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Developing Metacognitive Competence for Governing Self-Influence on Learning  
To Improve Collaborative STEM Learning

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## **Abstract**

### Developing Meta-Cognitive Competence for Governing Self-Influence on Learning To Improve Collaborative STEM Learning

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This dissertation examines an instructional approach aimed at developing co-empowered learning communities through self-empowered individual leaders, particularly in STEM fields, becoming metacognitively competent in governing their Self-Influence on Learning (SIL), while simultaneously educating them in the importance of co-empowered learning. I conducted the research at an after school, on-site-training environment. The goal of this approach is to train students to STEM learning Program, which provides year-long STEM enrichment to underserved children of color in Grades 1-8, using a project-based learning model with advanced technology tools. Twenty-three students in Grades 3-5 participated in the study during 2011-2012. I designed a systematic model, the Metacognitive Coaching Model (MCM), to guide each stage of the project and support assessment of student performance. The findings reveal that following the four-month MCM intervention, students demonstrated shifted understanding and practices in which they developed leveraged awareness and self-responsibility at an individual level. Furthermore, findings indicate an association between the MCM practices and students'

increased dedication to self-empowerment and to co-empowering their learning communities through their improved academic and social strengths. Results also showed that the practices gained through the MCM principles not only helped students develop SIL capacities but also generated a synergistic learning community in which members demonstrated care about each other's learning. Four months after the conclusion of the MCM intervention, analysis of students' verbal teamwork report revealed that they were more focused and efficient, and their actions were more thought-out when working hand-in-hand with their peers. Specifically, they were more attentive of the task at hand, were more fluent in their explanations, and demonstrated a more collaborative approach while sharing their learning progress. The results show that it is possible for students to acquire comprehensive metacognitive competence skills on SIL when provided opportunities to acknowledge and act on their individual and collaborative learning responsibilities. By helping students connect meta-emotional regulation components with metacognitive strategies, the MCM not only offers students a deeper awareness of their learning processes, but also helps them to develop their metacognitive thinking capacity to become better learners, team participants, and citizens.

## Dedication

To my beloved children; Valerie and Stefan  
and the children of the world...

through whom I found reasons, strength, and wisdom

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## **Chapter 1: Introduction to the Study**

### **The Need for Strengthening Collaborative STEM Learning**

“All young people should be prepared to think deeply and to think well so that they have the chance to become the innovators, educators, researchers, and leaders who can solve the most pressing challenges facing our nation and our world, both today and tomorrow. But, right now, not enough of our youth have access to quality STEM learning opportunities and too few students see these disciplines as springboards for their careers” (Education, 2015).

For students to effectively learn in the science, technology, engineering, and mathematics (STEM) disciplines, research suggests that they must develop strong collaborative as well as individual learning skills (Fulton, 2011; Marshall, 2009; Schools et al., 2014; Slavin, 2014). Developing these learning skills with an integrated focus on working for social, humanitarian, and global improvement may make STEM learning more meaningful. Arguably, any field would benefit from a more integrated approach to learning. In addition, such learning skills may help students more successfully join the workforce and contribute as global citizens.

Regarding the lack of interest in STEM fields, research done by Tai and colleagues (Tai, Liu, Maltese, & Fan, 2006) has demonstrated that although students show interest in STEM subjects in the eighth grade, this interest does not last long-enough for them to choose an academic path or career in a STEM field. Moreover, other research findings indicate that the reasons students decide whether or not to take a particular STEM course may have little to do with long-term career goals (Cannady, Greenwald, & Harris, 2014). Researchers have theorized that the learning practices in STEM classrooms may not provide students with the necessary framework to make such long-term goals: “Students’ [learning] experience is embedded in the temporal, material, emotional, and social organizational conditions. These conditions frame how students learn academic subjects but are underrepresented in content-focused studies of subject

matter learning” (Stevens, Wineburg, Herrenkohl, & Bell, 2005, p.147). In other words, one can argue that students aren’t necessarily relating the academic subjects they learn in STEM classes to the content-focused fields of STEM, or to their world around them.

The impetus for this project arose from my 20+ years of primarily STEM teaching and research (Baykent, 2002, 2005, 2006, 2007, 2010; Baykent & Esme, 2007)<sup>1</sup>, during which I have developed some theories based on my own observations and research findings that coincide with the literature. I have observed in my teaching and confirmed through my previous research that although the ideal of elevating society is almost always a goal for students early in their academic lives, they often temporarily shift their focus away from the more integrated ideal of *working toward personal improvement in the learning environment to achieve broader social goals*, or they give up on such ideals entirely.

