failure will influence one's perception about the ability to perform tasks.

The second source of self-efficacy beliefs comes from the *vicarious experience* of observing the actions and experiences of others, such as peers and classmates. Seeing a classmate experience success in a challenging situation may empower fellow students to believe that they too can achieve success. Models serve a more influential role during the transitional periods from elementary to middle school, during which time young students become more aware of information eliciting social comparisons (Eccles et al. 1984).

The third source of self-efficacy comes from *social persuasions* and evaluative feedback from teachers, parents, and peers. Supportive messages encourage students to bolster confidence in their academic capabilities (Bandura 1997). Younger students, in particular, depend on such feedback and may be most susceptible to what others tell them (Bandura 1997). Finally, the fourth source of self-efficacy, one's competence, comes from *physiological states* such as stress, anxiety, fatigue, and mood. Students tend to interpret their physiological states as an indicator of their academic competence as they evaluate their performances (Bandura 1997).

The four sources of self-efficacy play an important role in the development of students' self-efficacy beliefs. Mastery experience has been found to be a powerful predictor of self-efficacy across academic domains (e.g., Lopez and Lent 1992; Usher and Pajares 2006). The other three sources have been less clear as predictors of self-efficacy. For vicarious experience, some researchers have reported that it independently predicts self-efficacy (Matsui et al. 1990), while others have reported no such relationship (Kiran and Sungur 2012; Lent et al. 1991; Joët et al. 2011; Lopez and Lent 1992; Pajares et al. 2007). For social persuasion, researchers have found that it predicts self-efficacy of elementary and middle school students (Joët et al. 2011; Klassen 2004; Usher and Pajares 2006). The premise that physiological states predict self-efficacy has been supported by some (Lopez and Lent 1992; Matsui et al. 1990), although other research has not supported such influence (Lent et al. 1991).

While some researchers have found no significant differences by gender with regard to the sources of self-efficacy for students in science, mathematics, and writing, regardless of age group (Britner and Pajares 2006; Lent et al. 1991; Pajares et al. 2007), Usher and Pajares (2006) noted gender differences in the domain-general academic self-efficacy beliefs of 263 sixth-grade students. The results indicated social persuasion to be the primary efficacy source of influence in girls, whereas mastery experience was the most powerful efficacy source for boys (as expected). Similarly, Joët et al. (2011) examined whether the sources of self-efficacy differed as a function of gender for third grade students ($N = 395$) in mathematics and French. In mathematics, it was found that boys outperformed girls and reported higher self-efficacy, mastery experience, social persuasions, and lower physiological states. Within the subject of French, Joët et al. (2011) found no gender differences between the sources of self-efficacy. Girls outperformed boys on the French achievement test, but reported significantly lower self-efficacy.

Further evidence indicates that gender differences in the sources of self-efficacy may be a function of academic domain. For example, boys reported higher mastery experiences, social persuasions, and lower anxiety in areas of mathematics (Joët et al. 2011; Lent et al. 1996) and science (Britner and Pajares 2006), while girls

reported stronger master experiences and lower anxiety in writing (Pajares et al. 2007). Whether these gender differences exist in younger students is less clear. Therefore, the present study will focus on gender differences in the sources of self-efficacy among elementary students in grades three through five.

1.3 Purpose of the current study

While a majority of research on self-regulation, self-efficacy, and sources of self-efficacy has been conducted with middle school, high school, and college students (e.g., Usher and Pajares 2008; Zimmerman and Martinez-Pons 1990), there remains a lack of research exploring how these processes influence younger students. Previous research findings are inconsistent in terms of sources that are related to self-efficacy. Moreover, whether gender differences exist with respect to the sources of self-efficacy and perceived responsibility in mathematics learning remains unclear.

