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Problem Solution Exploration Papers

PSYCHOSOCIAL THEORIES TO INFORM A NEW GENERATION OF STUDENT SUPPORT STRUCTURES FOR LEARNING MATHEMATICS

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Introduction

The purpose of this paper is to provide a theoretical framework from social and educational psychology to enhance student support structures with research-based approaches. So, in turn, students can deepen their commitment to learning and increase productive persistence in the face of academic struggle through increased motivation and self-efficacy. The particular focus of this support is community college students in developmental mathematics classes, though the ideas may have broader application across the educational continuum.

Many teachers rate working with unmotivated students as the single most challenging aspect of teaching (National Mathematics Advisory Panel, 2008). However, motivation is not a simple concept, nor a singular one. Viewing motivation as a characteristic that students either have or don't have does not do justice to the complexity of motivation, nor does it help educators think about how they might increase student motivation.

Our culture tends to view mathematical ability as a talent, a quality that is there or is not there. Students as well as teachers may think some students are good at math, while others are not. In contrast, other cultures view math as something everyone can do with effort, though it may require harder work on the part of some individuals. In fact, research has noted that many students have difficulty not because of their inability to do the academic work, but because they do not believe they are capable of performing successfully (Pajares & Schunk, 2002, p. 17).

The objective of this paper is to explore theories from psychology that could inform a new generation of student support structures committed to increasing student motivation and academic success.

Figure 1. Four Sources of Self-Efficacy Mediated by Cognitive and Motivational Processes

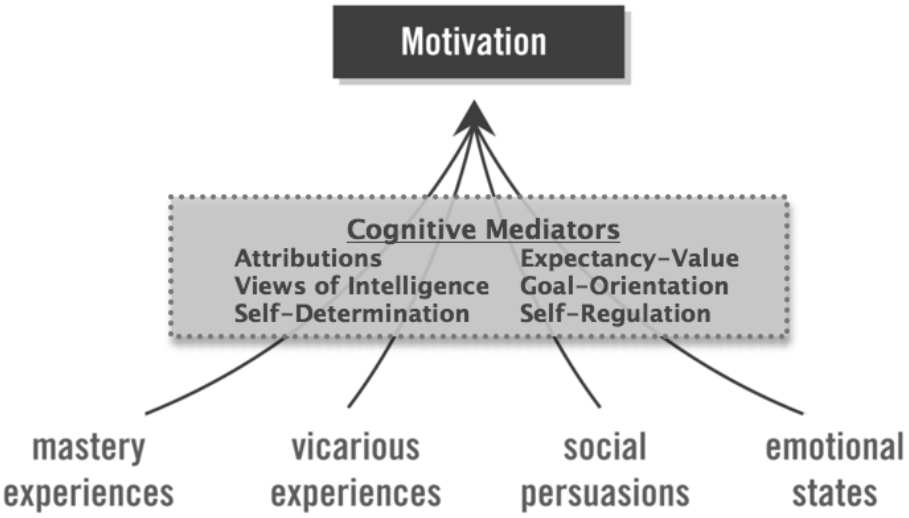

Figure 1 is a summary of the theoretical framework. Building on Bandura's (1977) theories of self-efficacy, motivation is derived from four sources of information: mastery experiences, vicarious experiences, verbal (social) persuasion, and physiological and emotional states. These four modalities are then mediated by cognitive processes that appraise and attribute information to inform beliefs of self-efficacy. The following synthesis of the subsequent social and psychological theories will build upon Bandura's theory of self-efficacy and will center on how to build mastery experiences mediated by motivational processes, situated in a social environment, and sustained by grit, resilience, and self-discipline. This framework incorporates psychological research and theories from the 1970s to contemporary (2009) theories.