In finding reasons for and solutions to this shift in focus, I have experimented with some remedies in different age groups at various times in my career. Through such exploration, I have found that one primary reason students lose their focus on learning as a means of bettering themselves and the world is a lack of understanding about the way self, others, and society are interconnected in an ideal learning environment. Based on these experiences, I have classified two categories, *(i) learning processes*, and *(ii) self, others, and self-society connections* (see Chapter 3 for more information), that if misunderstood, are possible reasons for this loss of interest in learning or shift to winning as the goal of academic achievement.

In my teaching, I have observed that when students do not have a robust understanding of these two categories, learning may turn into jockeying for position as the focus shifts to

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<sup>1</sup> the name under which I published or presented was my unmarried name.

winning, besting others, being recognized, and so on. This in turn may cause social and emotional power conflicts within and between students.

Moreover, I observed that when teachers don't provide adequate attention to balancing the social, emotional, and academic growth in the learning environment, students may either show reluctance to, or overly or solely focus on academic achievement as a result; thus, while the respect students gain out of well-deserved academic recognition may be functioning and perceived as a "power gain through winning over others." In otherwise case, when students feel incapable to attaining such "power," they may lose their interests and show reluctance toward trying to "be successful" in those academic disciplines.

In my observation, the young generations over the years often miss out on or lose sight of a more integrated approach to learning as they try to attend to the scenario, we educators set for them to be so called "successful achievers." Thus, while it is possible for some students to take a more holistic approach to learning, many more approaches the learning process as a goal that is achieved by besting and gaining power over others.

Where is the problem of origin in this picture? Confirmed by several researchers, (Brown & Campione, 1990; Brown, & Campione, 1996 in Schauble & Glaser, 1996), from my research and observations I also have come to a conclusion that it is the lack of a refined approach to creating learning communities for students. Even with the best intentions, it is all too easy to arrange activities for students that frame academic achievement in terms of "winners and losers" rather than on developing awareness, understanding, and capacities related to a learning processes that encompasses the two aforementioned categories, *(i) learning processes* and *(ii) self, others, and self-society connections*, or what I will henceforth refer to as holistic learning.

When such holistic awareness, understanding, and capacities are not developed in students regarding the connections among the learning processes, self, others and the self-others connections, various social, emotional and academic stressors may occur, and students may develop some engagement problems, learning barriers, or lack of interest (Boekaerts, 2002; Dweck, 1992; Kohn, 1993; Schlechty, 2002; Schlechty, 2011) in learning subjects in STEM disciplines.

While teaching, I was able to overcome such situations through some methodologies I used. I paid extreme attention to providing social, emotional and academic growth opportunities to my students through not only developing robust understanding about *(i) learning processes*, but also developing capacities through establishing awareness, understanding and practices about *(ii) self, others, and self-society connection*.

Thus, while I comfortably incorporated many fun challenge-based, game-like activities in P-20+ students I worked with cross-culturally, I simultaneously observed first hand on many occasions over 20 years how this shift to these two methodologies in my teaching helped students become more focused on self-investing in themselves socially, emotionally, and academically while co-empowering their learning communities working together hand in hand.

As a result, I developed a model called “Metacognitive Coaching Model” (MCM) for this dissertation. Questioning that, through the application of such model, whether once those fundamental foundations are built, will more students be awakened to their self-responsibilities, will they be more willing to invest in themselves to become self- and co-empowering agents who assume the required civic and social responsibilities.

To effectively support students for such possible outcomes, I designed many eye-opening learning experiences, through which they turn their spotlights to themselves and be introduced to

their own influence toward themselves, and to the roles with this influence they play in their social, emotional and academic interactions with the others. I also developed protocols within the model to help them develop strong capacities to govern their self-influence so that they can balance out their thought-emotion-action channel wisely to better participate in their community of learning through fulfilling their self-responsibilities.

Overall, with this model, I aimed to design systematically functioning protocols that help students develop such capacities while following this holistic approach. More specifically, my goal for this dissertation is to investigate, by means of the practices of the MCM, the following questions: Is it possible to help students realize their self-influence while learning STEM subjects? Is it possible to raise their awareness of their self-impacts toward themselves and others, and help them build the required capacities to become metacognitively competent in governing their self-influence on their learning to better assume their responsibilities? How does this capacity development in progress function in developing self and co-empowerment? Does this process engage students in assuming the required responsibilities both to self-invest in themselves while putting effort toward fulfilling the civic and social responsibilities in their learning communities?

### **The Framework and the Focus of the Project**

Several researchers have suggested that there is a connection between the inattention to social and civic responsibilities and the lack of interest in pursuing in STEM careers (Galston, 2004; Zaff et al., 2011). To elaborate, findings from my previous research suggest that while students develop an understanding of the epistemologies in STEM fields to some extent in their early school years, they may lack understanding of how STEM fields can provide both

individuals and societies with opportunities and tools to improve not only their own, but also the world's well-being, if used appropriately.