The context for this study is the International Baccalaureate (IB) Primary Years Programme (PYP). The IB PYP curriculum focuses on incorporating interdisciplinary themes into instruction, which provide the framework for teachers to engage students in learning. The IB organization is unique because IB teachers are trained to develop inquiry and to challenge students by encouraging critical thinking from a global perspective. IB schools have a presence across the globe, each sharing a core foundation of educational standards and practices. The IB student profile focuses on shaping learners to become inquirers, thinkers, communicators, open-minded, principled, caring, risk-takers, balanced, reflective, and knowledgeable. Studies have shown positive outcomes for students enrolled in the IB program; however, most have been conducted with high school Diploma Programme (DP) students. For example, data collected in a 2003 student survey indicated that high school seniors within the IB DP have higher SAT scores, college acceptance rates, and college grade point averages compared to general education students (IBO 2005). Few studies have examined the value of the IB program in supporting students' education at the elementary level. The PYP program is unique in that students do not self-select into the program as they do at the DP level; rather the PYP curriculum is implemented school-wide and all teachers receive training. The PYP curriculum is compatible with national Common Core standards and is presently implemented in more than 540 US elementary schools including Title I funded, urban and suburban, public and private schools (IBO 2018).

Given the gaps in the motivation literature as well as limited studies with elementary level students and the PYP, the present study seeks to assess the interrelationships among perceived responsibility, self-efficacy, and the sources of mathematics self-efficacy in upper elementary students, and differentiation as a function of gender and grade level.

2 Method

2.1 Participants and the setting

Participants in this study consisted of 442 third (n = 154), fourth (n = 145), and fifth (n = 143) grade students enrolled in U.S International Baccalaureate (IB) schools. Students were recruited from 69 classes within 16 IB PYP schools across 11 states. The sample comprised 235 girls (53.2%) and 207 boys (46.8%), with ages of students ranging from 8 to 12 years ($M = 9.54$, $SD = 1.15$). The ethnic composition of students was: 57% Caucasian, 17% Hispanic, 9% multi-racial, 9% Asian, 7% African American, and 1% other. Participation in the study was voluntary and no compensation was given. Approval was granted by the University's Institutional Review Board. The IB PYP curriculum is transdisciplinary and teachers place emphasis on the development of the learner as a whole. Students aged 3–12 are encouraged to become inquirers both at the school and beyond and take responsibility for their own learning.

2.2 Measures

2.2.1 Personal data questionnaire

A brief questionnaire was developed to obtain demographic information from the students (e.g., age, gender, grade, and ethnicity). The instrument was based on standard practice and previously utilized measures.

2.2.2 Sources of self-efficacy

The four sources of self-efficacy were measured using a 13-item scale adapted to pertain to mathematics by Usher and Pajares (2006) from a 24-item scale initially developed by Lent et al. (1991). The scale comprises four subscales: mastery experience (n = 3) (e.g., "I always do my best work in mathematics"), vicarious experience (n = 3) (e.g., "I admire people who are good at mathematics"), social persuasion (n = 4) (e.g., "People often tell me that I am a good mathematics student"), and physiological states (n = 3) (e.g., "I am nervous when I work on mathematics"), with responses to items coded from 1 (Not at all true) to 4 (Completely true). This scale has been shown to have good psychometric properties in a prior research study of elementary school students, with Cronbach's alpha coefficients ranging from .61 to .89 (Joët et al. 2011). In this study, the Cronbach's alpha reliability coefficient for each of the four subscales of the sources of self-efficacy was: .67 for mastery experience, .65 for vicarious experience, .68 for social persuasions, and .67 for physiological states.

2.2.3 Mathematics self-efficacy

The four-item measure used to assess students' self-efficacy in mathematics was adapted from Joët et al. (2011). A sample item included "I can solve math problems." Students responded to each item on a four point scale from 1 (Not at all true) to 4 (Completely true). The Cronbach's alpha reliability coefficient for the present study sample was .69.

2.2.4 Perceived responsibility for learning scale (PRLS)

The PRLS, developed by Zimmerman and Kitsantas (2005), included 18 items designed to assess students' perceptions of personal responsibility for learning—a measure of self-regulation. The respondents were asked to rate whether they perceived the student or the teacher as being more responsible for various learning tasks or outcomes, such as motivation (e.g., not really trying in class) and deportment (e.g., not behaving in class). A sample item was "Who is more responsible for a student NOT finishing their homework?" Students responded to each item on a 5-point Likert scale (1 = mainly the teacher; 3 = both the teacher and student the same; 5 = mainly the student).

