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Sul Ki Lee   April 17, 2013

Adaptive behavior in mathematics: Exploring the development of self-regulation in middle school students

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Abstract

Transition into middle school demands increased academic expectations and a greater focus on independent, self-directed assignments; however, students typically show a decrease in motivation, task value, and self-efficacy during this period. In recent years, self-regulation has received much attention because of its positive influence on student achievement and adaptive behavior. Though contemporary views of self-regulation have shifted from an individual constructivist perspective to a social constructionist perspective in which self-regulation is believed to be influenced by environmental context, there is limited research on how self-regulation is fostered within a middle school context. The purpose of this paper is to observe how self-regulation and factors related to this construct develop as individuals interact with others during math class. Survey data of 612 6th graders and 626 7th and 8th graders attending a public suburban school district in southeastern United States showed that perceptions of teacher support and co-regulation decreases throughout the middle school years. Moreover, teacher support alone was a significant predictor of the variance in 6th grade students' self-regulation behavior, where as all three constructs, teacher support, co-regulation, and self-efficacy were predictors of the variance in self-regulation in 7th and 8th grade students.

Keywords: *self-regulation, development, adolescence*

For many students the transition to middle school can be quite daunting (Cleary & Chen, 2009). Transition into middle school demands increased academic expectations and a greater focus on independent, self-directed assignments; however, students typically show a decrease in motivation, task value, and self-efficacy during this period (Cleary & Chen, 2009; Cleary & Zimmerman, 2004; Dembo & Eaton, 2000; Fuchs et al., 2003; Pintrich & De Groot, 1990). To add to the complexity, adolescents undergo major developmental changes within the brain structure and their socio-emotions. In other words, students must "readjust their feelings of self-confidence and self-worth as they encounter revised academic expectations and a more complex social world" (Berk, 2011).

In recent years, self-regulation has received much attention because of its positive influence on student achievement and adaptive behavior. Numerous previous literature have associated self-regulation with success in many different areas of life including higher academic achievement (Cleary & Zimmerman, 2004; Fuchs et al., 2003), higher levels of motivation (Pintrich & De Groot, 1990), as well as an increase in sense of self-efficacy (Zimmerman & Cleary, 2006).

Though there have been many publications addressing the positive influence of self-regulation, little is known about how this behavior develops over the course of a students' academic career, more specifically in a classroom context. Previous research assumes self-regulation to be a facet of temperament. However, more recent findings suggest that an individual's capacity for self-regulation develops across childhood through experience. Furthermore, its behavioral and neurobiological components continue to develop throughout childhood and even on to adolescence (King, Lengua, & Monahan 2013). Gestsdottir et al. (2007) posits that adaptive behavior like self-regulation is associated with the individual (i.e.

temperament and mental functioning) as well as his ecology (i.e. family, peers, and schools, etc.).

The purpose of this paper is to determine how self-regulation and factors related to this construct develop as individuals interact with others during math class. Furthermore, we will explore how much of self-regulation can be explained by teacher support, co-regulation and self-efficacy in 6th, 7th, and 8th grade students. Because this paper assumes self-regulation to be a learned rather than an innate skill, I hypothesize that factors in a students' environment (teacher support, co-regulation, and self-efficacy) will contribute differently throughout middle school years in predicting self-regulation behavior of adolescents. Furthermore, I will analyze qualitative interview data to explore other factors that may appear in adolescents with high levels of self-regulation.

Self-Regulation

Self-regulation is a commonly studied construct in the field of both psychology and education and is defined in various different ways. Cleary and Zimmerman (2004) defined it as "self-generated thoughts, feelings, and behaviors that are planned and cyclically adapted based on performance feedback to attain self-set goal," while Rothbart et al (2004) observed self-regulation in terms of effortful control and impulsivity.

Bandura's (1997; as cited in Zimmerman, 2000) social cognitive theory proposed a cyclical model of self-regulation, stating that self-regulation occurs in three cyclical phases: forethought, performance control, and self-reflection. In the forethought process, learning is optimized through behaviors including goal setting and strategic planning. The forethought stage then determines the student's ability to engage in performance control. During the performance control phase, the student will practice self-control and self-observation to internalize any

positive and negative behaviors that facilitate his or her learning process. The student then proceeds onto the self-reflection stage. The two general processes in this phase include self-judgment and self-reaction. After making a judgment of their learning habits, advanced learners who exhibit high levels of self-regulation typically react on their own judgments to make any alterations to their behaviors to optimize the learning process.

A child and an adolescent are markedly different in terms of psychological interests and cognitive abilities. Hall (1904) was the first to report adolescents' "storm-and-stress" period, claiming that children became more rude and impulsive as they entered their adolescent years. Adolescents today are marked with emotional volatility, negative affect, and impulsivity (Berk, 2011). Such major neurobiological and psychological changes in what an adolescent perceives in a given environment will undoubtedly be different than what a child will see in the same environment. King, Lengua, and Monahan (2013) reported that only effortful control, the cognitive component of self-regulation, was related to pre-adolescents' adjustment problems. Adolescence is marked by a stark increase in impulsivity (Berk, 2011), and students who exhibit high levels of self-regulation may perceive their surrounding environment in a more positive light than their peers. More research is therefore necessary in order for us to better understand how individuals with higher levels of self-regulation perceive their primary social environment.