In addition, it may be the case that students rarely understand how important and necessary it is for individuals to assume personal responsibility in developing STEM skills to improve their capacities as learners. In fact, they need a solid realization that they can only truly fulfil their responsibility to improve their well-being and contribute to their society *once they develop the necessary skills*. Thus, the type, quality, and strength of their skills matter a great deal, and more important, their commitment is the path to gain these capacities and skills to put into such service that improve the overall well-being.

Maybe most important, students need to realize that bettering oneself, and consequently society, requires they not only be highly skilled individuals, but also develop the capacity to be ethical and responsible global citizens who are willing to work hand-in-hand with each other. They need to better understand, and experience throughout their education that this is absolutely an achievable goal for every individual. They also need to discern that striving for developing such skills and capacities should not be underestimated, neither left alone for random opportunities.

My research findings and observations suggest that once they receive an adequate support that help them overcome any obstacles they may be perceiving as blockages against becoming such strong learners, then they can focus on self-investing themselves individually. Next, through embracing and valuing diversity, they may better focus on tuning into thinking critically and scientifically as they would find space to be, and share their theories, and inquiries of the scientific phenomena with each other in a supportive learning environment (Hogan, 1999a, 1999b, 2001). Thus, they collaborate to improve their understandings and skills more willingly,

producing a stronger workforce at a time together, they co-develop solutions to STEM problems and projects to elevate society. Hence, this dissertation project focuses on developing an instructional model to reinforce such ethically responsible STEM teaching and learning through engaging students in co-developing a successful learning environment by self-empowering to co-empower their learning communities.

### **Discerning the Importance of Differences and Diversity**

Over years of teaching and research cross-culturally, I theorized that for co-empowerment to happen, first, students must discern the necessity of having differences and diversity in order to develop the critical thinking abilities that trigger a broader, more complete understanding of any learning problem or project. A learning environment encompassing different voices, theories, perspectives, thinking, perceptions, and so forth, encourages students to see that this diversity can help them “see the other side of the coin” and thereby develop a better individual and collective comprehension for a solution of any problem or project in the STEM fields. A diversity-based environment can better help students acknowledge that a one-sided point of view may close down opportunities for an improvement or finding a broader, stronger solution to a problem. Through such experiences, students ideally come to realize that differences can be a key to success and well-being in any field if valued and operated adequately. Then students will be more willing to recognize that while a true success can be only achieved if the rooted issues are addressed, and strong solutions are provided, this requires gaining the needed knowledge and capacity as well as willingness to choose wisely and caringly meshing their skills with those of others for an improved teamwork at a time, resulting in a more diverse skill set and ultimately co-empowerment.

Research has shown that in the learning environment, each student directly or indirectly influences his or her own learning as well as that of others, and this affects the way students shape their learning communities (Baykent, 2010; Boekaerts, 2002; Brown, 1992; Dewey, 1959; Dweck, 2007a). Thus, the goal of co-empowering learning environments would be for students to become aware that the impact of all students' cumulative effort includes the efforts and skills of every student, and the type of impact that comes from each individual is significant and crucially important.

My theory is that for this co-empowerment process to occur, educators need to create effective, safe, and friendly environments that help students while comfortably developing their skills, share their understandings, perspectives, and perceptions with each other without any hesitation to develop a better, more diverse and broader common understanding.

Thus, the present study investigates whether this environment can be created through providing students with scaffolding guidance on how to harness their best efforts, resulting in each student not only bettering his or her small learning community, but at the same time influencing each-others' involvement in the community through taking charge of their own learning by regulated, well-shaped, thoughtful, balanced, and beneficial acts.

Specifically, research has shown that students benefit from understanding that taking charge of their own learning is important for their own and others' well-being, and that working toward this goal in their early education can contribute to their long-term success (Baykent, 2002, 2010). Through developing such comprehensive understanding, students will also have opportunities to take ownership of their own learning process. In order for students to assume this responsibility genuinely, they must initially be provided necessary opportunities to *realize their self-influence on their own learning as well as on that of others*.

## Why to Address the Three “WHYs”

Because, the three WHYs are knowledge and understanding that students need to develop on the necessity to create collaborative learning communities and the benefits of such environments on individual and collective basis. That are: (1) *WHY* students need to take charge of their own learning, (2) *WHY* taking charge of one’s learning is important for one’s own and others’ well-being, and (3) *WHY* one needs to work toward this goal of developing collaborative learning communities (Baykent 2002, 2010). In order to develop collaborative learning communities, particularly in STEM learning environments, students need to develop a genuine understanding and knowledge of these three WHYs in their early education for several reasons.