For this study, the PRLS was adapted and included only 12 of the original 18 items selected on the basis of their relevance to elementary school students. A factor analysis was conducted to determine how the items clustered together. The final scale consisted of only 5-items which explained 50% of the variance. The remaining items were dropped due to low- and cross-loadings. Previous research using the PRLS has been shown to have established a single factor structure and an alpha reliability coefficient of .90 (Zimmerman and Kitsantas 2005). The Cronbach's alpha reliability coefficient on the reduced scale in this study was .74.

3 Procedures

This study used data collected as part of a larger multiphase investigation of elementary students' self-efficacy and self-regulatory development in IB Primary Years Programme (PYP) schools. After collecting informed consent from the parent, students completed the assent form electronically, then filled out a Personal Data Questionnaire (i.e., the survey instrument) electronically either at home or at school. The surveys took approximately 20 min for students to complete.

4 Results

The overall aim of this study was to examine how student's perceived responsibility, self-efficacy, and the sources of self-efficacy in mathematics are manifested in upper elementary school students (grades 3–5), and whether these constructs differ as a function of grade level and gender.

4.1 Descriptive analyses

Table 1 provides the means and standard deviations of the sample by gender and grade levels for all variables.

Pearson correlation analyses were performed to examine the interrelationships among perceived responsibility, mathematics self-efficacy, and the sources of self-efficacy (see Table 2). Perceived responsibility correlated significantly with self-efficacy ($r = .11$, $p < .05$), students' mastery experience ($r = .12$, $p < .05$), vicarious experience ($r = .10$, $p < .05$), social persuasions ($r = .12$, $p < .05$), and physiological states ($r = .14$, $p < .01$). Moreover, consistent with the tenets of Bandura's (1997) theory of self-efficacy and previous studies (Britner and Pajares 2006; Usher and Pajares 2008), each of the hypothesized sources of self-efficacy were significantly intercorrelated ($r = .54$–$.72$, $p < .01$) and correlated with mathematics self-efficacy ($r = .66$–$.77$, $p < .01$). The strongest correlation was between self-efficacy and social persuasions ($r = .77$, $p < .01$).

4.2 Comparative analyses

Two factorial [2 (gender) × 3 (grade level)] analyses of variance were conducted to test whether there were any significant grade level and gender differences in self-efficacy and perceived responsibility. For self-efficacy there was a significant main effect for grade level, $F(2, 429) = 3.44$, $p < .05$, but no main effect for gender, $F(1, 429) = .23$, $p > .05$, or significant interaction effect between grade level and gender, $F(2, 429) = 1.53$, $p > .05$. Post hoc tests show that Grade 5 students had a significantly higher level of math self-efficacy than grade 3 students ($p < .05$). With regard to perceived responsibility, there was a significant main effect for grade level, $F(2, 436) = 5.31$, $p < .01$, but no main effect for gender, $F(1, 436) = .60$, $p > .05$, or significant interaction effect between grade level and gender, $F(2, 436) = 1.06$, $p > .05$. Post hoc comparisons indicated that students in grade 3 reported lower levels of perceived responsibility for their own learning than that of either fourth or fifth grade students ($p < .05$).

Furthermore, to examine differences in the four sources of self-efficacy a 2 (gender) × 3 (grade level) multivariate analysis of variance was conducted to test whether there were any grade level or gender differences in the sources of self-efficacy. There was no significant multivariate main effect for grade level (Wilks' $\Lambda = .97$, $p > .05$) or gender (Wilks' $\Lambda = .99$, $p > .05$), and no interaction effect between grade level and gender (Wilks' $\Lambda = .99$, $p > .05$).