Teacher Support

According to Patrick, Ryan, and Kaplan (2007), children's perceptions of the classroom social environment influence self-regulation and task-related interaction behaviors of 5th grade students. As students interact with their peers, teachers, and other adults in school they begin to formulate a perception of their social climate of the classroom, which then influence how adolescents behave in the classroom setting.

Teacher support refers to a student's perception of the extent to which their teacher will help and care for them. Measures of teacher support are typically divided into two different types: emotional and academic support. Emotional support refers to how much the student feels that the teacher cares for and likes the student, while academic support captures how much the student believes the teacher cares about the student's learning and academic success. Previous research reported 5th grade students who perceive positive emotional support from the teacher exhibit more classroom engagement (Patrick, Ryan, & Kaplan, 2007).

Paradoxically however, as students make their transition from elementary school to middle school and from childhood onto adolescence, students generally report lower levels of support from their middle school teachers (Steinberg & McCray, 2012). Such decreases in levels of teacher support could be due to the different classroom structure (decreased student-teacher interaction time) or due to the adolescents' heightened sensitivity to social relationships (Steinberg & McCray, 2012). Teacher support should therefore be of different importance to 6th, 7th, and 8th graders' level of self-regulation.

Co-regulation

Contemporary views of self-regulation have shifted from an individual constructivist perspective to a social constructionist perspective in which self-regulation is believed to be influenced by environmental context or situated in social activity systems (Hadwin, Jarvela & Miller, 2011). McCaslin (2009) defines co-regulation as one's "attempt to capture the dynamics of emergent interaction." Emergent interaction is the process to which a learner observes and internalizes social and cultural influences. Humans are social beings who have an innate ability to socialize and participate in social environments (McCaslin & Burross, 2011). This process of

socialization promotes individuals to think and behave in culturally appropriate ways, thereby forming unique sets of values, beliefs, and personal identity.

The concept of co-regulation was derived from Vygotsky's idea of zone of proximal development (ZPD). An individual learns within ZPD as he or she engages in active participation of another party. Both a goal and product of co-regulation is gaining social and cultural enrichment, which requires the individual to practice adaptive learning, such as self-regulation.

In elementary school, the two primary individuals that interact with one another in a learning environment are the teacher and the student. In middle school, however, teacher-centered instruction decreases and adolescents during this time show an increased interest in peer relations, creating a greater demand for the student to be an active participant of their learning experience (Berk, 2011; McCaslin & Burross, 2011). With decreased teacher-centered instruction, learners naturally gain more opportunities to socialize with and learn from one another. Self-regulation is enhanced with co-regulation by "responsive and contingent environments that demonstrate and validate the link between actions and outcomes" (McCaslin, 2009). Because students will reconstruct their academic expectations and become masters of social interactions and forming peer relationships, co-regulation may be a stronger predictor of self-regulation with increases in grade level.

Self-Efficacy

Self-efficacy refers to a person's beliefs about her ability to perform certain tasks (Bandura, 1997). As students transition into middle school, self-directed, self-regulated actions become a major factor influencing academic achievement. Students with higher levels of self-efficacy are more likely to set challenging academic goals for themselves and as a result engage in more self-regulatory behaviors (Zimmerman & Cleary, 2006). Self-efficacy also mediates the

relationship between perceptions of the social classroom environment (teacher support, co-regulation) and the student's levels of classroom engagement, including self-regulation (Patrick, Ryan & Kaplan, 2007). Students who perceive a supportive social environment are more likely to practice self-regulation when they are confident of their own ability to succeed on a given task. Therefore, self-efficacy may also be a strong predictor of self-regulation.

Methods

Participants

Two data samples were used for this study: 1) a sample of 612 6th grade students, and 2) a sample of 626 7th and 8th grade students, collectively referred to as middle school students. In this school district, the sixth grade is its own school, called the sixth grade academy, while the 7th and 8th grades comprise the middle school. Both the sixth grade academy and the middle school are part of a public suburban school district in the southeastern United States. Both are identified as Title I schools with 68% of students eligible for free or reduced-price lunch, and a predominantly non-white student population. In our sample, 47.4% of the seventh grade students and 65.3% of the 8th grade students receive free or reduced-price lunch. This data was not available for the students in the sixth grade academy (Table 3 and 4).

Survey data was collected at two time points for all three levels: mid-fall of 2011, and late-spring of 2012.

Measures

All constructs used in the survey questionnaires were assessed using 6-point Likert-type scales. The scales used in the sixth grade academy and the middle school differed slightly due to limited survey administration time in the sixth grade academy.