*(1) Students need to understand WHY they need to take charge of their own learning.*

Research supports that students are more likely to take responsibility for their own learning if they understand the importance of becoming of engaged, lifelong learners (Cook-Sather, 2010; Cornford, 2004). Students are more likely to take responsibility if they understand the learning intention, and the success criteria—both of which help them take charge of their learning (Wiliam, 2011); if they clearly understand why it is essential they develop academic knowledge and integrated this knowledge with social and emotional lifelong skills (Baykent, 2002); and if they pay a genuine attention to what and why they are learning (Baykent, 2006).

Once they develop such understandings, perhaps, they will be more willing to work toward assuming their personal responsibilities to self-invest in themselves to become self-leaders who empower themselves through committing to gain those lifelong learning skills.

*(2) Students need to understand WHY taking charge of one’s learning is important for their and others’ well-being.*

Students benefit from understanding that taking charge of their own learning contributes to their own and others' well-being and academic success. As explained by (Reeves, 2008), "The energy generated when students take ownership of their learning is surprisingly similar across different education settings. I found every student from kindergarten through high school engaging in service learning" (p. 84). Reeves describes student ownership of learning as "student empowerment," which is parallel to this dissertation's definition of self-empowerment.

The synergistic energy Reeves describes was evident in the co-empowerment students gained through taking charge of their own learning, a dynamic which I observed while teaching several different grade levels in diverse cross-cultural learning settings. My observations of such environments provided the basis of the MCM. The goal of this project is to assess the efficacy of the MCM intervention in building students' awareness of why self-empowerment generates co-empowerment and benefits themselves and others.

*(3) Students need to understand WHY they need to work toward this goal of developing collaborative learning communities.*

The engagement through focusing on gaining skills side by side with their peers facilitates students' ability and desire to improve their own *learning actions*. That in return improves their interactions with their peers and creates better collaborative learning opportunities (Baykent, 2002, 2010; Baykent & Esme, 2007). I use the term "learning actions" to encompass the types of academic and social actions students take in the learning environment that lead to collaborative learning. I break the category "learning actions" into two subcategories, *academic actions* and *learning actions*. Both of these actions are needed for individuals to practice through their learning enactments.

The first one, *academic actions*, I describe as student approaches to understanding academic subject matter, such as engaging with a discipline-specific concept in such a way that the concept can be clearly understood and successfully applied to complete a relevant task.

The second one, *social actions*, encompasses student actions toward other team members, for example, being supportive and respectful, giving importance to communicating clearly, valuing others' thoughts, demonstrating that you listen, and you care, and actively and voluntarily putting in effort to work well together so that each team member individually and collaboratively develops a better understanding of the concept being learned at a time.

To successfully enact learning actions, students' improvement in their academic learning capacity requires interactions with each other (Vygotsky in Karpov & Haywood, 1998). Considering that interactions are originated by each party's social and academic actions, students must also be educated adequately to govern their learning actions in ways that can produce the best quality of learning interactions (Baykent, 2002; Baykent & Esme, 2007).

As stated earlier, students need to understand WHY they need to work toward this goal of developing collaborative learning communities if they to take ownership of their own learning process. Research has shown that each student's regulating his or her own learning actions will consequently influence the quality of social interactions, and these interactions, in turn, influence cognition. Vygotsky's sociocultural cognitive development theories stress the fundamental role of social interaction in the development of cognition, as he believed strongly that social interactions play a central role in the process of "making meaning" (Cole & Vygotsky, 1978). According to Vygotsky, cognitive development stems from social interactions by guided, scaffolded learning within the zone of proximal development as children and their peers' co-construct knowledge (1978). For the MCM, the model created for this dissertation, the protocols

that are related to social interactions (Self- and Peer-Coaching Protocol, SPCP, please see Appendix A), were designed based on Vygotsky's zone of proximal development principles. That's based on the idea of supporting students to master their enacted learning actions that may be possible to do so on their own.

Bandura's social cognitive learning theory also highlights the importance of social contact in children's learning. According to Bandura, the environment shapes behavior, but behavior also shapes and changes the environment in a back and forth way. Thus, based on this theory, good role models produce better behavior in children than do negative ones (Bandura, 1986).

For this dissertation to examine whether, once students gain such understanding and capacities, a better learning environment will emerge naturally as supported by Bandura's theory, the following steps are aimed: to ensure developing a successful learning community through shaping students' behaviors, initially, some cognitive factors are aimed to be cultivated in students, such as *raising the students' self-awareness of their learning actions*; then, through incorporating the practices of MCM protocols into the daily learning processes it was aimed to help students develop the *metacognitive knowledge and capacity necessary* to implement the desired learning actions.

