How a Montessori Prepared Environment Builds Executive Function in a Primary Classroom

By

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Abstract

Developing Executive Function in a Montessori Primary Classroom

Increasingly, research across social science fields illustrates the positive impact of executive function and social competence skills on academic and overall life achievement. Specifically, self-regulation skills are shown to produce greater results academically and are beneficial to overall life achievement. Some research indicates that a high fidelity Montessori environment; one that more strictly aligns with Maria Montessori's approach produces better academic and social-competence results than Montessori schools with supplemented curriculums or lower fidelity programs (Lillard, 2012). With consideration of the critical nature of these findings, action research has been undertaken to explore and identify the components of a prepared Montessori environment that promotes the development of executive function skills. The intent of this study is to align with a high fidelity Montessori environment. This study measures some executive function skills such as: Self-regulation, planning, and persistence over a 6 week period following lessons in the Practical Life, Grace and Courtesy and Sensorial areas. We gathered data through pre and post intervention observations and a parent survey and questionnaire. We implemented interventions for the duration of a six week period. Observations occurred 5 days a week during a 3 hour work period in a Montessori Primary classroom located in rural Southwest Minnesota. The participant's ages ranged between 2-4 years and included four girls and one boy. The study demonstrated that a Montessori prepared environment offers multipronged strategies to build executive function and pro-social behaviors indicated by the correlation between children advancing in self-regulation skills and pro-social behavior. Given the serious attention among the social science fields to equip young children with self-regulation skills, this study demonstrates the strength a Montessori education innately offers toward this end.

Keywords: self-regulation, executive function skills, high fidelity, academic, social-competence, pro-social skills

Introduction

Executive function skills are a set of skills determined by growing research as necessary for overall academic, social and life achievement. Executive function skills may be more strongly linked to school readiness than even IQ and content knowledge such as early math and reading (Diamond, 2011). Self-regulation, a subset of executive function skills has been shown to play a critical role in promoting school readiness and future academic success (Willis, 2014). Lillard identified in her research that a relationship exists between levels of self-regulation and academic achievement (Lillard, 2012).

The definition of self-regulation varies across the social science fields. Within the field of education, self-regulation refers to "a set of behavioral skills that include working memory, inhibitory control and attention" (Willis, 2016, p.663). Willis describes working memory as the ability to hold a thought or rule in one's head while manipulating a concept. Steven Hughes, a leading neuropsychologist defines working memory as the ability to hold information in memory while performing complex tasks. Working memory incorporates the ability to draw on past learning or experience and apply it to the situation at hand. (Hughes, 2014). Inhibitory control is defined as one's ability to suppress impulse and select a thought out-approach. Attention is on task behavior. Hughes offers that one with good attention is capable of staying on task in spite of distractibility, fatigue, or boredom (Willis, 2016; Hughes, 2014).

This study explored the effects of a Montessori prepared environment on supporting children in developing self- regulation and more complex executive function skills like planning, problem solving and goal setting persistence. Dr Hughes defines goal setting persistence as the capacity to have a goal, follow through to the completion of the goal, and not be put off by or distracted by competing interests (Hughes, 2014). Goal-setting persistence is receiving much attention as a result of a publication by Dr Carol Dweck. She writes about a mastery-oriented mindset in her book "Mindset: The New Psychology

of Success." Dweck writes (as cited in Lillard, 2017, p.1783) "having a mastery-oriented mindset predicts achievement over time." Mastery orientation boils down to persisting. It is a growth mindset and a belief that "with effort one can master challenges and increase one's abilities" "They are resilient, persisting even in the face of failure" (Lillard, 2017, p.1783).

The attention on executive function skills is largely due to the change in our society's industry. In the post WWII factory model, it worked well for the majority of people to do the same thing at the same time. Now, industry leaders are companies demonstrating innovation. These companies are served well by creativity and one's ability to adapt, be flexible, persist and demonstrate social-competency skills. Diamond illustrates that children will "need working memory to mentally work with masses of data and see new connections among elements, flexibility to appreciate different perspectives, and self-control to resist temptations and avoid doing something they would regret. Tomorrow's leaders will need the discipline to stay focused, seeing tasks through to completion" (Diamond, 2011 p.959). Consequently, there is a need to build these skillsets within our education system.

This Action Research study is conducted in a Montessori environment prepared with adherence to principles regarding the preparation of the physical environment. Teaching practices also adhere to the principles of Montessori philosophy and pedagogy. The differentiation between high and low fidelity of Montessori implementation is important because there are mixed results among Montessori literature on academic performance. This is due in part to a lack of literature in implementation. Traditional Montessori materials, practical life works rated high in fidelity by both AMI and AMS Montessori teachers and grace and courtesy lessons will serve to measure growth in executive function over the course of six weeks. The purpose of this action research is to determine in what ways a Montessori environment supports the development of executive function skills in a primary classroom. The main

research question is "How does the Montessori prepared environment build executive function in a Montessori primary classroom? The subsidiary questions include: How do grace and courtesy, practical life and sensorial works build executive function? Do children modeling self-regulation skills influence self-regulation in others? Is there an increase in emotional control with an increase in concentration? And is there a relationship between a child self-correcting and trying new or challenging work?

Literature Review

Early childhood as optimum time to build executive function

Mounting research indicates the significance of investing in early childhood education. In the article "Looking at How Children Succeed", Boulmeir states there is a strong correlation between early childhood experiences and overall life achievement in career, family and education. Developing strategies to build self-regulation in early childhood environments may be more beneficial to academic and school readiness success than focusing on academic content (Willis, 2014). Preparing an environment rich in opportunities for the practice of self-regulation is supported by research indicating "the development of self-regulation skills occurs through the preschool years and can begin as early as age two (Willis, 2016, p.665).

In a research article demonstrating children's emotional regulation, the author stated ages 3-5 are particularly unique to children gaining in emotional understanding as they are simultaneously developing in other social and emotional understanding, like theory of mind (Cole, 2009). These non-cognitive skills were referenced in an Adverse Childhood Experiences (ACE) Study as critical to life achievement (Boulmier, 2014). Maria Montessori called the ages 0-6 as a timeframe when children possess an absorbent mind. Children have an ability to learn information effortlessly. She writes "Hence the period under 6 is decisive. Whatever abilities the child constructs they will remain incarnate in him

for life. His ways of moving and of doing things, become fixed and permanent features of his personality, and they will mark him as a person." (Montessori, 1985, p. 181). An infant is born with an exact number of neural cells for life. However, the neural connections are what continue to grow and expand according to a child's experiences. An enriched environment not only expands neural connections, it strengthens existing connections. A similar analogy is converting a dirt road to an interstate. An interstate has multiple connections and it is a permanent structure improving over time (Ongan, 2000, p.29).