4.3 Regression analyses

Regression analyses were conducted to determine which sources of self-efficacy predict self-efficacy for mathematics and perceived responsibility for learning, and if gender or grade level moderates these relationships. The results revealed that 70% of the variance in students' mathematics self-efficacy was accounted for by mastery experience ($\beta = .25$), vicarious experience ($\beta = .24$), social persuasion ($\beta = .38$), and physiological state ($\beta = .09$), $F(7, 426) = 144.06$, $p < .001$, $R^2 = .70$. Effects

Table 1 Means and standard deviations for all variables by gender and grade level

Variable grade	Gender			
	Male		Female	
	M	SD	M	SD
Perceived responsibility				
3rd	4.30	.89	4.19	.89
4th	4.45	.68	4.54	.70
5th	4.54	.54	4.40	.59
Self-efficacy				
3rd	3.03	.65	3.13	.64
4th	3.18	.59	3.03	.60
5th	3.28	.65	3.24	.57
Sources of self-efficacy				
3rd				
Mastery experience	3.23	.72	3.19	.55
Vicarious experience	2.93	.68	3.10	.66
Social persuasion	3.05	.66	3.07	.60
Physiological state	2.85	.75	2.96	.79
4th				
Mastery experience	3.31	.57	3.15	.69
Vicarious experience	3.02	.71	2.95	.67
Social persuasion	3.18	.63	3.11	.61
Physiological state	3.03	.73	2.85	.77
5th				
Mastery experience	3.43	.70	3.37	.59
Vicarious experience	3.19	.68	3.14	.58
Social persuasion	3.26	.61	3.19	.58
Physiological state	3.10	.77	2.93	.66

Table 2 Pearson correlations among perceived responsibility for learning, self-efficacy and sources of self-efficacy in mathematics

	1	2	3	4	5	6
1. Perceived responsibility	–					
2. Sources of self-efficacy	.11*	–				
3. Mastery experience	.12*	.69**	–			
4. Vicarious experience	.10*	.73**	.61**	–		
5. Social persuasions	.12*	.77**	.66**	.72**	–	
6. Physiological states	.14**	.66**	.54**	.69**	.71**	–

*$p < .05$; **$p < .01$

for social persuasion were the strongest, accounting for greater unique variance than other sources. Grade and gender (dummy coded) were also included in the analysis, but were not significant moderators of the relationship between the sources of self-efficacy and mathematics self-efficacy.

5 Discussion

The purpose of this study was to examine: (a) relationships among elementary students' perceived responsibility for learning, mathematics self-efficacy, and sources of self-efficacy in mathematics, and (b) whether these variables differed as a function of grade level and gender. These students were enrolled in the International Baccalaureate Primary Years Programme. In regards to relationships among perceived responsibility, self-efficacy, and sources of self-efficacy in mathematics, regression analyses revealed that mastery experience, vicarious experience, social persuasions, and physiological states independently predicted elementary students' mathematics self-efficacy. This finding is consistent with the tenets of social cognitive theory, specifically Bandura's (1986) hypothesized sources of self-efficacy, and confirm previous research findings (e.g., Usher and Pajares 2006). Social persuasion accounted for the greatest proportion of the variance in IB elementary students' mathematics self-efficacy. This was the case for the entire sample of students, as well as for third, fourth, and fifth grade students specifically. Contrary to Bandura's notion that mastery experience is the most influential source of self-efficacy, this study found that emulation (i.e., demonstration of skill with directed feedback and guidance) fostered the mathematics beliefs of elementary students in this particular group. This finding is not surprising, given that practice solving mathematics problems and receiving guidance and feedback from a more experienced learner such as a teacher or classmate are essential components of self-regulatory development (Zimmerman 2000). The effects of receiving feedback are particularly relevant in this context, as teachers and peers can play a powerful role in a student's development of self-efficacy.