### **The Gap**

Currently, educators lack mechanisms for building a foundation on which students can learn to govern their self-influence on learning (SIL). SIL is directed toward both students' own learning and that of others, and it affects the way students take charge of and take part in building their own learning communities.

Since the time of Dewey (Dewey 1902 in Dewey, 2001), educators have enacted reforms in science teaching; one of their “key aims of science teaching reform efforts has been to engage students in the epistemological aspect of science authentically” (Ford & Wargo, 2007, p.134). One-way educators have accomplished this aim is by “engaging students in reasoning practices in science, offering explicit guidance on the roles students can assume to monitor their own and their peers' thinking, and thus fostering a sophisticated epistemology of science by having students experience science as a process of revision” (Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999b, p. 451).

A number of instructional models also implement metacognitive assessment strategies that increase students’ metacognitive awareness and regulation capacity (Cleary & Zimmerman, 2004; Darling-Hammond, 2007; Engle & Conant, 2002; Hacker, Dunlosky, & Graesser, 1998; Herrenkohl, Palincsar, DeWater, & Kawasaki, 1999a; White & Frederiksen 1998, in Minstrell & Van Zee, 2000; Peters & Kitsantas, 2010; Brown & Campione 1996, in Schauble & Glaser, 1996). These models provide researchers and practitioners with guidelines for choosing effective approaches to improve learning in STEM fields for K-8 students, particularly by improving students’ epistemology of science through inquiry and the nature of science (NoS) instructions, and by promoting successful scientific learning communities.

These studies, along with related studies from various perspectives (explained in more detail in Chapter 2), all use metacognitive strategies effectively to help students improve their metacognitive awareness as a means of improving their academic achievement and developing successful learning communities. These approaches provide insightful instructional tools for improving students’ understanding of the epistemology of science, mathematics, and technology, both individually and collaboratively. Some metacognitive strategies improve students’ self-

awareness capacity for self-monitoring and ability to execute learning strategies. Other metacognitive strategies increase students' intellectual progress by fostering cognitive and social processes that engage students by incorporating content and interactions.

These studies provide invaluable visions and techniques, through these metacognitive strategies, in terms of helping students develop various metacognitive competences in developing epistemology of science. These metacognitive strategies, however, lack a mechanism for building a foundation with which students can systematically become self-motivated learning agents who take charge of building their own learning communities together with the help of their teachers and peers, or in other words, have the capacity for governing their SIL.

For this dissertation project, in order to develop such a mechanism to help students develop the necessary capacity for governing the SIL, I designed the Metacognitive Coaching Model (MCM), which has three main steps, as illustrated in Figure 1.1: (1) developing metacognitive awareness of the SIL, (2) developing metacognitive (declarative, conceptual, and foundational) knowledge of the SIL, and (3) developing regulatory control by practicing and internalizing of “*what to do*” and “*how to do*” to govern the SIL. In the metacognition literature, these three steps, referred to as *awareness*, *knowledge*, and *regulatory control*, are used in describing metacognition in many cases (explained in more detail in Chapter 2). In this dissertation project, I used them as consecutive subprocesses to developing the capacity of metacognitive competence in governing the SIL.



Figure 1.1. Process goals of the MCM.

These steps are the process of developing metacognitive competence in governing the Self-Influence on Learning that are designed to fill students' need to have many meaningful realization moments about how they influence their own learning.

The first step is to help students learn to effectively govern their influence on their own and others' learning, by becoming aware of how they react to their own emotions and thoughts, and as a result, how they shape their actions that come across otherwise as a reaction (out of those emotionally loaded thoughts) while learning.

The second step is designed as a training process to help students gain knowledge and understanding of how to act consciously (through becoming metacognitive) on their own emotions, thoughts, and actions during their learning processes, and why it is necessary.

Finally, I designed the third step as a practice process to provide a scaffolded pathway for the students to practice developing regulatory control over those emotion-thought-action chain processes by performing; the purpose of this process is to help students *eventually develop the necessary metacognitive competence to govern the SIL as an extension of step one and two.*

Next, I will provide a further detail about training and practice processes in order to highlight the specific implementations used to help students develop the needed metacognitive competence to govern their SIL toward co-building collaborative learning communities.