A child between the ages of 0-6 also experiences finite sensitive periods of development. These are periods of time when a child is most attuned to learning particular areas of development effortlessly given a nurturing environment. Talay writes "if these windows of opportunity are not properly provided for during these most impressionable times, the young brains seem to have a most difficult, and sometimes impossible task of achieving that function." These are phases of time when the brain possesses an increased plasticity to organize and adapt. Consequently, during these periods a child can develop skills more easily than any other time in his or her life. The brain's plasticity decreases as one ages. Talay indicates based on early intervention and enrichment program investigations that the timing of an enriched experience is crucial. She writes "neuroscience seems to suggest that the safest maxim for early intervention from birth on is not to soon" (Talay, 2000, p. 30). Haines further offers that "after the age of four or so, the sensitive periods wane." This adds greater urgency to investing in early childhood (Haines, 2017, p.52).

Given self-regulation is inclusive of controlling emotions it is key to equip children with strategies to manage emotions, particularly sadness and anger at 3-4-years. It is at this age that they are capable of understanding, recognizing and generating sad and anger strategies. Cole defines sadness as a giving up of goals and anger is defined by a readiness to act forcefully to regain well-being. His research

indicates children ages 3-4 have an ability to understand sad strategies, but 4 year old children showed a greater ability to understand anger strategies. Children with less access to sad strategies will be more likely to seek help or become destructive. The more strategies a child recognized for sadness, the more alternative solutions a child tried, and less sought support or became disruptive.

The more strategies for regulating anger a child recognized, the more persistence showed in challenging tasks including: attempting different methods and seeking less adult help. Strategy understanding and strategy recognition predicts a young child's behavior in a challenging situation when help is not present. A child who can recognize a variety of strategies to regulate emotions will have a greater ability to cope. This is important to note as a child may go from anger to sadness in a challenging situation and therefore needs different strategies to cope.

Research is limited on the results of equipping young children with pro-social behavior skills. It is also limited on the relationship between self-regulation and pro-social behavior. However, there is increasing evidence demonstrating the effects of lacking pro-social skills. Targeting executive function skills in early childhood is critical based on evidence for children ages 3-11 who do not demonstrate good self-control (less persistence, more impulsivity and poorer attention). These children "tend to have worse health, earn less and commit more crimes 30 years later than those with better self-control as children" (Diamond, 2011, p.959). Research does indicate that children who lack social-emotional competencies become disconnected from school and "tend to demonstrate negative emotionality by engaging in high-risk behavior, such as substance abuse, sex, violence, and depression" (Willis, 2016, p.666). Research also indicates that "adults with mature pro-social skills are significant contributors to well-being, resiliency, flexibility, increased happiness and an overall virtuous life" (Willis, 2016, p.665).

Lillard's reference to economic studies gives merit to early intervention. She writes that "economic analyses show that the highest rates of return on educational investments in human capital

are derived from preschool programs" (Lillard, 2017, p.2). She emphasizes this point further by stating that "self-regulation at age 4 predicts health, wealth, and criminality outcomes at age 32" (Lillard, 2017, p. 3). Self-regulation is a hot button in social science fields and programs are being urged to equip children with these skills in preschool. They are deemed vital for success to face 21st century social and academic schooling demands. Programs identified to best build self- regulation have a common thread. They provide an environment of: flexibility, creativity, self- control and self-discipline. Most notable of these programs are: Montessori and Tools of the Mind Curriculums (Willis, 2016).

Defining the Prepared Environment

In reading about the Montessori way of educating children, one will come into frequent direct contact with a term "prepared environment". Maria Montessori viewed the environment as a laboratory. It is a living space which, the teacher, changes based on her observations, in order to meet the developmental needs and interests of the children. Montessori valued scientific observation. Her observations of children led her to a personal transformative experience, which in turn led to what we now refer to as the Montessori Method, the cornerstone of which is the prepared environment.

A Montessori prepared environment offers multiple strategies to build executive function skills. These strategies are expressed through features like: freedom of movement; choice; self-correcting, hands on materials; multi-age learning; the teacher serving as guide; multiple expressions of order and grace and courtesy targeting specific social challenges. "Concentration lays the basis for the development of character and subsequent social behavior (Haines, 2017, p.58). Young writes "Concentration is always solitary, even in the midst of a crowd and there is no real achievement without it" (as cited in Haines, 2017, p. 58) and so to facilitate children building concentration, Montessori

prepared an environment full of things to concentrate on and appropriately sized. This she referred to as the Children's House.

A unique feature to Montessori education is the self-correcting, didactic materials. Maria Montessori's own experience witnessing a 3 year old in a fixated state of concentrated effort deconstructed her previous belief that young children were incapable of sustained attention for long periods of time. Maria, as a scientist and anthropologist, utilized her keen observation and experimentation skills to develop the right size, quantity and type of materials to attract and keep the attention of children. Haines writes "through experimentation, Maria believed she would establish "with the greatest precision, all necessary exterior stimuli definite in qualities and quantity" (as cited in Haines, 2017, p.46). These works must engage the child and Montessori wrote "exercise the intelligence and develop qualities we consider lofty…such as patience and perseverance in work, and in the moral order, obedience, gentleness, affection, politeness, serenity" (as cited in Epstein, 2012-13). These qualities so valued in character and social behavior are formed through concentration.

A second feature is order. The prepared environment is structured to build the sensitive periods of development to their best advantage. Between the ages of 0-6 children have a sensitive period of order. Consequently, materials are sequenced from simple to complex and left to right. Materials are taken off the shelf and placed back in the same location. Additionally, there is one of each type of purposeful material. The value is best expressed in Maria's own words (as cited in Haines, 2017, pp. 45-46):

> "The environment must give the child every facility for concentration and choice. The objects in this environment should be retained with ease in the memory of the child. There should be a quantity of objects all of which, in due course, a little child will be able to remember. He will also be able to remember the place where the object belongs so that after a time the environment

> will no longer impress the child as something new; and thus at this point it will not distract his attention."

Great attention is given on a holistic level to promote building concentration and as an expression of order. This includes the aesthetics of the environment such as: light or neutral wall color; comfortable lighting; low noise level; and simple, yet beautiful artwork easily observed from a child's height perspective.

The prepared environment includes attributes like freedom of movement and freedom of choice. Each of these take advantage of two important keys to learning: a child's sensitive periods and a child learning by exploring with their hands and senses. Children's sensitive periods serve as an inner flame that give children a great enthusiasm for certain things and a disinterest for others. Children driven by their sensitive periods will choose what is necessary for development. Maria Montessori wrote "the hand is the instrument of the mind…the use of the hands brings a profound attention." In the video "Why a 20th Century Education Won't Work in the 21st Century, Neuropsychologist Dr Steven Hughes states "learning is about engaging the environment. We are built to learn through our hands" and it is necessary to have "experimental interactions with the environment. If those are absent, huge aspects of cognition will not develop" (Hughes, 2014).