Self-Regulation

The scale measuring self-regulation in both the sixth grade academy (α= .871) and middle school (α= .890) was an 8-item self-regulation scale, with answers ranging from 1 (not very well at all) to 6 (very well) (Linnenbrink, 2005). The items addressed factors like how well an individual can keep him or herself on track, how organized s/he is, and how well s/he keeps up with work outside of the classroom (Appendix A).

Teacher Support

Both sixth grade academy (α= .907) and the middle school students answered a 16-item teacher support scale (α= .950). Students were instructed to choose from 1 (definitely false) to 6 (definitely true) Likert-type scale. Questions captured students' perception of their mathematic teachers' academic support (i.e. My math teacher does a good job answering my questions), emotional support (i.e. My teacher cares about how I feel), and regulation support (i.e. My math teacher directs me to resources that I can use to help me learn math) (Appendix B).

Co-Regulation

Due to time constraints, a 6-item scale was used to capture co-regulation in sixth grade students (α= .855), while a 13-item co-regulation scale was used for the middle school students (α= .920). The 6 items used in the sixth grade academy captured co-regulation predominantly available within the classroom. Students answered questions like, "Someone besides my math teacher checks over my math work." To ensure that the questionnaire answered by the middle school students captured the same constructs of co-regulation, we only included the items that captured co-regulation sources available within the classroom (Appendix C and D).

Self-Efficacy

A10-item mathematics grade self-efficacy scale captured the sixth grade (α= .871) students' and middle school students' (α= .917) confidence in their mathematic abilities. The

answers ranged from 1 (not confident at all) to 6 (completely confident). (Usher & Pajares, 2009). Sample items include questions like, "How confident are you that you can do a good job on important math tests," and "How confident are you that you will get good grades in math this year" (Appendix E).

Analyses

To observe the developmental changes in adolescents' self-regulation and its related variables, we used a paired-sample t-test to examine if there is significant difference between mid-fall and late-spring for the means of the self-regulation, teacher support, co-regulation, and self-efficacy in sixth, seventh, and eighth-grade students. Previous findings have reported that students generally show a decrease in motivation during adolescence with students in grades 6-9 experiencing the greatest rates of decline (Davis, Chang, Andrzejewski, Poirier, 2009; Jacobs et al., 2002). Decreases in motivation have been linked to decreases in academic achievement, self-regulation, self-efficacy, etc. We therefore expect to see a general decreasing trend throughout the middle school years in all the variables. We then performed a hierarchical multiple regression analysis to examine the predictive utility of teacher support, co-regulation and self-efficacy in explaining self-regulation in both the 6th grade and middle school students.

To further explore and identify possible themes that may contribute to middle school students' development of self-regulation, we conducted semi-structured interviews. Four students who exhibited high levels of self-regulation during the spring semester of their 7th grade academic year were pulled out from the survey pool. Because of time delay, the students were in 8th grade when the interviews were conducted. In-depth qualitative interviews provided the opportunity to explore the range of factors associated with self-regulatory behavior of 8th grade adolescents. All interviews were conducted in person and audiotaped by 4 researchers. The

recordings were later transcribed verbatim and transcripts were analyzed with a qualitative

thematic analysis as outlined by Braun and Clarke (2006).

Table 1. *Characteristics of the interviewee*

	Demographics		7th grade spring semester scores		
Name	Gender	Ethnicity	Self-Regulation	Co-Regulation	Teacher Support
Celine	Female	White	6.00	5.69	-
Jane	Female	Black	5.43	5.77	5.19
Kevin	Male	White	5.38	6.00	5.25
Trey	Male	Other	5.75	5.15	5.13

Results

1) How do levels of self-regulation, teacher support, co-regulation, and self-efficacy develop over the course of the middle school years?

Overall, there was a decreasing trend in the mean scores of self-regulation, teacher

support, and co-regulation throughout adolescents' middle school years when we compare

students across fall and spring semesters of all three levels: 6th grade, 7th grade, and 8th grade.

The mean scores for self-efficacy generally stayed the same for all students. A paired sample t-

test was conducted to identify significant decreases in levels of self-regulation, teacher support,

co-regulation, and self-efficacy between fall and spring semesters.

In sixth grade, there was a significant decrease in level of self-regulation from the fall

(M=4.82, SD=0.86) to spring (M=4.68, SD=0.95) semester (t (268)=2.04, p<0.05; d=0.15).

There was also a significant decrease in levels of perceived teacher support from the fall

semester (M=4.72, SD=0.81) to spring semester (M=4.50, SD=0.86, t (368)=3.56, p<0.001;

d=0.26).

In the seventh grade sample, only teacher support showed a significant decrease from the fall (M=4.44, SD=0.95) to spring (M=4.31, SD=1.10) semester (t (205)=2.77, p<0.01; d=0.13).