This process includes questions for educators. To initially ask students, nine questions (detailed below), which, if asked in concert, can help develop a foundation of metacognitive knowledge and understanding. This question-asking process can be very useful in establishing such a foundation by helping students not only realize their own influence on their and others' learning, but also acknowledge the need to take ownership of and responsibility for their own learning, both individually and collaboratively. If students arrive at the answers through this process, the information will be more meaningful for the students and the strategies they learn can be applied more effectively. The nine questions to be used by educators to prepare students for an effective and collaborative STEM learning are (1) what does a successful learning community look like; (2) how can teachers and students co-establish this successful learning community; (3) how does this community work; (4) why is such a community important to students' learning; (5) what is each participant's role<sup>2</sup>; (6) how does each participant's role contribute to the community's success / why is it important to the learning community's success that each participant fulfill his or her role / how does each participant's approach toward fulfilling their roles impact the community / why does each participant's approach matter so much for the community's success; (7) how can these roles be interpreted as individual responsibilities to co-construct learning communities; (8) what happens when participants fail to fulfill their responsibilities; and (9) what happens when participants gracefully, wholeheartedly, committedly, selflessly, and altruistically fulfill their responsibilities?

Clear answers to these questions will provide a strong foundation for developing successful learning communities and will cultivate further self-awareness in students,

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<sup>2</sup> "Participant" in this case refers to both *students and teachers* – an important element of this model.

encouraging them to more fully develop their inner potential to take ownership in regulating their own learning actions (academic and social).

However, based on my understanding gained through the research and teaching experiences, answering those questions is not enough to provide the needed foundation. Thus, through applying the necessary metacognitive awareness, knowledge, and understanding into the metacognitive regulation practices at a time, a capacity development process is needed.

It is crucial that educators train students to develop a strong foundation of knowledge about *becoming cognizant of their emotions, thoughts, and actions while learning*. As illustrated in Figure 1.2, the social-emotional tensions that may be caused due to some external or internal stimuli during learning, or any social interaction, can capture students' minds both individually and / or collectively through their thoughts otherwise. Then actions are transformed as a product of the emotionally loaded thoughts that directly influence learning interactions (academic and social). Thus, these reactive processes immensely influence the dynamics of learning environments and communities as well as the learning achievement as a result.

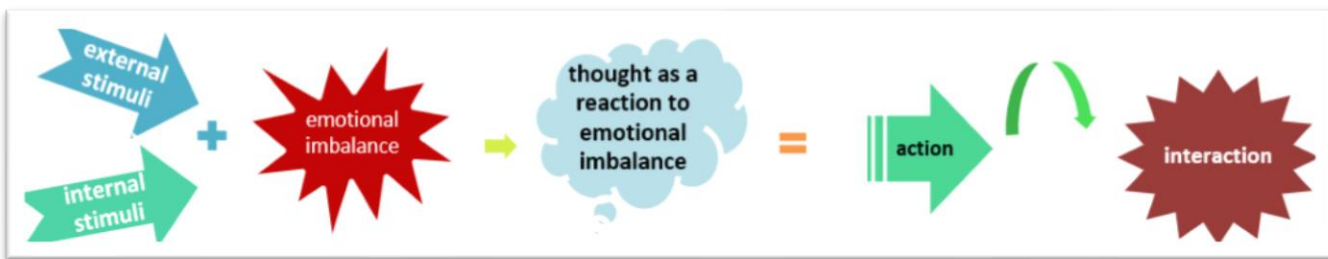


Figure 1.2. An illustrated process of a thought stream.

In order to prepare students adequately and to take the necessary precaution for any possible undesired influence against developing a successful learning community, during the training process, after answering the aforementioned questions, I taught the following four concepts, explaining them via friendly small group and classroom discussions:

1. How to become aware of the concept of learning through gaining knowledge about “learning orientation,” which is about understanding *the why of learning*. When students misinterpret why they need to learn, they may exhibit behaviors, such as “jockeying for position” to gain recognition instead of learning to learn to develop their capacities (Biggs, 1988; Dweck, 2007b, 2010; Kohn, 1993) that interrupt the building of learning communities and students’ ability to genuinely learn.
2. How to become metaemotional through becoming aware of social stressors (Boekaerts, 2002), which are social-emotional tensions between what benefits an individual and what benefits the whole team.
3. How to develop goal framing (Boekaerts, 2002; Dweck, 1992) that proactively and productively supports the individual and co-learning processes.
4. How to become metacognitive in learning actions through planning, executing, monitoring, and revising as well as reflecting.

During the training process, I aim to help students gain that important metacognitive knowledge and understanding as a foundation to govern their SIL.

Such process of developing metacognitive competence in SIL through this project is aimed to address the root issues and solutions to further improve of emotional intelligence, social, emotional and academic achievement and well-being (Bridgeland, Bruce, & Hariharan, 2013; Goleman, 1995a; Mayer & Salovey, 1993; Mayer, Salovey, & Caruso, 2004).

At the end of this training process, students are expected to better understand that their influence on their own and others’ learning comes from their own performances, which are the results of the emotionally loaded actions.