Vicarious experience also predicted mathematics self-efficacy. Some studies have found a significant relationship between vicarious experience and self-efficacy for specific groups of students, such as those with learning disabilities (Hampton 1998) and those of Indo-Canadian descent (Klassen 2004). For example, Stevens et al. (2006) found that vicarious information had a greater influence on Hispanic students than Caucasian students. In another study, Usher and Pajares (2006) found that vicarious experience predicted reading self-efficacy beliefs of Grade 6 students across various reading ability levels (i.e., above level, on level, and below level). Usher (2009) qualitatively investigated Grade 8 middle school students' sources of self-efficacy in mathematics, and noted that all students in the sample ($N = 8$), regardless of mathematics self-efficacy level, relied on vicarious information to interpret their own mathematics capabilities. These findings suggest that the extent of vicarious experience in forming students' self-efficacy beliefs may be influenced in part by contextual factors.

Mastery experience and vicarious experience both predicted mathematics self-efficacy nearly equally. The predictive utility of physiological states was significant; however it was less powerful than the other three sources. These findings support previous research showing that mastery experience consistently predicts self-efficacy, and that physiological state is the least powerful indicator (e.g., Britner and Pajares 2006; Joët et al. 2011; Usher and Pajares 2006). Along with

accomplishments, these findings suggest that the influence of peers, parents, and teachers, as well as emotional and physiological well-being (e.g., anxiety, arousal, mood) are essential for elementary students to interpret beliefs about their mathematics capabilities.

Regarding grade level differences for the entire sample, results revealed a significant main effect for self-efficacy, with grade 5 students displaying greater levels of math self-efficacy than grade 3 students in the IB curriculum. This finding is consistent with previous research suggesting that children's self-efficacy increases as they learn and develop skills throughout the school years (Schunk and Pajares 2002). The beliefs that children hold about themselves are linked to future behaviors, which are often influential in career choice (Borkowski and Thorpe 1994). A student who has a strong belief in his or her mathematics ability is more likely to take personal responsibility for learning and doing homework, thus putting forth the effort to persist with challenging tasks. Further, these students may ultimately aspire to the study of mathematics for a career. Developing a positive sense of self is not only influenced by self-efficacy judgments, but also by attributions (i.e., reasons for one's success or failure). If a student attributes prior accomplishments for success and failure to uncontrollable factors (e.g., luck, subjective evaluation of others), the student is less likely to envision a hopeful future and will not feel confident about his or her mathematics abilities.

There was also a significant main effect for perceived responsibility across grade levels. Student perceptions of responsibility for their own learning and knowledge of mathematics increased with elementary grade level. This finding is consistent with previous research suggesting that self-regulatory functioning increases as students' progress through school and develop greater depths of knowledge (e.g., Zimmerman and Martinez-Pons 1990).

Factorial ANOVAs were conducted to examine the effects of gender on self-regulation and self-efficacy across third, fourth, and fifth grade students. The analyses revealed that boys and girls did not differ with regard to perceived responsibility and self-efficacy. Furthermore, the lack of gender differences may be due to the uniqueness of the IB PYP curriculum at the elementary school level. Through its transdisciplinary framework, IB teachers focus on the development of the learner as a whole, thereby challenging IB students to take responsibility and ownership for their own learning. Clearly, the findings of this study support this basic tenet of the IB PYP curriculum, specifically the development of IB student confidence levels with their peers, regardless of gender. Consistent with previous research findings, boys and girls in this study reported similar confidence in their mathematics abilities during the elementary years. However, Midgley et al. (1989) and Pajares (2005) did note differences following students' transition into middle school.

Results also indicate that there were no gender differences or grade level differences in the sources of self-efficacy. Mean differences do, however, indicate that boys had slightly stronger mastery experience than did girls. This finding is consistent with Lent et al. (1996), who suggested that boys report stronger mastery experience in the area of mathematics. For girls, mastery experience was the strongest indicator of mathematics self-efficacy. Clearly, contextual and

demographic factors play a significant role in the interpretation of these findings. Usher (2009) reported that students may rely on different sources of self-efficacy as a function of their gender, academic domain, and ethnic background. For example, researchers have found that girls report stronger social persuasions and vicarious experiences in mathematics (Lopez et al. 1997), but greater mastery experiences and lower anxiety in writing (Pajares et al. 2007). Collectively, the findings from the current study provide worthwhile information about the developmental and gender differences in elementary students' self-regulation, self-efficacy, and sources of self-efficacy in mathematics both in IB PYP and other educational settings more generally. That is, although the IB PYP is a unique sample and teachers are trained in inquiry-based learning and use a transdisciplinary framework to teaching, PYP programs also share some common ground with other educational approaches, such as the implementation of the Common Core State Standards (CCSS).