Movement is developed and refined through the prepared environment. Haines adds, "When a so called sensitive period focused the child's energies towards one aspect of the environment, the information or characteristic associated with that aspect was thought to be assimilated". Montessori (as cited in Haines, 2017, p.47) added assimilation occurred "rapidly and brilliantly". A child attracted to a material will repeat its sequence. It is through repetition that concentration is achieved. Repeated moments of concentration develop the child's personality in a wholesome and healthy way (Haines, 2017). Maria Montessori referenced the value of movement, "A room in which all the children move

about usefully, intelligently, and voluntarily, without committing any rough or rude act, would seem to me a classroom very well disciplined indeed" (Montessori, 1964, p. 93).

The teacher or guide is critical to preparing the environment. She follows the children's interests through observation. She is mindful of their interests while guiding and scaffolding learning with invitations to work with the didactic materials. She is, as Haines references the "dynamic link to get the whole process going and to keep it going" (Haines, 2017, p. 48). One attribute of a Montessori learning environment facilitated by the guide is the lack of extrinsic rewards. Extrinsic rewards are often found in conventional education environments and tend to encourage a performance based mindset as opposed to a growth mindset (Lillard, 2017).

Another attribute is the multi-age classroom. An environment with young and older children combined with the features of freedom of movement and choice creates a unique learning opportunity that would not occur without this multiple prong approach. Now current brain research provides value to the mirror neuron effect that reveals through observation of another's work the knowledge gained is as if the child were doing the work himself! (Haines, 2017). So, the wandering child, or the child who for a time chooses to watch or the child having a hard time making a decision is still learning by watching friends at work. The opportunity afforded to simply observe is a learning opportunity and may also serve as a catalyst to attract him to a material.

The advantages of this multi-pronged educational approach are described well by Dr. Ginny Riga, a Montessori consultant for the S.C. Department of Education. The Riley Institute of Furman University, SC recently completed the most comprehensive, longitudinal study regarding Montessori in public schools. She states, "The Montessori method pulls together many solid classroom strategies, all guided by the Montessori philosophy of how children develop and learn. This method stands out among

other education approaches by combining multi-age classes, a hands-on curriculum and individualized learning, making the classroom 'success oriented' for all students" (News, 2018).

High fidelity versus a low fidelity Montessori environment

There is much discussion as to what educational approach may best equip America's children. In the article "Looking at How Children Succeed, Boulmier indicates research supporting the value of self-regulation, character education and executive function skills and explains the existing need to better identify "how" to do preschool education (Boulmier, 2014).

Lillard references a study conducted in Milwaukee, WI during the last year of Primary (3-6 years) and the last year of elementary (6-12 year olds) with children in a classical Montessori environment and children in inner city public school, suburban public school and private/charter schools. Children were tested on skills relevant to life success. The results were then categorized into cognitive/academic and social/behavioral skills. Results showed the high fidelity Montessori environment demonstrated greater results in social and academic skills. (Lillard, 2006).

In another study measuring self-regulation over the course of 3 years both quantitative and qualitative data were collected from parents, teachers and students in grades K-2. A Montessori environment resulted in increased self-regulation from K-2, specifically a trend showing an increase in work habit and social skills in Montessori classrooms vs non-Montessori classrooms. Non-Montessori classrooms either decreased or made no change (Ervin, 2010).

A third study evaluated high fidelity Montessori, supplemented Montessori and traditional education settings. A supplemented Montessori environment was defined as: ½ hour work cycle, supplemented with traditional materials, special programs, additional teachers for extracurriculars, grades and homework. A classic Montessori environment was defined as: a 3 hour work cycle in the AM (if over 4, in the PM as well), 3 year age grouping, one trained teacher, freedom of choice, use of classic

materials and freedom of movement. The percentage of students using Montessori materials and the frequency of use was evaluated in both environments. Executive function skill gains in the high fidelity Montessori environment were significantly higher than supplemented Montessori and conventional settings. This is critical given the influence of executive function skills in overall life achievement. Furthermore, strong executive function skills in kindergarten show academic and social competence presently and in the future. Her research credited another study in which high schoolers who had previously attended classic Montessori schools excelled in science and math (Lillard, 2012).

Lillard offers further longitudinal research support in a study conducted over the course of 4 years beginning Fall 2010 and ending Spring 2013. She addressed previous research limitations of sample size and selection bias by increasing the sample size to 141 and selecting Montessori schools utilizing a random lottery selection process. In sum, her research demonstrated gains for Montessori students in areas of academics, social understanding and mastery orientation (Lillard, 2017).

A point of interest from the latest Lillard study is the equalization effect between children of low and high social-economic demographics. Given research has shown children of a high social-economic status have greater achievement, this point has significant implications to the value of Montessori to close the socio-economic gap. This result gains greater credibility with the recent study completed by The Riley Institute of SC to evaluate Montessori in public schools. Dr Culclasure, the principal investigator states “Sometimes people assume that Montessori is an elite approach to education for privileged students, and is only available in the private sector. The reality is the majority of Montessori students in public schools are from low-income households, and they seem to be benefiting in several ways from Montessori education” (News, 2018).

The study conducted by The Riley Institute is the most current and most comprehensive longitudinal study of public Montessori implementation. The study took place between 2011 and 2016

and included a total of 7,402 students. Classrooms were chosen at random. However, Montessori students and Non-Montessori students were matched in terms of demographics and baseline academic performance. In terms of Montessori fidelity, this study rated 22 schools as high fidelity, 14 as mid fidelity and 8 as low fidelity. These numbers were determined through surveying principals annually and unannounced observations. "When compared to non-Montessori public school students across the state, Montessori students were more likely to have met or exceeded the state standards in each of the four subjects" (Culclasure, 2018, p. 14). Montessori students showed significant more growth in creativity and executive function in some years of the evaluation. Other assessments indicated Montessori students had better school attendance and behavior (Culclasure, 2018, p.27).

Practical Life, Grace & Courtesy and Sensorial as a pathway toward executive function

Children in early childhood classrooms begin their year in the Practical Life area, which serves as a gateway to other curriculum areas. These materials indirectly develop order, concentration, coordination, and independence. Practical life engages the student in purposeful work. The child can see his or her actions produce a result. Yet, it is not for results that a child works. Insight into this phenomenon is gained through the words of Maria Montessori. The child through his work is constructing himself. She states "You can no more hurry him than you can hurry the work of an artist" (Standing, 1998, p. 146). Often a child will repeat a routine again and again, satisfying an inner, developmental need. This repetition may seem mundane and useless to the adult, but again Maria Montessori reminds us "it only seems useless to us because we are judging the child's work by our adult standards. The aim of the child's work is not external but internal. He works in order to grow" (Standing, 1998, p. 143). The important point is to allow the child to spontaneously choose and repeat a given work. The freedom of choice is shown to have several positive outcomes. These include:

supporting memory, task performance, persistence, desire to engage, creativity, and emotional benefits (Lillard, 2007).

In the article "Hands on Practical Life", Gilder provides evidence of executive function skills learned like planning, goal setting, increased attention span and intrinsic motivation. Research encourages schools to maintain integrity of Practical Life because children learn skills both to prepare them for life academically and socially (Gilder, 2017). Practical Life is the students' first opportunity to develop habits of practice and work which is associated with building self-regulation, greater academic achievement and care for others (Erving, 2010).