This is one way to train students to regulate their own learning actions through first becoming aware of their self-actions (MCM Step 1), then developing metacognitive knowledge and understanding of the essential concepts to govern their SIL (MCM Step 2), and then practicing the metacognitive regulation of SIL to finally developing the needed metacognitive competence over their own emotions, thoughts, and actions to appropriately govern their self-influence (MCM Step 3). This is to provide a tool for individuals to gain capacities in gauging their inward and outward balance at a time, rather than being navigated by any burst out imbalanced, emotionally loaded-actions that can occur through any un-controlled, unfiltered, unprocessed emotional imbalances, or inner conflicts.

To provide a systematic pathway to establish such metacognitive competence, I embedded the essential daily “to-do” list in two protocols within the MCM. The Self Action Regulation Protocol (See Appendix A) that is the only one I used in my measurement. Through this protocol, I first ask students to adjust their mood for their current learning activity in a way that they can co-empower their team through self-empowering themselves emotionally and logically through their strategic planning, composed of acknowledging the current situation, turning things around through logical decision making, and compassionate intention setting.

Next, I ask students to develop self and co-empowering goal framing by stating their personal responsibilities both for their own learning and for their team’s collaborative learning.

Then, I use a unidimensional Likert-Scale, (see Table 4.6), asking students to decide on how much they are willing to enact academic (e.g., being focused, being efficient) and social (e.g., being supportive, being respectful) actions. While the written interpretations of the scale were included in their entry and exit forms, they are asked to write the corresponding numbers in these forms. For the measurement of this dissertation project, I used these forms my students

submitted with their overall action-plans, and execution-reflections for each activity during the practice process.

As findings in several studies confirm, while learning any academic subject, neither strategy regulation nor emotional regulation alone would be sufficient developing a metacognitive competence (Cleary & Zimmerman, 2004; Peters & Kitsantas, 2010; Zimmerman, 2000b). Particularly for developing a foundation of metacognitive competence as a basis for SIL, instead, strategy and emotional regulation should be blended with a personal awareness of the self. This understanding shall be put into a process metacognitively to achieve this new cognitive foundation toward learning.

I propose that in order to develop the lifelong learning skills in our students, we need to help students develop skills through understanding both their own strengths and weaknesses, and through learning how to address and cultivate them along with the pursuing required practices that help them develop such skills and a habit of mind to use those. Developing metacognitive thinking capacity in our students' minds can be one strong strategy to attain this goal.

Some research suggests that there is a need for major curriculum revision and a revolution in approaches to teaching and learning through the teaching of cognitive and metacognitive skills (Chapman & Aspin, 1997; Cornford, 1999, 2002, 2004). As Cornford states that “the vast majority of teachers at all levels of education have good intentions to promote effective learning by their students, but they have never been taught how to incorporate the teaching of cognitive and metacognitive skills into their sessions. In short, along with changes in curriculum, a revolution in approaches to teacher education may well be necessary” (2004, p.13).

This dissertation project aims at closing such a gap through proposing one way for developing students' metacognitive competence by means of gaining metacognitive regulation

capacity in SIL supported by mindfully developed awareness, knowledge, understanding, and practices.

### **The Purpose of the Dissertation and Research Questions**

The purpose of this dissertation that is situated in the STEM teaching in Grades 3-5 in an after-school program is to investigate whether implementing the MCM enables student to develop metacognitive competence in SIL by self-empowering team members to co-empower their entire teams via improved academic and social achievements. More specifically, as a result of the SIL capacity students developed, it is expected that they will better engage in social learning processes together with peers, resulting in making further progress in their own understanding of complex STEM projects as well as developing shared understanding of complicated problems and projects.

To this end, I ask the following research questions:

**RQ1.** Before the intervention (BI), that is, before undertaking the training and practices of the MCM intervention, how aware were students of their social and academic actions during individual, and collaborative/team learning?

In other words, before the MCM intervention, what is the level of students' initial metacognitive competence regarding their learning actions in general? More specifically, are they able to accurately monitor and reflect upon their learning actions before the training and the application of the MCM intervention?

**RQ2.** During the intervention (DI), are students developing metacognitive regulation over learning actions as they practice and perform the MCM protocols using the planning, execution, and reflection assessment cycle, and if so, do students demonstrate any consistency in (a) executing their plan of actions or (b) reflecting their executed plan of actions?

**RQ3.** What is the association between the MCM application and students' metacognitive competence for regulating their learning actions/governing their SIL after four months of the intervention, within spring quarter when compared to before the intervention (BI) that took place in the fall quarter?

**RQ4.** While practicing MCM protocols toward developing metacognitive competence over their SIL, is there any observable pattern on students' responses to the mood adjustment, goal framing, and academic achievement test scores that shows engagement in and attainment of self-empowerment and thus collaborative-empowerment?