6 Limitations

According to social cognitive theory, Bandura (1986, 1997) emphasizes the importance of evaluative feedback in the development of children's beliefs about their capabilities. In this study, social persuasion was the strongest predictor of students' mathematics self-efficacy. This finding suggests that receiving feedback from teachers, parents, and peers may influence students' interpretation of their own mathematics capabilities more so than do accomplishments, observation, and physiological arousal.

When interpreting these findings, a few limitations must be considered. First, the psychometric quality of the sources of self-efficacy subscales in this study were modest. Previous research studies have similarly reported low to modest reliability coefficients for vicarious experience (e.g., Lent et al. 1991; Stevens et al. 2006; Usher and Pajares 2008) and with Grade 3 elementary students (Joët et al. 2011). In a meta-analysis, Usher and Pajares purport that this inconsistency in reliability for the vicarious experience subscale may be likely due to the multidimensional nature of this variable. Peer and adult role models have remarkably different influences on students' perceptions and beliefs about their academic learning at different developmental stages (Harris 1995; Pinker 2002). Bandura (1997) contends that young children's self-efficacy beliefs are more likely to be influenced by peer (e.g., classmates) than adult (e.g., parents) role models. In particular, students perceived as similar according to age, gender, ethnicity, and/or ability will likely be the most influential in raising or lowering self-efficacy beliefs. Studies of vicarious experience which only include items measuring adult or peer role models may provide an incomplete picture. Nevertheless, researchers remain convinced that social models play a central role in developing one's sense of self (Bandura 1997; Marsh et al. 2008).

A second limitation of this study is that data were collected at only one point in time. As such, the findings do not allow us to account for understanding potential developmental changes in students' self-perceptions throughout the school year and between years. Several researchers (e.g., Cleary and Chen 2009; Joët et al. 2011)

have noted that it is important to take into account the evolving nature of students' self-perceptions as they grow and acquire new experiences. Exploring this evolution over time will help to better understand the processes underlying self-regulation and self-efficacy and the role these play in students' academic learning and performance in school.

Third, the present study utilized only self-report data to examine students' perceptions and beliefs about their mathematics abilities. Quantitative data from teachers (e.g., test scores, final grade reports) would serve as further verification and a check for validity of self-report. Qualitative data may also provide a more in-depth consideration about the processes and techniques younger students use to evaluate their academic abilities (Pajares and Schunk 2005; Usher 2009; Zimmerman 2008). Future studies should therefore incorporate both quantitative and qualitative methods to validate and obtain a deeper understanding of the developmental differences and gender effects in elementary students' self-regulation, self-efficacy, and the sources of self-efficacy.

Finally, given that the present study focused on IB students in the PYP curriculum a further limitation of the study is the generalizability of the findings to non-IB school settings. It should be noted however, that these findings might be relevant more generally to other settings as the IB curriculum is consistent with the Common Core State Standards. Overall, exploring the influence of classroom practices with this group where research is limited would be beneficial for educators in developing curricula that encourage elementary student's academic self-efficacy and self-regulatory competence.

7 Implications for future research and practice

The findings of this study suggest more research is needed to identify and understand the extent of elementary school students' self-regulation, self-efficacy, and sources of self-efficacy in mathematics and other subject areas. Particularly, investigation of how these self-perceptions develop in younger students is needed. Though some studies have started to explore the processes underlying young children's self-regulation (e.g., Kitsantas et al. 2009) and self-efficacy (e.g., Joët et al. 2011), further replication or adaptation of these studies with elementary school students is warranted. Such information could provide insight for developing interventions that best support young students' perceptions and beliefs about mathematics learning.