An aspect of self-regulation is an ability to control one's emotions. A Montessori environment naturally guides children to regulate each other's behavior, especially through practical life works and grace and courtesy lessons. Children are learning how to regulate emotions in real life social situations. Additionally, teachers who serve more as guides are encouraged to use as few words as possible and use modeling as a more developmentally appropriate teaching strategy. The advantage of realism and less language is indicated in the article "Preschoolers' Emotion Regulation Strategy Understanding: Relations with Emotion Socialization and Child Self-Regulation Methods." Cole indicates situations based on reality and less demand for language are ways children respond best (Cole, 2009).

A significant contributing factor to self-regulation is the multi-age classroom characteristic of Montessori. This provides a priceless opportunity for children to assimilate self-regulation skills simply by what older children model and becomes an eye witnessing opportunity for the younger children. Children between the ages of 0-6 have what is referred to as an absorbent mind. They learn effortlessly. Soholt writes "it is also interesting to watch the older children sometimes step in to these situations and play the role of the facilitator." Soholt cites Maria Montessori as follows "the young children's absorbent minds are still active, and they will incarnate all the aspects of the

environment including the limits and social guidance…. It is obvious why Maria Montessori thought social change was only possible if we begin with the children" (Soholt, 2015, p.61).

Touching on self-regulation as a means toward social achievement, Sara Hacala provides in her book "Saving Civility" a compelling reason to insist upon grace and courtesy. She writes (as cited in Soholt, 2015, pp.57-58) "In a cacophonous sphere, where everyone talks at once but no one listens, where we say hurtful things and do harmful deeds at will without remorse or punishment, and where outrageous exploits are protected by a veil of anonymity, we are fast approaching danger zone. Without any resistance, bad behavior continues to spread, threatening to become the new norm." Grace and courtesy is a way to provide preventative medicine for all that is written above and dismisses the need for constant correction" (Soholt, 2015, p. 58). Grace and courtesy is one characteristic of the Montessori environment equipping children with strategies to transition their thinking from the emotional part of their brain to the thinking part of the brain. Children rise to the occasion. In the event a first lesson may not result in the taught skill demonstrated, the guide simply represents again as joyful and fresh as if it were the first time and "the problem will be solved" (Soholt, 2015, p.54).

The Sensorial materials, like Practical Life, indirectly build order, concentration, coordination and independence. There is a direct aim of strengthening the senses. A Montessori environment allows for independent work and freedom to choose. The self-correcting function of the Sensorial materials combined with freedom to choose and to work independently collectively facilitate developing executive functioning. (Boulmier, 2014). Furthermore, children are shown a work cycle. A complete work cycle is defined as getting work out, doing work, and putting the work away. A child who completes a work cycle demonstrates an ability to take steps toward a goal, plan, persist, self-correct and exhibit emotional control.

Practical Life provides the setting for children to practice lessons learned in Grace and Courtesy like serving food, passing food, and cooperatively setting the table. Sometimes these community-based situations and the fact there is only one of each material in a Montessori prepared environment give way to conflict. The children then have opportunities to exercise strategies learned regarding conflict resolution. Conflicts are opportunities to assess emotional control and teach new strategies. The Montessori environment of following the child is helpful in forming individual strategies because what works for one may not work for another. Bettman in "True Work" cites there is a significant differentiator of seeing the individual child with special needs as opposed to a class of students.

Mindfulness

Given the definition of mindfulness as an ability to focus, sustain and/or switch attention, the exercises of Practical Life, Sensorial and Grace and Courtesy are a means toward this end. Willis states in "Contemplative Practices in Early Childhood: Implications for self-regulation skills and school readiness" that there is a link between contemplative practices and neurological processes, cognitive functioning and behavioral regulation (Willis, 2014). Willis presented research indicating Montessori children demonstrated an ability to develop internal standards of performance and needed less supervision to resolve conflict. Currently, there are few established mindfulness practices for children under 6. One study of children 7 to 9 years old showed greater executive function improvement with mindfulness training compared to control group. This training consisted of exercises to hold attention, wandering attention and shifting attention back to target (Diamond, 2011).

A Montessori environment incorporates mindfulness through exercises that build concentration and focus using active movement and/or exercises inviting the children to control physical movements. One example is Walking on the Line activities. These sometimes include carrying a vessel containing water

without spilling or holding a bell without it ringing. Another mindfulness practice is the Silence Game. This has many variations. The essence of the activity is for the child to be silent while listening to sounds in the environment. (Diamond, 2018). Research in the field of neuroscience identifies the link between brain development and movement. Hughes writes "Cognition is unavoidably linked to movement… executive function skills develop if there is opportunity to develop them. Montessori understands an enriched environment. Montessori children exhibit strong core executive function skills" (Hughes, 2014).

A prepared environment is key to supporting concentration. Bettman offers insight to help prepare the environment to minimize distraction and support concentration. Some key points include: Utilizing the assistant to minimize distractions to presentations, being mindful of words that may disrupt a repetition and being mindful of how space is set up to mitigate distractions; i.e. one person at a table. Additionally, utilizing an object to signal one is working with a teacher is helpful to minimize interruption; i.e. wearing something in hair. Fifteen minutes of a work is considered a concentrated effort. This is supported by Willis' article that less than 15 minutes daily in early childhood classrooms is encouraged to develop self-regulation skills.

In sum, the field of neuroscience emphasizes the importance of an enriched environment in early childhood to maximize sensitive periods of development and capitalize on the brain's finite plasticity. Research assessing achievement in academics and social competency skills indicate a link to possessing self -regulation skills (Willis, 2016). A child may grow stronger in his ability to: self -correct, control emotion, plan and make decisions provided a high fidelity Montessori environment. This may be achieved through interaction within a prepared environment that provides the following: freedom to plan, make decisions in choosing materials and do purposeful work; opportunity to build concentration by engaging in a material of choice and of interest; the opportunity to self-correct and last, the

opportunity to build emotional control through experiences like learning to wait a turn, receive and give assertive communication, and practice ways of resolving conflict in realistic scenarios with peers.

Methodology

Participants and Setting

This qualitative study took place in a private Montessori Primary School in a small, rural Southwest Minnesota town. The school is in its first year of operation. The school enrolls 6 students between ages 18 months and 5 years. The five girls are Caucasian, and the one boy is Native American. The socio-economic demographic of our school is middle to high income earners. In order to stay more closely aligned with a high fidelity Montessori primary class, we collected data from children ranging in ages from 2.25 years to 4.75 years and included 4 girls and 1 boy. Children in the study had no prior Montessori or pre-school experience. My assistant and I are parents to children participating in the study.

Survey and Questionnaire Procedure

Prior to and post study I sent a survey and questionnaire to parents. The survey utilized a rating scale format while the questionnaire offered open ended questions. These tools provided insight into the parents' perception of their child's emotional control, persistence, self-correction concentration, planning and decision making pre and post study. Parent responses provide insight into each child's growth in self-regulation, persistence and more complex executive function such as planning and problem solving (See Appendix A for a copy of the survey and questionnaire).