Finally there was a significant decrease in self-regulation from the fall (M=4.25, SD=0.99) to spring semester of 8th grade students (M=4.02, SD=1.07), (t (170)=4.14, p<0.001; 0.22), and a significant decrease in self-efficacy from the fall (M=4.49, SD=0.95) to spring semester (M=4.55, SD=0.94), (t (295)=-2.48, p<0.05) (table 5).

2) How much of self-regulation is predicted by teacher support, co-regulation, and self-efficacy in 6th, 7th, and 8th grade students?

A hierarchical multiple regression analysis was used to examine the influence of teacher support, co-regulation, and self-efficacy on student self-regulation behavior. The independent variables were entered in four blocks: (i) gender and ethnicity, (ii) teacher support, (iii) co-regulation, and (iv) self-efficacy. The first block, gender and ethnicity, was entered as a control. Hierarchical multiple regression analysis allows for an examination of the predictive utility of the three factors on student self-regulation.

The correlations of the variables included in the hierarchical multiple regression analyses for the 6th grade data are shown in Table 6. Table 7 shows the results of the hierarchical multiple regression analyses, and lists the standardized coefficients of the predictors in the model. Of the three factors, teacher support alone significantly explains 38.6% of the self-regulation in sixth grade students (adjR^2=.144, R^2=.150, p<0.001). Co-regulation and self-efficacy were not significant predictors of self-regulation for the sixth grade students.

To examine the unique variances that contribute to the development of self-regulation for 7th and 8th graders, a hierarchical multiple regression analysis was performed. The independent

variables were entered in four blocks: (i) gender and ethnicity, (ii) teacher support, (iii) co-regulation, and (iv) self-efficacy.

Unlike the sixth grade results, all three variables, teacher support, co-regulation, and self-efficacy, were significant predictors of self-regulation for both seventh and eighth grade students. The correlations of the variables included in the hierarchical multiple regression analyses for the 7th grade data are shown in Table 8. Table 9 shows the results of the hierarchical multiple regression analyses, and lists the standardized coefficients of the predictors in the model. In the second model, teacher support alone explains 32.7% of variance in self-regulation (adjR^2=.319, R^2=.327, p<0.001). In the third model, both teacher support and co-regulation are statistically significant and co-regulation alone explains an additional 3.2% of variance in self-regulation. Teacher support and co-regulation together explain 36% of variance in self-regulation (adjR^2=.483, R^2=.359, p≤0.001). In the final model, when we include self-efficacy, all three variables are statistically significant and self-efficacy alone explains an additional 3.1% of variance in self-regulation. Teacher support, co-regulation, and self-efficacy together explain 39% of variance in self-regulation (adjR^2=.378, R^2=.391, p≤0.001).

The correlations of the variables included in the hierarchical multiple regression analyses for the 8th grade data are shown in Table 10. Table 11 shows the results of the hierarchical multiple regression analyses, and lists the standardized coefficients of the predictors in the model. In the second model, teacher support explains an additional 14.9% of variance in self-regulation in addition to the 0.8% predicted by gender and ethnicity (adjR^2=.144, R^2=.158, p≤0.001). Co-regulation significantly explains an additional 4.4%, explaining a total of 20.1% of variance in self-regulation (adjR^2=.184, R^2=.201, p≤0.01). Finally, teacher support, co-

regulation, and self-efficacy together explains 29.8% of variance in self -regulation (adjR^2=.279, R^2=.298, p≤0.001).

3. What are some specific themes that appear in adolescents who exhibit higher levels of self-regulation?

Upon interviewing four 8th grade students who reported high levels of self-regulation, I identified four themes that contributed to students' self-regulatory behavior. The four themes are as follows:

Theme 1: Students perceive academic support from their teachers

Consistent with the findings of Cleary and Zimmerman (2004), the 4 students who reported high levels of self-regulation perceived high levels of academic support from their teachers.

> *I go to my teacher because she's really good about helping us out if we need help or sometimes, if we need to we can stay after school for extra help* (Celine).

> *If I need help, then I will ask the teacher and I'll usually get it whenever she helps me* (Jane).

Students were not only confident about their teacher's ability to help, but they also expressed that their teachers are available to them whenever they are in need of guidance.

Theme 2: Teachers encourage co-regulation amongst students

In addition to being confident of their teacher's ability as well as their availability, the students also expressed that the teachers encouraged them to engage in co-regulation.

Each of the four 8th grade students' math classes were structured in a similar way, in a manner that encouraged students to work with one another. During the 55 minute-class period students first spend their first 10 minutes solving warm-up problems. All of the teachers provided their students with worksheets and lecture materials instead of using a textbook. After receiving their packets, the teachers would lecture for about 20 minutes, and leave the rest of class for the students to work in groups.

In addition to structuring the class to encourage group work, the teachers also explicitly instruct students to work together.

He would just let us to just either read or help out our other groupmates (Trey).

We have…special quizzes that we could do with one partner (Celine).

The teachers also encouraged co-regulation by treating the group as one unit. When a student asks a question, the teacher would answer it to the whole group, creating an opportunity for all members of the group to learn.