The overview of this paper:

- Bandura's Theory of Self-Efficacy
- Motivational Processes
- The Social Environment

- Grit, Resilience, and Self-Discipline
- Incorporating Theory With Practice: Academic Youth Development

Bandura's Theory of Self-Efficacy

The foundation of the theoretical framework is Bandura's (1977) theory of self-efficacy. He defines perceived *self-efficacy* as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3, 1997). In order to achieve these kinds of self-beliefs, Bandura outlined four sources of information from which they are constructed. These four sources are (1) *enactive mastery experiences* that indicate capability (2) *vicarious experiences* that alter efficacy beliefs through transmission of competencies and comparison with the attainments of others (3) *verbal persuasion* and social influences regarding one's capabilities and (4) *physiological and affective states* from which people judge their strength, capability, and vulnerability to dysfunction.

Enactive mastery experiences. Mastery experiences are successes that bolster self-efficacy as learners overcome obstacles through perseverant effort, and these direct experiences are understood to be the most influential and authentic source of efficacy information. Through mastery experiences, learners gain the confidence to persevere in the face of adversity and setbacks. Enacting these experiences requires cognitive and behavioral self-regulative tools that organize the demands of a task and the necessary skills for execution. Moreover, these strategies must be applied consistently and persistently in order to instill a stable sense of control within the learner.

Factors involved in effective mastery experiences are task difficulty, contextual factors, effort expenditure, self-monitoring, and attainment trajectories. First, the perceived difficulty of the task must not be too easy. Redundant success is not as effective as success on challenging tasks, which ultimately raise beliefs in one's capabilities. Second, contextual factors, particularly those that reflect non-ability of the learner can lower self-efficacy as success can be attributed to external assistance, the adequacy of resources, or other circumstances, instead of personal attributions. Third, the amount of effort a learner exerts on a task requires an ability to regulate and control the level of effort to maintain performance motivation. Effort is an unstable internal cause unlike ability (which Bandura describes as a stable cause; however, later work by Dweck

questions this assumption), so the effort expenditure needs to be firmly self-regulated. Fourth, learners must self-monitor their previous success and failures so that successes are noted and remembered and that poorer performances are not dwelt on. Lastly, the awareness that self-efficacy requires a long period to develop competencies is essential in understanding setbacks and plateaus in the context of overall improvement.

Vicarious experiences. Modeling serves as another way to raise levels of self-efficacy as learners vicariously judge their own competencies through the success of others. Learners appraise their own capabilities by social comparison and group norms. One aspect that increases the effectiveness of vicarious experiences is perceived similarity between model and learner. Seeing people who are recognized as similar to one's self succeed will raise perceived efficacy. If someone similar to the learner is capable, the learner can come to believe that she or he is capable of learning as well. However, models can be more than social standards; they can also provide guidance and motivation for self-development by instilling encouragement and confidence during difficult tasks, ultimately becoming mentors to the learners.

Verbal persuasion. Social persuasion can strengthen or weaken a learner's beliefs of self-efficacy. If positive feedback is in realistic bounds, learners can mobilize greater effort and try harder to succeed. Thus, self-affirming beliefs from an outside source can boost development of skills and perceived self-efficacy. Alternately, criticism can have a very negative effect on learners, lowering their sense of self-efficacy and aspirations. In general, in order to be effective, evaluative feedback requires a knowledgeable and credible source as well as a level of appraisal that is moderately beyond what learners can do; thus, verbal persuasion needs to be authentic and appropriate for the learner.

Physiological and affective states. The last source of self-efficacy is the somatic information found in physiological and emotional states. One's physical status, stress levels, emotional proclivities, and interpretations or misinterpretations of bodily states can alter efficacy beliefs. And more importantly, the physical or affective response is not the sole cause that can affect a sense of self-efficacy, but it is the cognitive interpretation of these bodily and emotional states that regulates self-efficacy.

The integration of these four modalities of influence into a coherent and effective sense of self-efficacy is a complex matter as learners weigh the diverse inputs toward their self-persuasion. However, when learners successfully construct a sense of personal self-efficacy, these efficacy beliefs, constructed by processing information conveyed inactively, vicariously, socially, and emotionally, can contribute to the quality of human functioning in diverse ways.

The other psychological and social theories explored in this paper build on Bandura's framework for self-efficacy. As the model illustrates, various cognitive mediators contribute to motivation: first, motivational processes through which self-efficacy beliefs produce their effects; second, the social environment that provides a safe environment for learning; and third, the grit, resilience and self-discipline to persevere in spite of setback and struggle.