Classroom Checklists and Observation

I introduced two observer checklists. One monitored work cycle activities by student (See Appendix B). The work cycle checklist tracked the type of work, if participant chose the work, the time duration of use for each work, number of repetitions, self-correction, completed work cycle and if child created his/her own variation or extension. This checklist provided insight about a child's executive function as it relates to self-regulation, persistence, problem solving decision making, and planning. The other checklist monitored emotional control and emotional outburst (See Appendix C) behaviors by tallying respectively. The emotional behavior checklist included observed behavior, time of occurrence, students involved and context. The executive functions monitored are inhibitory control and emotional control. This checklist also provided insight into problem solving.

I executed one week of practice using these checklists with my assistant prior to beginning the study. Simultaneously, both of us conducted whole class running record observations five days a week for the work cycle period ranging from 9:00 am to noon. These observations helped heighten our awareness regarding a child's interest and triggers for emotional outbursts. As a result, I was better equipped to link a child's interest with a material. This insight guided me in my decisions of what Practical Life, Grace and Courtesy and Sensorial lessons to give the children.

Procedure

Each week I introduced two new lessons in Practical Life and Sensorial (See Table 1). I chose these two subject areas because both are foundational to other curriculum areas. A Montessorian is encouraged to redirect a child experiencing academic, physical or even behavioral struggles to Practical Life to regain confidence, re-familiarize a child with a concept or classroom norm or refine body coordination. I chose two different lessons each week to create some diversity and choice. I determined options were important to increase the likelihood that the children would engage a work implemented

for this study. I used the following criteria to determine my choices for new works: developmentally appropriate and perceived interest. Some works were chosen as a scaffolding work because I thought the child would have an interest in the challenge.

The checklists monitored only behavior/activity regarding new lessons provided for the purpose of this Action Research study. The Whole Class Observations included total activity and behavior regarding any work or Grace and Courtesy practices. Consequently, this offered insight into my subsidiary questions. My intent was to show the lessons early in the week. However, I was careful to respect the child's choice of accepting or refusing an invitation to do a new lesson. I demonstrated lessons one on one. I did allow children to observe a demonstrated lesson. Once a work was introduced, it remained available for the children to choose for the duration of the study. I created two songs regarding trying new things and making mistakes. These served as tools the children embraced when engaging their work.

Grace and Courtesy lessons were chosen based on observations illuminating areas children needed support to help navigate social situations respectfully, kindly and assertively. At the start of the study, I intended to introduce one new Grace and Courtesy lesson each week. This changed based on observations. For example, for two weeks we modeled the same Grace and Courtesy lesson because we experienced a challenge with the same kind of behavior. I created a couple songs regarding personal space and kindness. I incorporated these into my respective lessons. Grace and Courtesy lessons were introduced to the group and often occurred in the morning following our welcome time songs. Once a Grace and Courtesy lesson was introduced, I continued to implement either one on one or as a group as necessary.

I implemented a coding system for our observations and checklists. I assigned a number to the new works and Grace and Courtesy lessons introduced. I assigned a letter to the executive function

skills. In analyzing the data I assessed the number of instances specific executive function skills were demonstrated during a work or were exhibited as grace and courtesy behavior such as the use of respectful language.

Table 1

Introduction of Practical Life, Sensorial and Grace and Courtesy Lessons

Weeks	Practical life	Sensorial	Grace and Courtesy
1	Nutmeg Grading	Constructive Triangles	Respecting Others work
	Sorting	Smelling Cylinders	
2	Coffee Grinding	Sound Cylinders	Personal Space
	Hammer	Geometry Cabinet	
3	Sewing	Baric Tablets	Personal Space
	Shell Scrub	Colored Cylinders	
4	Iron	Brown Stair	Respecting someone else's opinion
	Make Tea Sandwiches	Colored Cylinders & Knobbed Cylinders	
5	Soap Grading	Geo Solid Attributes	Greet a guest
	Necklace Making	Tasting	

6	Making Skewers	Tactile Boards	Set table for guest
	Cut/Paste	Color grading	

Data Analysis

Prior to the baseline week of study, I had not been journaling the amount of time a child spent on an individual work but had paid attention to the total work cycle. At the time of the study, our class did have a 3-hour work cycle. Prior to the study, two of the children had more difficulty choosing their own work. One particular child tended to avoid challenging work.-During-the baseline week, there was not a work completed for a duration of 15 minutes or longer. Most conflicts were the result of a few causes. One, our boy bumping, pushing and generally colliding with another's personal space. Second, two or more children desiring to use the same work; and third, a child disrespecting another's work. Disrespecting another's work typically included such behavior as taking something off a work rug/mat or sitting in someone's chair when a child moved temporarily from his/her workspace. These incidents would create an emotional outburst that sometimes would include physical contact with some children.

It is necessary to define terms for this study in order to understand Figures 1 and 2 indicating executive function, a clarification or definition of terms is necessary. Concentration or focused attention is measured by a child executing a work for a time period of 15 minutes or more. Self-correction is measured by a child recognizing an error and persisting to correct it successfully. Problem solving is present with self-correction and in many social situations like negotiations.

I often saw a relationship between emotional control and inhibitory control. I chose to mark inhibitory control when a child did not react in a physical way during a conflict who likely would have previously or did not take something who might have previously. The children demonstrated emotional control when they chose assertive and respectful language in situations with potential conflict conditions

or responded to this language positively as opposed to reacting defiantly, or with sadness or anger. Regarding the work cycle checklist, I did not include emotional control. I assumed that a child demonstrating self-correction successfully and completing a work cycle was exhibiting emotional control. Additionally, I did not indicate persistence which was indicative of a growth mindset on the work cycle checklist. The assumption I made here was a child demonstrating self-correction and a work cycle activity of greater than 15 minutes was demonstrating persistence. Therefore, as one reviews Figure 1, one can conclude that a participant showing growth in focused attention and self-correction was likely showing growth in persistence. It could be argued that completing a work cycle is indicative of persistence because they need to follow through with multiple tasks. I chose not to include this because I am viewing this more as a classroom norm and consistent with decision making.

As the results of the study are explored below I will refer to the following in different sections: Self-Regulation, Planning and Persistence. Self-Regulation includes working memory, concentration and inhibitory control. Results from the work cycle and behavior checklists indicating problem solving skills and emotional control are indicated under self-regulation. I will often refer to Figure 1 as a reference in the discussion.