If it's something that we're working on like in class and we go up to the board and we show it, if somebody has a question he'll make us answer the question like the person that was working it out on the board and so -, on the board and if someone does not get it we'll explain it to our classmates instead of him explaining it (Kevin).

I wasn't really understanding what exactly we were doing and she came over and me and my partner we work at a desk up front, and so she came over and she like really explained it to us while the rest of the class were doing the worksheet (Celine).

Theme 3: Recognizing the positive benefits of co-regulation

If the teachers function as the facilitators of co-regulation within the classroom, the students who exhibit high-levels of self-regulation perceive the importance of it and take advantage of the opportunity. All of the interviewees explicitly mentioned the importance of "building off of each other." Students mentioned two consequences of co-regulation on learning. First, students could check their work and used each other as resources, especially because it is more convenient to ask a peer than a teacher who may be unavailable at the moment.

> *Well, if I have homework I'll maybe call up my friend and we'll do it on the phone or they might come over, but I normally like in class, we normally do assignments that are partners, which helps me. If I have a question, I can ask my partner instead of going to the teacher all the time… Me and my friends we are all in the same—mostly—in the same math class, and they're really motivated and umm… if I don't understand something, they're the first ones there to help before the teacher* (Celine).

> *…but they'll compare answers with other students to see if they're correct* (Trey).

> *Since in my math class, we sit in groups, if I wasn't there that day that he told us about what it is, I try and ask the members of my group to see if I can just figure out what it is. And if that isn't working, it usually takes me at least like a day or two to figure it out, but I will get it figured out soon enough* (Trey).

In addition to using each other as resources, students build reasoning abilities as they work and teach each one another. Jane expressed how she is able to express her thoughts and position to her group member while the other member may express his or her different thoughts about the same problem. Similarly, other students expressed the same positive consequences of working together.

These two guys in my class that I used to sit with are pretty good. There are some

questions that I have for them and some they have for me. Then we go back and forth

between, sometimes we would argue what's right and what's wrong, but we usually figure

it out easily and compromise (Trey).

Moreover, students gain self-efficacy as they successfully explain what they know to a peer who is struggling.

It feels good in class you know because I know what's going on and sometimes some of

the other people don't understand it but I do. So I kind of like that I can help my friends

out (Kevin).

Theme 4: Strong family support and future aspiration

When asked why they believe some students struggle in math, Jane, Celine, and Trey stated that it is because students fail to participate. Furthermore Celine and Kevin explained that it is because they don't have the motivation. Three of the four students attributed academic failure to poor family support.

A lot of the kids don't have somebody at home to help them out. Like I'm lucky that my

parents know math and they're pretty good at it but and they urge me to learn it but like

some other kids don't have that at home and some of them lack the motivation (Kevin).

Well, asking questions is one and my family, they help me and motivate…me to do better

and my teacher, she motivates me too... Either-, either at school, either my friends or the

teacher and at home, my older brother or like family members in my, in my school-, in my

house (Jane).

...being able to find one that – a job that helps with my needs and having support from

friends and family (Trey).

Related to strong family support, all four students' future aspirations were inspired by a successful close family member. Three of the students had a clear idea of what they wanted to be as adults and though Kevin expressed that he wasn't sure what he wanted to be, he was eagerly looking.

Celine wanted to be a wedding planner and observed her father achieve his goal of becoming a successful builder through persistent work. She strongly articulated that she must set-up short-term goals to reach her ultimate future aspiration.

I make like short term goals and I try to reach every single goal so that eventually it will

lead up to a bigger goal (Celine).

Similarly, Jane wanted to become a dentist and was inspired by many of her family members who work at the hospital. Jane also had a family role model-her brother-whom she looked up to and based her short-term academic goals from.

I think it's better to be like in school so that will give you the start off for being successful

so you it can look -- so you kind like transfer to being successful in the future…

Because he maintain(ed) his grades, the program he is in like that's -- like that only --

that's only like for a certain amount of people that can go on that program. These are

only the people that like have a good grade point average and maintain their grades right

(Jane).

Abundant literature suggest the ability to regulate behavior in accordance with an individual's long-term and short-term goals emerge during adolescence (Brandtstädter, 1998; Demetriou, 2000; Geldhof et al., in press; Kopp, 1982; McClelland et al., in press; Moilanen, 2007; Raffaelli, Crockett, & Shen, 2005; as cited in Gestsdottir et al., 2009). Consistent with such findings, our interviewees attributed the importance self-established goals in exercising self-regulation. Furthermore, our interviewees all expressed that family members and their support played a great role in them finding their aspirations.