While findings of this study indicate that social persuasion is the most powerful source of mathematics self-efficacy for elementary students, the reliability of the items measuring this source was relatively modest, as was the case for the other sources of self-efficacy. This affirms findings of other researchers who have found low to modest reliabilities and inconsistency, especially with vicarious experience in predicting self-efficacy. Future research should address this issue by developing a measure that accurately captures vicarious experiences among students. Lent et al. (1996) suggested that items assessing vicarious experience should be divided into sub-categories so that the influence of peer and adult role models can be evaluated

separately. This may help to better understand the nature of vicarious experience and to document the relationship between this source and self-efficacy.

Though the findings indicated all four sources of self-efficacy predicted mathematics self-efficacy for the entire sample, the contributions of each source in students' development of self-efficacy differed by grade level. To foster positive development of self-efficacy, parents and teachers should construct learning environments that are favorable for children's development. Bandura et al. (1996) found that parents who have a high sense of efficacy are more likely to construct favorable environments for their children. These students come to school prepared and are motivated to learn (Bandura 1997). However, students hold different beliefs about their capabilities as they enter new learning situations in school. Teachers can enhance students with low self-efficacy by giving them feedback that their success was due to effort. Giving students positive feedback conveys that effort is responsible for success and that they are developing skills necessary for success (Schunk 1989). These messages may encourage the student to continue to perform well with hard work. Students develop their skills as they learn strategies, in turn increasing self-efficacy (Alderman 2008). Another strategy for enhancing self-efficacy is by observing and emulating role models through vicarious experience, which is the second most powerful source of self-efficacy as purported by Bandura (1997). The findings in this study revealed that social persuasions played a central role in how elementary students established their self-efficacy beliefs in mathematics. Teachers should continue to promote students' social persuasions. In the classroom, teachers should create learning experiences such as practicing with mathematics problems that help students work towards mastery-based learning and provide positive feedback to help enhance students' confidence in mathematics. Given that peers serve as better models than do adults in increasing self-efficacy for young children, teachers should encourage students to demonstrate to the class how they solved a mathematics problem and acknowledge mistakes. Such relationships and impact also point to the value of peer tutoring and modeling. As observed in the IB PYP classrooms, teachers should encourage group work activities as it provides students opportunities to work closely among their peers and to teach one another. An interesting aspect for future research could be to explore further the role of the IB PYP program on students' development of self-regulation, self-efficacy, and the sources of self-efficacy. The IB curriculum and philosophy may provide a foundation for self-regulation and self-efficacy, and understanding these developments in IB PYP students may help teachers to better foster students' confidence and self-regulation strategies in mathematics.

8 Conclusions

The findings of this study revealed that elementary students' self-efficacy in mathematics and perceived responsibility for learning increased as they progressed through Grades 3, 4, and 5 in the IB PYP context. Furthermore and consistent with previous findings, the study found that the four sources of self-efficacy proposed by Bandura predicted self-efficacy in mathematics across the third, fourth, and fifth

grade IB students. Social persuasions were the greatest predictor of mathematics self-efficacy for the entire sample in this study. Mastery experience, vicarious experience, and physiological states were significant in predicting mathematics self-efficacy. In regards to gender effects of these variables, data revealed that boys and girls did not differ in either perceived responsibility, self-efficacy, or the four sources of self-efficacy.

The students in these PYP classrooms worked on core subjects in interdisciplinary thematic units using inquiry-based learning practices. Gender differences in self-efficacy and self-regulation, which have sometimes been shown with older students, were not present in this group of elementary age students. Because of the limited research with this age group, it cannot be ascertained if the lack of differences is due to age or curriculum. However, since the curriculum for this sample of students was common and the teachers were specifically trained in inquiry-based learning and interdisciplinary education, our study suggests that perhaps the lack of differences is due to the context of learning. Overall, these findings provide insight into classroom practices that teachers can develop to enhance students' self-efficacy beliefs and self-regulated learning during the primary years.

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