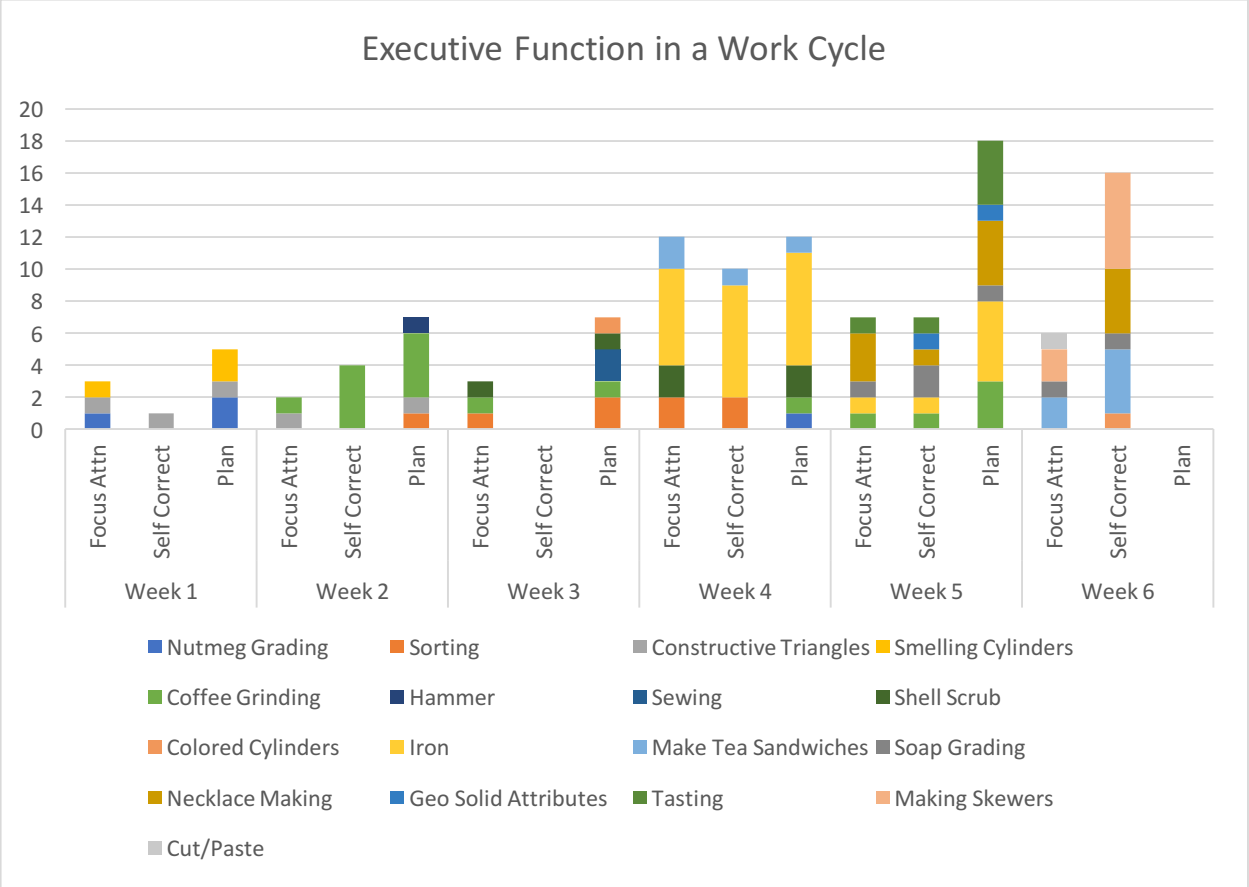

Figure 1. Executive functions expressed through works.

This chart does not include all of the works introduced. This graph references only the works a child engaged in during the study.

Results and Discussion

Self- Regulation

The results from the parent survey indicate 4 of 5 children showed improved emotional regulation when experiencing something challenging outside of school. The parents indicated no change in children responding with extreme and prolonged sadness or anger when experiencing something

hurtful. My assessment is this is normal for children of this age and a more accurate measure of emotional control for children at this age is their response when experiencing challenges as opposed to a hurtful act. Some parent post survey comments referencing 4 of the 5 children surveyed are as follows:

1. She will concentrate on these for sometimes long periods of time.
2. …She can continue to play for 30-45 minutes
3. Often she is willing to try to self correct. More often now she is able to correct an error, but if not, she can become easily frustrated.
4. Yes (self correction), very visible at home when she is doing puzzles and tries to self correct pieces that don't fit. Most often she is calm and will try various ways until it fits, occasionally she will get frustrated, especially if the piece actually doesn't go in that spot.
5. She is good at recognizing error, I think she has started to self-correct more instead of just moving on to a new activity. She will re-try something so that she can succeed. "the mistake song"
6. I feel like these emotional outbursts have started to become less and less.
7. After everything is cleaned up and "fixed," he will spontaneously sing the "mistakes help you get better" song from school and moves past it really quickly.

In comparing observation notes with the work cycle checklists, it is apparent the children showed growth in concentration and self-correction. Simultaneously, the children showed growth in building on existing activities. An observation of one of the girls is particularly noteworthy. A general observation prior to the study was her short bursts of working with an activity and her tendency to go to and fro quickly from one work to the next. We experienced an astonishing moment with her and another child during week 5 of our research. This particular child chose the soap grading work. The other chose a bubble making work. One would make the soap, then hand it to the other who would mix it in her bowl of water to create bubbles. The scene they were acting out was baking a cake. Initially, they chatted back and forth. Then, the conversation became less as the one child became more and more focused on her soap grading. We annotated at least 25 repetitions for approximately 31 minutes! She is 4.25 years old.

Towards the end of the study there are several indications of 25-40 minute individual work cycles for the 3 oldest girls in areas of Practical Life towards the end of the study. It appears the works

that are most associated with real life activities that children could connect to drew the greatest interest. These longer work cycles often included evidence of planning, problem solving, self-correction, persistence and emotional control. Powerful collaborating conversations took place. Frequently children would engage the works while creating imaginative, yet real world scenarios. The interest and engagement in real, purposeful work supports what Maria Montessori stated about children valuing purposeful work and about interest begetting concentration.

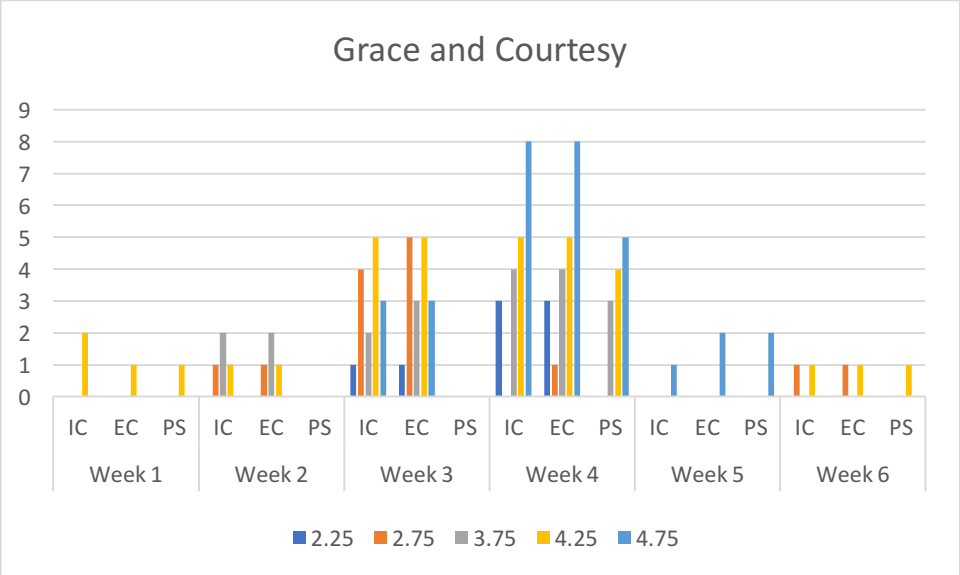

Figure 2. Executive functions expressed through Grace and Courtesy Behavior and Language.