Discussion

Self-regulation is a type of adaptive behavior that develops over the course of an individual's lifetime. High levels of self-regulation have been associated with higher academic achievement (Cleary & Zimmerman, 2004; Fuchs et al., 2003). Gestsdottir et al. (2007) identify self-regulation as behaviors that are mutually beneficial to both the individual and other in his or her environment, but little research has been done to explore which factors within a classroom environment contribute to the development of self-regulation in middle school children. The purpose of this paper was to determine how self-regulation and factors related to this construct develop as individuals interact with others during math class. We also explored how teacher support, co-regulation, and self-efficacy contribute to the development of self-regulatory behavior in mathematics.

Overall, there was a decreasing trend in the levels of self-regulation, perceived teacher support, and co-regulation throughout the middle school years. Furthermore, 6th grade students differed from their 7th and 8th grade counterparts in the factors that contribute to the levels of self-regulatory behavior. For the 6th grade students, teacher support was the only significant

predictor of self-regulation, whereas for both 7th and 8th grade students, all predictors—teacher support, co-regulation, and self -efficacy—were significant predictors of self -regulation.

There are numerous facets of self-regulatory behavior. King, Lengua, & Monahan (2013) recently utilized Rothbart's (2004) definition to explore pre-adolescents' development of self-regulatory behavior. According to Rothbart (2004), self-regulatory behavior can be observed in two components: effortful control and inhibition of impulsivity. Effortful control captures a students' executive attention regulation and inhibitory control, a cognitive component of self-regulation while impulsivity captures the absence of inhibition of inappropriate response or behavior, thereby addressing the motivational component self-regulation. According King et al. (2013), decreases in effortful control in pre-adolescent children alone showed increases in adjustment problems suggesting that pre-adolescents' self-regulatory behavior is primarily driven by cognitive abilities rather than motivation.

Considering such findings, it is possible that the 6th grade students, who are closer to their pre-adolescent years report higher self-regulatory behavior because they have not yet fully entered puberty, a period marked with the "storm-and-stress" period when adolescents experience emotional adjustment issues. Moreover, it is with entry into middle school that students start to become much more responsible for monitoring their own learning processes and are asked to depend upon themselves and their peers much more for learning material. With limited experience, the only source of self-regulation support that the 6th grade students are familiar with is teacher support. In addition, it is at about this time that students may begin questioning their abilities in math as the math that they are being asked to do becomes more difficult.

According to Gestdottir et al. (2009), regulation-relevant cognition, internalized control, and the ability to regulate behavior in accordance with long-term goals emerge during adolescence. One of the themes that appeared in our interviews was recognizing the importance of family support and future aspirations. Students who exhibited high levels of self-regulation expressed that they had high levels of family support in establishing their long-term goals. As such some additional factors that we may explore for future research are family support and whether or not these students have future aspirations and long-term goals.

Limitations

The participants for this study were selected from a middle school and the sixth grade academy in the southeast region of the country. As such the findings may not be generalizable to the larger population. Also, because this is a cross-sectional study, there may be confounding variables that influence the individual cohort of the participants. The interviewees chosen for the study only includes those who reported high levels of self-regulation. Future studies should include students who report low levels of self-regulation to see if the themes identified for this study are indeed unique to students who exhibit high self-regulation.

Future research

Future research is needed to explore more fully the possibility of bi-directionality of the variables. For example, literature has shown that self-efficacy is related to self-regulation but that these processes operate in a feedback loop in which increases in self-regulation would then lead to self-efficacy. Structural equation modeling would be essential to tease apart this sort of bi-directionality. We include in Appendix A, additional reading on self-regulated learning that would help guide such future research.

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Table 2.
Demographic Characteristics of MSGA (6th grade) Students

	n	%
Gender		
Male	273	48.7%
Female	287	51.2%
Race/Ethnicity		
American Indian or Alaska Native	8	1.4%
Asian, Asian-American, or Pacific Islander	16	2.8%
Black or African-American	214	37.9%
Native Hawaiian	4	0.7%
Hispanic or Latino	135	23.9%
White	82	14.5%
Multi-Racial	80	4.6%
Other	26	14.2%

Table 3.
Demographic Characteristics of 7th Grade Students

	n	*%*
Gender		
Male	193	47.2%
Female	216	52.8%
Race/Ethnicity		
Native American or Alaskan Native	3	0.8%
Asian, Asian-American or Pacific Islander	11	2.8%
Black or African-American	183	45.8%
Hispanic or Latino	111	27.8%
White	67	16.8%
Multi-Race	12	3%
Other	13	3.3%
Free Lunch		
Paid Lunch	127	31.4%
Free or Reduced-Price Lunch	278	47.4%

Table 4.
Demographic Characteristics of 8th Grade Students

	n	%
Gender		
Male	174	46.9%
Female	197	53.1%
Race/Ethnicity		
Asian, Asian-American or Pacific Islander	19	5.3%
Black or African-American	159	44.7%
Hispanic or Latino	95	26.7%
White	54	15.2%
Multi-Race	15	4.2%
Other	14	3.9%
Free Lunch		
Paid Lunch	150	34.7%
Free or Reduced-Price Lunch	282	65.3%