Motivational Processes

Historically, the idea of motivation has undergone drastic shifts in the last century. Following the Cognitive Revolution in the 1970s, motivational theory moved from a behaviorist approach to more social and cognitive approaches, incorporating how one cognitively appraises the self and the environment in understanding motivational processes.

Attribution Theory. In 1972, Weiner described a then-recent development called attribution theory that brought to light the functional significance in cognitive processes amid the behaviorist movement in psychology. Investigating the perception of causality, attribution theorists studied how people judged why a particular incident occurred and how these attributions guided subsequent behavior. Specifically in education, Weiner highlighted the important implications of causal biases when interpreting successes or failures in student achievement. He reported that individuals high in achievement motivation perceived effort as an important determinant of success, and conversely, that individuals low in achievement motivation believe that how hard they tried only weakly influenced the outcome.

Moreover, attribution theorists explained how high achievement individuals, when compared to their low achievement peers, were more likely to (1) initiate achievement activities, (2) work with greater intensity, (3) persist longer in the face of adversity, and (4) choose more challenging tasks. First, if a learner attributes success to internal causes such as high ability and effort, there

is more personal investment when succeeding in tasks and greater feelings of pride. Thus, the heightened reward attributed by personal factors increases the likelihood of initiating achievement activities. Second, high achievement individuals, when faced with failure, attribute it to a lack of effort. Since effort is an unstable attribute—being in one's control—they are motivated to continue in striving towards an unattained goal with great intensity and persistence. Lastly, attempting more difficult tasks increases the sense of attributed worth to ability and effort.

Expectancy-Value Theory. Another cognitive motivational theory is the Expectancy-Value Theory, proposed by Eccles et al. (1983). They initially developed this model of achievement performance and choice in the mathematic achievement domain. In this theory, motivation is explained by a learner's beliefs about how well he or she does on a task and the extent to which they value the task. Eccles et al. defined expectancies for a learner's success as beliefs about how well he or she will do on upcoming tasks. They then described achievement values as the combination of attainment value, intrinsic value, usefulness and cost; this encompasses the importance of doing well on a task, the level of enjoyment derived from the activity, the utility for future plans, and the required amount of effort and emotional cost. In sum, motivation requires high amounts of both expectancy to succeed and achievement value. Relevant research in mathematics education showed that beliefs about expectancies for success were the strongest predictor of subsequent math grades as well as subjective task value strongly predicting students to take advanced math courses (Wigfield & Eccles, 2000).

Self-Determination Theory. In the 1980s, Ryan and Deci described motivation in regards to three fundamental human needs: the need for *competence*, *autonomy*, and *relatedness*. When these three psychological needs are met, the individual is "self-determined" (Ryan & Deci, 2000). Competence—similar to expectancy from Expectancy-Value theory—is how likely one is to succeed presently. Autonomy is how much the individual is in control of a task via the option of choice. Lastly, relatedness is the sense of security, relationship, and authentic connection to others. In Self-Determination theory, motivation occurs when external factors are perceived to increase these three conditions.

Malleability of Intelligence. Dweck (2002) discussed how students' theories about intelligence affect their achievement and motivation. She examined two views of intelligence: the first is that intelligence is *fixed*—something given, characteristic, and unchangeable—the second is that intelligence is *malleable* and can be changed and increased.

Students who believe that intelligence is fixed and unchangeable tend to believe that failure in learning or even the need to expend effort indicates low intelligence. When these students encounter concepts they do not understand immediately, without effort, they tend to believe that they are incapable of understanding, and they react by expending even less effort. A study conducted by Aronson, Fried and Good (2002), found that when an experimental group of students were given information about the malleable or incremental view of intelligence and that their intelligence can grow through effort and hard work, there was greater enjoyment over academics reported compared to the control group.

Blackwell, Trzesniewski and Dweck (2007) expanded this work by studying students' theories of intelligence as predictors of achievement across the transition through junior high school. They found that students who viewed intelligence as malleable—capable of incremental change—also tended to hold stronger learning goals. Further, their data showed that students with incremental views of intelligence were less likely to experience the downward coursework grade trajectories that are typical as students move through their junior high years.