The above graph indicates inhibitory control, emotional control and problem solving related to the Grace and Courtesy lessons presented during the study. By Weeks 5 and 6 we no longer experienced any physical retaliations to a personal space violation. The challenges of personal space still occurred, again I think this is more about our boy's developmental stage, but the children increased their use of strategies to mitigate outbursts. The children demonstrated greater abilities to negotiate, communicate boundaries and use language to express desires. We also began to see the two youngest children (including the boy) increase their use of language and behave in ways more indicative of emotional and inhibitory control. This is especially apparent in Weeks 3 and 4. I made an error in Week 2 of

demonstrating an unwanted behavior in a lesson in order to provide the children with useful language should this occur. I did not account for 3 of the children in the absorbent mind phase. Consequently, the image they held onto was taking the work! As a result I faced multiple incidents in Week 3 and 4 of two children taking others' work because they saw me do it and thought it was amusing! My response was to change the grace and courtesy lesson from taking to asking "May I use your ____?. This lesson learned emphasized the value of teaching only the behavior I want to see, especially with children younger than three years.

The observations also indicate a marinating time for the younger children. Though personal space lessons were taught in Weeks 2 and 3, I didn't begin to see the positive outcomes with our boy were not observed until Weeks 5 and 6 and more so post study. Observing how quickly the older children absorbed and executed the strategies but seeing a delayed execution with our youngest indicated to me "model, model, model and wait." The younger children may need more processing time.

A point of interest is in Week 4, occurred during the time that we experienced a Full Moon and Lunar Eclipse. I wrote a note about having an "off day." A combination of our boy's developmental stage, modeling an undesired behavior in a grace and courtesy lesson and weather might account for the escalation in behaviors during weeks 3 and 4. Simultaneously, however, I also witnessed very powerful use of language to negotiate and greater inhibitory and emotional control. One act that surprised me regarding modeling grace and courtesy daily was the interest the children had to participate in the lesson and then do it on their own.

The following are some examples of different children expressing emotional, inhibitory control and problem solving in their language:

1. Student A: "Are you coming to disturb or to watch? Please don't disturb my work. You may say May I please watch your work".

Student B: "May I please watch your work?"
Student A: "Ok, when you watch someone's work, you sit and don't touch"

2. Student A: Asks Student B to move and waited 12 seconds until student B moved.
3. Student A: "Please stop. Please don't touch me"
   (Student A in situations 2 and 3 may have previously hit rather than use words and wait)
4. Student A: “How about you (Student B) do it for 4 minutes then you (Student C) can do it for 4 minutes?”
5. Student A: “Student B, please not disturb my work.”
6. Student A "Student B, do you remember what to ask when someone is working?"
   Student B: "May I watch your work?"
7. Student A: “That is my chair. Would you like this chair or a different chair?”
   Student B: “I’ll take a different chair

Generally by Weeks 5 and 6, I am observing greater use of language in our two youngest children as evidenced above in numbers 5 and 6. By Week 6 the older children are serving more in coaching capacities. Numbers 1 and 6 above provide insight into the coaching role. The older children ask more questions of the younger children to guide behavior. Number 7 above is a strong example of problem solving via negotiation and occurred in other contexts.

Planning

The results from the parent survey indicate 4 of 5 children showed an increase in building upon existing activities outside of school. The parent survey indicates 3 of 4 children showed an increase in choosing activities on their own. Two children showed no change. These two children demonstrated frequently choosing activities on their own prior to the study. Some parent comments post survey are as follows:

1. She enjoys building on an activity or varying it. When she is washing cabinets, she might start scrubbing the fridge or might start scrubbing with various sponges/toothbrushes, etc. She makes connections between things like a panda book, panda family and panda silverware (she made a panda knife using a sticker).

2. In the last 2 weeks of the research period (and since then too) she has begun doing "works" at home again (like she did at the beginning of school). She will ask to clean mirrors and cabinets, draw, write, color, chop carrots, etc.

3. Much more often now! She will get out a cup when thirsty and has grown, so she is tall enough to get water on her own. She even figured out how to pull a step stool over when she wants something high. One example from both school and home is her necklace creations - planning which colors.

4. Much more now! She might build something with blocks, and then expand the idea or vary the idea and add more to make it something else.

5. He has gone a long way in working on his planning ability and order processing (first this, then this, then this).

6. He loves connecting puzzles, books and toys (ex. putting together a puzzle, picking out an image from it, finding a book with a similar image, finding a toy with a similar image and matching them all together). He is also really great at integrating learned material into imaginative play and storytelling (making a pirate ship and talking about sailing to the different continents to visit animals native to those places).

7. She will start playing with something and very easily expand on her original idea and create a changing environment that she can continue to play in for 30-45 minutes

Figure 1 indicates an increase in the children's planning abilities. Though planning is not represented at Week 6, this does not mean that planning was not occurring. It simply means it did not occur within the given works during this study. A few examples from our observations supporting the children's self directed planning include: Making necklaces, then handing out to their friends; Getting out a different tool if the one on the tray didn't work well; Creating a tasting work; Incorporating the linen washing work with ironing; Imagining a birthday scenario and collaboratively baking a cake using the soap grading and bubble making work; and getting a bag for crushed coffee beans because they want to take the coffee home to mom and dad.

Persistence

The results from the parent survey indicate 4 of 5 children showed improved persistence with challenging tasks. Additionally, survey indicated 4 of 5 children showed an increase in choosing more challenging activities or activities outside his/her comfort zone. The following are comments from parents:

1. Before Study: She often asks for help. She has less emotional investment in overcoming a challenge. After Study: She will often try, and if it is too difficult, she will often ask for help (or sometimes cry). She is not bothered or frustrated right away.

2. Yes. He will keep at it or ask for help. He rarely, if ever, just gives up.

3. Sometimes there is a little sadness about it not working right, especially if he's tired, but once help arrives, he's fine.

4. Now I can talk to her and get her to try new things a little more often when she doesn't feel like she knows exactly how to do it.

According to Figure 1, one could draw the conclusion that children did grow in persistence given the increase in concentration and self-correction. It is possible based on the frequency of children singing the "mistakes song" that the song contributed to a positive perspective regarding making mistakes and trying again.

Research Limitations

It is difficult to find consistency in defining executive function skills. They differ across the social science fields. Consequently, I thought it important to provide definitions for how I approached assessing particular executive function skills. These are defined in the data analysis section.