Table 5.
Means (SD) and t-test results of Self-Regulation, Teacher Support, Co-regulation and Self-Efficacy in math by middle school students

Variables	Semester	6th Grade (n=369)		7th Grade (n=184)		8th Grade(n=171)	
		Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Self-Regulation	**Fall**	4.82*	0.86	4.40	1.04	4.25***	0.99
	Spring	4.68*	0.95	4.47	1.06	4.02***	1.07
		t=2.04 p=0.43				t=4.14 p=0.000	
Teacher Support	**Fall**	4.72***	0.81	4.44**	0.95	4.04	1.03
	Spring	4.50***	0.86	4.31**	1.10	4.02	1.07
		t=3.55 p=0.000		t=2.77 p=0.006			
Co-Regulation	**Fall**	3.76	1.27	3.62	1.27	3.32	1.35
	Spring	3.80	1.24	3.65	1.28	3.34	1.11
Self-Efficacy	**Fall**	4.55	0.77	4.41	1.00	4.49*	0.95
	Spring	4.51	0.76	4.53	0.93	4.55*	0.94
						t=-2.48 p=0.014	

Note: Significant results of paired-sample t-tests were marked as ***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$

Table 6.
Correlations of Variables included in Hierarchical Multiple Regression Analyses for 6th Grade Model

	1	2	3	4
1. Self-Regulation				
2. Teacher Support	0.383***			
3. Co-Regulation	0.071	0.07		
4. Self-Efficacy	-0.036	-0.034	0.167***	
Mean	4.81	4.71	3.71	4.59
SD	0.86	0.8	1.3	0.74

Note: ***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$

Table 7.
Hierarchical Regression Analyses (Standardized Beta Coefficients) Predicting Self-Regulation for 6th Grade Students

Variables in equation	Full Model, Self-Regulation of 6th Grade Students		
	Step 1	Step 2	Step 3
Teacher Support	.39***	.387***	.386***
Co-Regulation		0.056	0.062
Self-Efficacy			-0.038
N		415	
R2	0.15	0.153	0.154
Changes in R2		0.003	0.001

Note: ***$p \leq 0.001$; **$p \leq 0.01$; *$p \leq 0.05$

Table 8.

Correlations of Variables included in Hierarchical Multiple Regression Analyses for 7th Grade Model

	1	2	3	4
1. Self-Regulation				
2. Teacher Support	0.545***			
3. Co-Regulation	0.333***	0.296***		
4. Self-Efficacy	0.427***	0.473***	0.374***	
Mean	4.40	4.44	3.67	4.69
SD	1.05	0.95	1.28	0.85

Note: ***p≤.001; **p≤0.01; *p≤0.05

Table 9.

Hierarchical Regression Analyses (Standardized Beta Coefficients) Predicting Self-Regulation for Seventh Grade Students

Variables in equation	Full Model, Self-Regulation of 7th Grade Students		
	Step 1	Step 2	Step 3
Teacher Support	0.547***	0.491***	0.407***
Co-Regulation		0.193***	0.137*
Self-Efficacy			0.212***
N		240	
R2	0.327***	0.359***	0.391***
Changes in R2	0.299	0.032	0.031

Note: ***p≤.001; **p≤0.01; *p≤0.05

Table 10.
Correlations of Variables included in Hierarchical Multiple Regression Analyses for 8th Grade Model

	1	2	3	4
1. Self-Regulation				
2. Teacher Support	0.393***			
3. Co-Regulation	0.311***	0.259***		
4. Self-Efficacy	0.434***	0.321***	0.162***	
Mean	4.25	4.03	3.42	4.50
SD	1.03	1.06	1.33	0.94

Note: ***p≤.001; **p≤0.01; *p≤0.05

Table 11.
Hierarchical Regression Analyses (Standardized Beta Coefficients) Predicting Self-Regulation for 8th Grade Students

Variables in equation	Full Model, Self-Regulation of 8th Grade Students		
	Step 1	Step 2	Step 3
Teacher Support	0.388***	0.334***	0.237***
Co-Regulation		0.222**	0.192**
Self-Efficacy			0.333***
N		190	
R2	0.158***	0.201**	0.298***
Changes in R2	0.149	0.044	0.097

Note: ***p≤.001; **p≤0.01; *p≤0.05

Appendix A. *Self-Regulation Survey Questionnaire*

1. When I do math, I check over my work.
2. Even when I don't want to work on math, I force myself to do the work.
3. When I make a mistake, I try to figure out where I went wrong.
4. I force myself to finish my math work even when there are other things I'd rather be doing.
5. Before I start a math problem, I read through all of the information to see how to organize it.
6. Even if I don't see the importance of a particular math assignment, I still complete it.