Goal-Orientation Theory. Interestingly, Dweck (1986) also linked her research in student views of intelligence with goal orientation approaches. The goal orientation theory describes motivation as the goals an individual chooses to pursue and the methods used to pursue those goals. She showed how those with an incremental view of intelligence tend to have different goal orientations than those with an entity or fixed view of intelligence. Those individuals who had a malleable view of intelligence were more likely to have a mastery goal orientation, or to have learning goals in which learners seek competence or mastery of a new topic. In contrast, individuals with a fixed view of intelligence were more likely to have performance-approach goals, in which individuals seek to gain favorable judgments or avoid negative judgments regarding their performance.

Individuals are categorized in terms of goal orientation based on three factors: mastery, performance-approach, and performance-avoidant. Individuals with a mastery goal orientation seek challenging tasks and value learning (intrinsic). Highly performance-approach oriented individuals seek tasks that allow them to demonstrate the skills they already possess (extrinsic), and the highly performance-avoidant tend to avoid tasks where they may fail and can appear incompetent.

Self-Regulation. As a crucial component to many of these theories of motivation, self-regulation links the individuals and the context to shape their own development. A comprehensive definition is "the ability to flexibly activate, monitor, inhibit, persevere and/or adapt one's behavior, attention, emotions and cognitive strategies in response to direction from internal cues, environmental stimuli and feedback from others, in an attempt to attain personally-relevant goals" (Moilanen, 2007, as cited in Gestsdottir & Lerner, 2008). Gestsdottir and Lerner (2008) specified two types of regulation: *organismic* and *intentional*. Organismic self-regulation concerns broad attributes of an individual's biological and physiological and emotional functions that contribute to the relationship with the environment. Intentional self-regulation is characterized by goal-directed behaviors through monitoring demands and resources in the learning context to enhance self-development. This kind of self-regulation involves many components: self-representations and an awareness of others that informs the individual of past experiences, accurate self-evaluations, and directions for future development; self-monitoring of where the individual is situated in relation to his or her goal; self-modification to correct the person to increase opportunities to attain the goal. In sum, the self-regulatory process requires making choices, planning appropriate goal-directed actions, and executing subgoals with a commitment to persist toward the larger goal.

Gestsdottir and Lerner (2008) further described a model within intentional self-regulation called Selection, Optimization, and Compensation (SOC), which was first developed by Baltes et al. (1997). First, a goal-directed person selects a goal; *selection* involves the development and commitment toward a personal goal. Second, the individual seeks strategies that are compatible with pursuing this goal; *optimization* requires monitoring progress toward the goal and applying persistence, focused attention, delay of gratification and intentional practice to ensure goal achievement. Third, in the face of a loss or adversity, the individual compensates by finding

alternative means to reach his or her goal; *compensation* is counteracting or avoiding failure in the face of a goal-relevant loss. Gestsdottir and Lerner (2008) found that SOC was a global factor in Positive Youth Development (PYD), showing how SOC scores were positively linked with greater competence, confidence, character, connection and caring values and negatively related to depression, delinquency, and risk behaviors (p. 218).

Social Environment

The classroom environment and culture is an essential and often overlooked feature when discussing motivational processes related to learning. Ryan and Deci (2000) argued that one of three fundamental needs is a sense of relatedness, or authentic connection with others, in order to be a self-determined, motivated learner. Therefore, two topics, stereotype threat and sense of belonging, will be addressed here to highlight how the class culture and environment can negatively or positively affect student achievement.

Theories of *stereotype threat* suggest that the presence of a negative stereotype of a social group can reduce levels of task performance of members of the group (Steele, 1997; Aronson et al., 2002; Shih, 1999, 2006). However, research in reducing stereotype threat give a reason for hope on the basis that people can be categorized by multiple social identities, some of those being subject to positive stereotypes (Rydell, McConnel & Beilock, 2009). Given that people tend to view themselves positively, increased identification with the positive stereotype can reduce stereotype threat, focusing more on an asset-based approach towards learning.