There are a few research limitations specific to this study. This study included a great deal of data and required observations of multiple activities and behaviors. It would have been useful to have two people completely dedicated to observations. Our classroom is split between two rooms and this made it challenging to observe all children simultaneously. This study did not include data on multiple pronged approaches to meet developmental needs and behavior challenges. An example is the young age of our boy. His less frequent use of language and more frequent personal space violations may be more a result of his developmental level. As his behavior and language improved toward the end of the study and certainly post study, it is unclear if this is a combined result of his natural development,

incorporating gross motor movement and grace and courtesy. What is a fair conclusion is that the prepared environment met his developmental needs and his behavior and language improved.

Another limitation is the school is in my home, and one of the children in the study is my daughter. I'm including the information regarding my daughter and home because sharing her mother and her home have been a difficult transition for her. This created opportunity for different coping strategies that another Montessori Guide may not have had to employ. Last, a limitation for this research is my own inexperience in determining best practice for collecting and analyzing data.

Discussion/Conclusion

Some particular items of interest as a result of this study is how the Montessori environment allows one to really see a child's strengths and struggle areas and then design strategies, through the prepared environment and grace and courtesy, to help each child grow. Strategies employed through preparing the environment combined with consistent observation helps the guide determine if external resources may be necessary to equip a child. As I bear in mind how the prepared environment allows a guide to meet each child's needs, I understand how the most recent Montessori research is indicating a gap closure in achievement between low and high socio-economic children.

A second point of interest is how the characteristics of the prepared environment, particularly freedom within limits, freedom of choice and interesting, purposeful work creates the opportunity for concentration. This then, with advancing pro-social behavior seems to create opportunity for more complex executive function to occur like planning and creative problem solving.

This study did reveal some answers to my subsidiary questions. For instance, towards the end of the study I began to see greater use of respectful and assertive language to communicate a need or

desire, particularly among the youngest children. The freedom in the prepared environment provides greater opportunity for real conflict which then provides opportunity for a Grace and Courtesy lesson to equip children with practical, real life communication strategies. I saw this to be especially true in Weeks 3 and 4 when our class experienced multiple instances of our boy violating others' personal space work. The transformation at this time was the matched increase in positive communication strategies of the children, some who previously might have hit, yelled or cried.

The older children increased in modeling and asking questions of the younger children to help them in their self-regulation skills. This may be due to their interest and engagement in Grace and Courtesy lessons. I found it interesting to discover multiple benefits to modeling the desired behavior. The children were mesmerized by the acting out of a Grace and Courtesy lesson and would often bring chairs in from the other classroom to watch as if at the theater. Often times, the children wanted to participate in the grace and courtesy lesson and would re- enact the lesson multiple times. In Weeks 5 and 6, given some processing time, the increase in positive communication began to emerge with the younger two children, to include the boy. This observation leads me to conclude that there is a definite relationship between children modeling self-regulation and influencing self-regulation in others.

A second subsidiary question was to identify if a relationship exists between an increase in emotional control and an increase in concentration. I did find with the oldest child who exhibits the strongest emotional outbursts that if she were concentrating or working industriously she seemed more capable of inhibiting her emotions and responding calmly. Language communicated by other children involved in focused work sounded like a calm "please don't disturb my work" or if invited by a child to do something else, might say "no thank you, I'm doing this right now".

In summary, the results of this study do show that a Montessori prepared environment helps build executive function skills. An environment of freedom within limits paired with a guide observing children and presenting applicable Grace and Courtesy lessons creates opportunity for growth in social skills. An environment comprised of hands on, purposeful works that children are free to choose paired with a guide following children's interests creates opportunity for growth in concentration. As children build self-regulation skills, they exhibit greater abilities to plan, persist and problem solve.

Research shows a need for equipping children with self-regulation skills. It is already known these skills have positive lifelong benefits in all areas of one's life. What educators and policymakers will need to agree to is how children are equipped with this skillset. The Montessori prepared environment with its freedom in movement, choice of purposeful works for long, uninterrupted periods of time and mixed age classrooms combined with modeling grace and courtesy behaviors is an effective and proven model for self-regulation and pro-social behavior. It is worthy of attention as an asset to mainstream education in the 21st Century.

Future Action Plan

This study brought a keen awareness for me regarding the younger children ages 2.5-3 years. I will continue to model desired behaviors through both Grace and Courtesy lessons and my interactions with others. Now, I have the understanding that there is a processing time that needs to take place often before the desired behavior or language is expressed. Generally, the children were really drawn to Practical Life works that are relatable to the world. I will look for ways to incorporate more challenging Practical Life works that involve the children doing purposeful work.

I am interested in exploring the relationship between greater self-regulation and increased engagement in other curriculum areas, e.g., language and math. This study did not show the other works

children chose to do during the 6-week period. The parent surveys and questionnaire indicated most of the children increased in welcoming challenging activities. I am also interested in seeing more research on a relationship between increased self- regulation and group work. Towards the end of the study, I observed more collaboration with works. I wonder if this is due to the children gaining in concentration as well as stronger problem solving, emotional control and planning skills. Lastly, this work revealed some strategies that I'm interested in sharing within and outside the Montessori community to help others understand executive function and that these skills are possible to achieve in young children with a prepared environment.

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Appendix A. Parent Rating Scale and Survey

Rating Scale to Parents. Please use the following corresponding number value to answer the question. This provides me with some quantitative data whereas the survey below is more qualitative and gives room for explanation.

Very frequent	**(1)**
Somewhat frequent	**(2)**
Rarely	**(3)**
Never	**(4)**
I don't know	**(5)**

1. How often does your child choose activities on his or her own?

2. How often does your child build on an existing activity?

3. Does your child react with sadness, frustration or anger when he/she doesn't get their way?

4. When your child experiences something hurtful, is the response extreme and prolonged sadness or anger?

5. How often does your child choose activities that are challenging or outside his/her comfort zone?

6. Does your child persist at a task when having a challenging time accomplishing the task?

7 . When experiencing something challenging, how often does your child demonstrate anger and/or sadness?

8. How often does your child communicate what he/she would like to do?

Parent Questionnaire

1. How would you describe your child's approach to situations or activities that are challenging? Or outside his/her comfort zone? Include emotional response.

2. In what ways does your child show an ability to plan or monitor progress?

3. In what ways does your child build on an existing activity or create something new from existing?

4. Does your child show an ability to recognize an error?

Appendix A (cont.) Parent Questionnaire

5. Does your child show a willingness to try and self-correct an error? Please include emotional response.

6. What types of situations tend to cause extreme emotions like anger or sadness? Are there any conditions that contribute; ie hungry, tired, soiled diaper or is the situation isolated from other contributing conditions?

Appendix B. Work Cycle Checklist

Name of child/ Material	Child Chose work	Duration of Use Per Work		# Repetitions	Self-Corrected	Completed Work Cycle	Does child create a variation or extension?
		Time Start	Time Stop				Record observation

Appendix C. Emotional Control Checklist

Emotional Control			
Tally	Time	Students Involved	Context