Appendix B. *Teacher Support Questionnaire*

1. My math teacher lets me choose what I learn about in math.
2. I feel like my math teacher understands me.
3. My math teacher believes I can do well in math class.
4. My math teacher likes it when I ask questions.
5. My math teacher is someone I can trust
6. My math teacher does a good job answering my questions.
7. My math teacher listens to my ideas.
8. My math teacher cares about how I feel.
9. My math teacher helps me when I do poorly in math.
10. My math teacher tries to understand how I see things
11. My math teacher assists me when I need help.
12. My math teacher cares about me as a person.
13. My math teacher explains math concepts in ways that I can understand.
14. My math teacher directs me to resources that I can use to help me learn math.
15. My math teacher talks to me about my math work.
16. My math teacher asks me questions to guide me through the steps to solve math problems.

Appendix C. *Co-Regulation Questionnaire (6ᵗʰ Grade)*

1. I talk with someone else besides my math teacher about the steps I used to solve a math problem.
2. Someone besides my math teacher explains math concepts in ways that I can understand
3. Someone besides my math teacher tells me that I am on the right track in solving math problems.
4. Someone besides my math teacher asks me questions to guide me through the steps to solve math problems
5. Someone besides my math teacher directs me to resources that I can use to help me learn math.
6. Someone besides my math teacher checks over my math work.

Appendix D. *Co-Regulation Questionnaire (7ᵗʰ and 8ᵗʰ grade)*

1. I have someone in class who can discuss math with me
2. I teach someone in my class to solve math problems.
3. My class members and me teach each other the concepts we learn in class.
4. Someone besides my math teacher explains math concepts in ways that I can understand.
5. Someone besides my math teacher tells me that I am on the right track in solving math problems.
6. I talk with someone else besides my math teacher about the steps I used to solve a math problem.
7. Someone besides my math teacher asks me questions to guide me through the steps to solve math problems.
8. Someone besides my math teacher checks over my math work.
9. Someone besides my math teacher directs me to resources that I can use to help me learn math.

Appendix E. *Self-Efficacy Questionnaire*

1. In general, how confident are you in your abilities in math?
2. How confident are you that you will do well in math this year?
3. How confident are you that you can learn math?
4. How confident are you that you can do well on standardized tests in math?
5. How confident are you that you will get good grades in math this year?
6. How confident are you that you can do a good job on important math tests?
7. How confident are you that you can do math work that a 4th grader would do?
8. How confident are you that you can do math work that a 6th grader would do?
9. How confident are you that you can do math work that a high schooler would do?

Appendix F. *Semi-Structured Interview Questions*

<div align="center">Motivation/Help Seeking/Co-Regulation:</div>

1. Describe how you feel in math class or when doing a math assignment (How motivated are you in learning the concepts that you learn in math class?)

2. Describe a time when you had difficulty with math, and talk about how you managed it. (When you have difficulties with math, what do you do?, Do you have someone who is able to help you with math? Who? How do they help you?)

3. What are the things that could help you do well in math? (Do you attend tutoring at school? Why or why not?)

4. What are the things that prevent you from doing well in math.

5. Who do you go to for help when you don't understand something? How do they help you?

6. Do you feel comfortable asking questions during class? Why or why not? (Do you generally ask questions when you don't understand something? Why or why not?)

7. If you don't ask for help, what do you typically do when you don't understand something?

8. How much do you talk with someone besides your math teacher about mathematical concepts? Who do you talk to?

<div align="center">Teacher Support:</div>

1. Describe how your teacher teaches and interacts with students in math class. (What are some specific strategies that your teacher teaches you to improve your learning in mathematics? How much time does your teacher lecture in class or explain how to solve problems on the board?)

2. Tell me about the last time you asked a question in class, what was it about, how did your teacher help you. (Do you have opportunities to ask your teacher questions after class if you need to do so?)

3. How much time do you spend doing work with peers in class?

4. How much time do you spend doing individual work in class?

5. When you answer questions in class, does your teacher ask you to further explain why you think your answer is correct?

6. What does your teacher do if you/other students complete work early? (Does your teacher give you more challenging work if you complete your work early?)

Self-Regulation:

1. How do you organize your materials in your math class? (Do you take notes in your math class?)

2. How do you keep yourself on track if you are distracted?

Questions about success:

1. Think of someone who you would consider successful. Who is this person and why do you think they are successful?

2. When you're a grown up, what would it mean to say that you are successful?

3. What might prevent you from being successful as an adult?

4. What would you like to be when you grow up? Why? Where did you get this idea from? What do you think you need to be doing now to prepare?

5. What are the things that you think might prevent you from being successful at becoming what you would like to be when you grow up and what are some of the things that might help?

6. What does it mean to you to be successful in school?

7. How important do you think it is to a person's future success to be successful in school?

8. Do you think that the person you named as being successful was also successful in school? Do you think this is why this person was successful? Why or why not?

9. Describe any student(s) who you believe are good mathematics students.

10. How do you know they are good in math?

11. Compared to most of your other subjects, how good are *you* in math?

12. How good would you be at learning something new at math?

13. What *expectations* do you have of *yourself* in mathematics?

14. Why do you think that there are some students who don't do well in math?

15. How would you feel about being regarded as a good math student?