Shih et al. (1999) showed that Asian women performed differentially by two social categories on mathematics tasks. Specifically, when the social category was accessible (being Asian is consistent with stereotypes of better math ability), math performance increased; alternatively, when the female stereotype was accessible (being female is consistent with stereotypes of better math ability), performance decreased. In a similar study, Rydell, McConnel & Beilock (2009) presented female participants conflicting positive (college student) and negative (female) stereotypes concurrently to test how the availability of multiple social identities affected math performance. They found that math performance did not suffer in the multiple identity condition, suggesting that women adopted the identity that served to maintain a more positive view of the self. Shih et al. (2006) mirrored their earlier study with the same two identities of female and

Asian but reversed the valence of associated stereotypes with a verbal test. As expected, performance results were reversed, indicating that identities are not globally adaptive or maladaptive. In sum, one must understand how flexible multiple social identities are in their accessibility and valence adaptability in order to ensure success in a particular domain.

In consideration of the negative effects of stereotype threat, the social learning environment can be a potentially threatening context for students (Inzlicht & Good, 2006). In light of Dweck's research on the malleability of intelligence, when negative stereotypes are coupled with messages regarding a fixed nature of intelligence, students can feel like they do not belong. They feel like outsiders and believe their contributions do not matter. These threatening environments undermine a student's *sense of belonging*—being a valued member in an academic community (Inzlicht & Good, 2006). On the other hand, environments that foster beliefs of competence through effort can create a secure sense of belonging; one's interest, commitment and progress towards learning may have a greater effect upon a sense of belonging than one's perceived ability (Inzlicht & Good, 2006, p. 15). They argued that changing people's perception of their environment can be an effective way to counter stereotype threat; one possibility is promoting a malleable view of math intelligence to buffer the effects of stereotypes and to increase the sense of being valued in a community.

Grit, Resilience and Self-Discipline

A related field to motivation is the capacity to persevere in the face of challenges and obstacles. A few of these constructs are *grit* (Duckworth et al., 2007), *resilience*, (e.g. Masten, 1990), and *self-discipline* (e.g. Duckworth, 2009).

Grit refers to perseverance and passion for long-term goals, often involving strenuously working through challenges and maintaining high levels of interest and effort in the face of failure, adversity and plateaus in the learning process (Duckworth et al., 2007). Grit emphasizes long-term stamina as gritty individuals pursue a given aim over years even in the absence of positive feedback. Using a self-report questionnaire (the Grit scale), the researchers found that gritty children work harder and longer than their less gritty peers, and thus, perform better.

Duckworth et al. (2007) also showed that grit was more related to success outcomes such as higher GPAs despite lower SAT scores, higher first summer retention at Westpoint, higher levels of education and fewer career changes than traditional used measures such as IQ. They argued that achievement is a product of talent and effort, with effort defined as a function of intensity, direction, and duration of striving towards a goal—essentially, grit. With the metaphor of a marathon, the gritty individual has stamina to keep persisting at a goal and staying on course.

A related construct to grit, resilience is defined as "good outcomes in spite of serious threats to adaptation or development" (Masten, 2001, p. 228). Resilience requires two major kinds of judgments, the threat side and the quality side of the inference. First, one must address the threats or hazards that are causing the individual to be resilient against. These are often associated with risk factors such as low socioeconomic status. Second, one must assess the quality of the adaptation or developmental outcome, the result of the resilience.

Interestingly, research reveals that resilience arises from ordinary human adaptive processes including metacognition, regulation of emotion and behavior, mentor relationships, and motivation for learning and engaging in the environment (Masten, 2001). In early studies of resilience, there was a misplaced emphasis on extraordinary or exceptional qualities that comprise resilient individuals, neglecting the smaller global factors such as connections with others and the community, cognitive and self-regulation skills, positive views of self, and motivation to be effective that were really at work. Dr. Ginsburg (2006) has studied resilience in children and identified the seven "C"s for instilling resilience in students: *competence* is knowing how to handle a situation; *confidence* is belief in one's own abilities; *connection* is developing close ties and a sense of belonging; *character* is a solid set of values; *contribution* is the understanding of personal contributions as a source of purpose and motivation; *coping* is how to effectively handle stress; and *control* is awareness of the ability to bounce back. Through these features of resilience, students can develop the ability to negotiate their own challenges and to become more capable.

Martin and Marsh (2006, 2008) have specifically examined the academic context and the associated challenges, setbacks, and pressure and argue for greater understanding of academic adversities and the ways to deal with them. They have termed a different construct called

academic resilience, which refers to academic achievement despite a challenging or threatening circumstance in the educational process. There has been little research on academic resilience despite how all students may experience some level of poor performance, adversity, or challenge at school.

Lastly, self-discipline is the capacity to manage thoughts and emotions and to plan the appropriate behavior to reach one's goals. Duckworth (2009) argued that self-discipline predicts a wide range of positive outcomes such as higher SAT scores, emotional coping skills, happiness, and a better handling of stress. Cultivating self-discipline requires helping students understand how to achieve their goals by teaching them how to appropriately marshal willpower, uphold standards, and delay gratification. Duckworth states that self-discipline is essential to sustaining motivation in pursuit of one's goals: "When we teach children how to regulate their attention, emotions, and behavior [self-discipline], we empower them to pursue goals that are most important to them" (p. 536).

Grit, resilience, and self-discipline all describe the power of perseverance in the face of struggle or setback. Understanding these constructs can shed light on how students can stay motivated and learn how to endure through failure, staying the course toward their personal and academic goals. If we understand that these characteristics are malleable, they can be viewed as not only as resources to be incorporated in educational settings, but also as possible outcomes of education.

Incorporating Theory with Practice: Academic Youth Development

In order to address the gap between research and practice and provide suggestions for implementing ideas from these theories, the following example, Academic Youth Development (AYD), melds best practices in supporting algebra-readiness skills with recent advances in developmental and social psychology. The immediate goal of Academic Youth Development (AYD) is to support the successful transition of middle school students into Algebra I by shaping students' commitment to success in rigorous academic programs. Beginning in 2006, AYD has grown from just two schools and three cohorts of students (cohort sizes range from 20 to 30 students) to 23 schools and 23 cohorts in the pilot year. The program grew to approximately 100

schools and 124 cohorts in 2008, and now currently, AYD serves 126 schools and 183 cohorts.[1]

Research demonstrates that relatively modest interventions aimed at shaping the culture of classrooms can have powerful effects on student success. Practitioner wisdom, as well as research, also demonstrates that effective improvement efforts must address the students and their self-beliefs along with the overall culture of the learning environment. As a two-week summer bridge experience, AYD shapes the way students think about themselves as learners, develops their commitment to high achievement, and creates a set of social supports that sustain their responsible and productive engagement in challenging courses.

Intended to serve schools and their mathematics programs, AYD equips cohorts of students with surprisingly infectious information and skills to share with their peers, thus improving the learning culture—and outcomes—for all students and teachers who come in contact with them, not only during the summer, but in the classes during the academic year as well. One central feature of AYD is helping students understand that intelligence is malleable, not fixed. Drawing from recent neuroscience advances, AYD shows students how their brains actually change as they learn new things. AYD also incorporates ideas from the social psychology theories described above regarding effective effort, attribution of effort, and the significance—in learning academic content—of interpersonal skills, sense of belonging, and motivation. The program provides students and teachers with an explicit set of tools and strategies for applying these ideas in the Algebra I classroom and in daily learning. AYD also provides mathematics content focused on problem solving, proportionality, and use of multiple representations—connecting the students' previous learning with what they will experience in their first year of algebra.

To develop and support a cohort of student allies and their algebra teachers, AYD uses online curriculum resources that include: interactive animations, simulations, and visualizations that deepen student understanding of key concepts; explorations and investigations that challenge students and show them the power of the mathematical and psychological concepts. The

[1] AYD was created by the Charles A. Dana Center and Agile Mind in collaboration with networks of school districts and a working group of educators and psychologists. The design was shaped by the observation that students who fail the high school gatekeeper course, Algebra I, also fail other high school courses. Remediation attempts commonly focus solely on mathematics rather than on building new understanding of student motivation and engagement. Currently, the program is being implemented with 4,000 students in 150 schools in 8 states.

curriculum not only enforces content knowledge, but also supports the development of positive self-beliefs and attributions for success.

Student participation in AYD begins with the 14-day summer bridge experience, taught by two AYD teachers with up to 30 students in a cohort. The relaxed context gives students and teachers the opportunity to experience teaching and learning that can promote strong gains in achievement. During the summer bridge, students build relationships with other students and with their future Algebra I teacher, and they learn and apply strategies for effective effort. Along with a sense of belonging, they also gain a sense of competence and expertise in key problem-solving strategies they will need for Algebra I.

During the school year, AYD is designed to nurture crucial relationships between students and their teachers, administrators, and counselors. The ongoing program structure helps AYD students and teachers continue to support each other as a learning community, guide students in activating and reflecting upon what they learned in the summer bridge experience, and, most importantly, sustain student aspirations for high achievement in the face of obstacles

From evaluations in 2008, AYD was positively affecting the beliefs and behavior of both students and teachers. In pre/post surveys and interviews, participating students reported:

- Higher self-confidence and a higher level of support in mathematics from their peers and teachers
- Higher motivation and persistence—students were less likely to give up when frustrated or when working on particularly challenging math problems
- Increased use of metacognitive learning strategies—for example, purposeful selection of approaches when engaged in problem solving
- A greater understanding of theories of intelligence, especially the understanding that with hard work and effort, they could increase their intelligence and their capacity for academic success

Participating teachers pointed toward changes in classroom culture. That is, a majority of teachers talked about the emergence of a culture of respectful engagement (a key goal of the

AYD initiative). In follow-up interviews, teachers reported:

- Students taking more responsibility for their role in creating a positive academic learning environment
- Better student-to-student communication—for example, talking through ideas, solving problems together
- Higher levels of student engagement—for example, almost all students, even those who previously were disengaged in school, participated more in class
- Increased willingness of students to work with one another and to encourage and support one another in their learning

Conclusion

Understanding social and developmental theories is a crucial element in constructing effective student support structures that maximize student achievement. Current and emerging psychology theories have not always been acknowledged and incorporated into educational work. The framework presented in this paper highlighted theories about the sources of information from which students assess their sense of competence, the mediating and self-regulating processes that appraise and attribute these sources, and the potential outcomes, specifically, a strong sense of self-efficacy, high levels of motivation and a gritty resilience. Moreover, the example of Academic Youth Development reveals how integrating motivational theories and creating a community of learners can be implemented into strategies for students to productively persist in rigorous and challenging academic courses. In conclusion, this theoretical framework will hopefully generate student support structures committed to student motivation and success.

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About the Problem Solution Exploration Papers

A series of background papers was prepared for Carnegie to support its work in developmental mathematics in community colleges, to devise measures for student success, and to help identify problems of practice for potential future work.

Student Learner Study
"What Community College Developmental Mathematics Students Understand About Mathematics," James Stigler. Because the research literature did not cover what mathematical knowledge students have, James Stigler undertook fieldwork to learn more about students' understanding of basic mathematics, and student perceptions of what they believe it means to *do* mathematics.

Language Learning
"The Developmental Mathematics and Language Project," Guadalupe Valdes and Bernard Gifford. Includes an extensive review of literature and field work, with interviews of students, faculty, and administrators at three community colleges –San Jose City College, East LA Community College and El Paso Community College.

Human Resources
"Community College Faculty and Developmental Education: An Opportunity for Growth and Investment," by Amy Gerstein provides a descriptive analysis of full- and part-time community college faculty, and their preparation for teaching.

Social/Cultural Support
The two parts of this paper are a review of literature of current student success courses by Laura Hope of Chaffey College, and a white paper on social and educational psychology by Carlton Fong of the Charles A. Dana Center. These two together map the landscape of current practice and new possibilities.

A more detailed introduction to the papers by Rose Asera is also available.

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