**RQ5.** Do students continue regulating their academic and social actions (learning actions) four months after the conclusion of the MCM intervention? If so, is there any observable pattern in their learning communications that indicates improvement that may be correlated to the MCM intervention?

### **Significance of the Research**

Through this dissertation, I intend to develop a metacognitive competence for what a social system requires to work successfully, and why and how each individual should contribute to its success. In order to do this, I aim to enhance student awareness of metacognitive self- and peer-coaching skills by introducing metacognitive coaching processes during teamwork. These processes will help students develop metacognitive competence to better think, plan, execute, monitor, and improve their learning actions within their social communities of learning through empowering individuals to co-power the teams. This should support students in developing and improving their capacity for self-reflection – the capacity to objectively observe and reflect upon their own thoughts and acts – during the individual and collaborative learning process.

## **Organization of the Dissertation**

In the next chapter, I share my literature review, focusing on metacognition and its implications in the K-8 STEM field. Then, in Chapter 3, I present the MCM approach. In Chapter 4, I lay out the methodology for this study, and in Chapter 5 I report the findings of the data analysis. Chapter 6 is the discussion, where I summarize my conclusions and discuss the limitations of the study and possible implications and future recommendations.

## Chapter 2: Literature Review

### Overview

This review examines metacognitive approaches in K-8 STEM fields, particularly in science education, for developing students' knowledge of science and scientific inquiry. My aim with this review is to find out the aspects of the previous research studies developing metacognitive competence in students learning actions. I am interested to see how much and in which ways the previous studies worked on developing metacognitive competencies in students particularly in terms of developing metacognitive awareness, knowledge and understanding as well as regulation. I am mainly interested in helping students *develop metacognitive competence for governing their self-influence* while learning STEM disciplines. I aim to attain such goal through developing self-empowerment toward establishing collaborative empowerment by means of building successful learning communities. Thus, I am interested to find out how other researchers approached toward these issues, and how the metacognitive assessment tools/strategies are being used.

Next, I initially address the main components of metacognition, generally referred to as knowledge of cognition (cognitive process) which is also called primary condition and regulation of cognition (control process) which is namely secondary cognition (Brown, 1987; Flavell, 1979; Nelson & Narens, 1990; Pintrich, 2002; Schraw & Moshman, 1995).

Next, I highlight the most frequently used metacognitive approaches in research studies for grades K-8<sup>3</sup>. Then I review studies on developing awareness and knowledge of as well as

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<sup>3</sup> Please note that when necessary, I draw various research studies that are relevant, but not necessarily from K-8 grade levels. I used some STEM disciplines related research when relevant as well.

regulation skills in using the metacognitive process. After that, I analyze the metacognitive approaches that are used in developing self-regulated as well as co-regulated learning.

In the “Learnings from the Other Studies” section, I outline, examine and discuss these approaches in general, drawing findings and implications from this literature review, and showing the effects of the studies that gave me perspectives and insights in developing the Metacognitive Coaching Model (MCM).

With this model, I aimed to help students develop metacognitive self- and peer-coaching capacity through developing metacognitive competence in their thinking mechanism. For this I attempted to raise students’ metacognitive awareness and develop the necessary metacognitive knowledge and understanding to genuinely recognize/apprehend their self-influence that comes from their actions in theirs’ and others’ learning. Once the foundational metacognitive awareness and knowledge is structured, I aim to help student develop metacognitive regulation capacities to govern their own actions/learning actions as well as regulating any internal and external stimuli in their thought streams that may be impacting their actions and consequently their learning interactions. Thus, my aim is helping students developing metacognitive thinking capacity. Hence, through this literature review I examine the previous studies from this lens.

## **Metacognition**

### **Development of the Metacognition Concept**

The emergence of the idea of metacognition in academic studies took place gradually through various research studies. In the early 1900s, metacognition’s strategic activities (questioning, monitoring, and reflecting) were recognized well before the emergence of the term. (Brown, 1975; Huey, 1908; Piaget, 1968; Thorndike, 1915; see in Brown, 1987; Dewey, 1910; Flavell, 1971; Markman, 1977). In *Memory and Intelligence*, Piaget focused on remembering

and making connections with understanding (Piaget & Inhelder, 1973, 1971). Later, Flavell compared metamemory and metacognition. He defined metamemory as “knowledge about memory and memory processes”, while describing metacognition as “knowledge of cognition and monitoring and control of cognitive activities” (Flavell, 1971). In the same decade, a few studies focused on metacognition, particularly on monitoring and controlling of cognitive activities. Markman (1977) for example, questioned “how people become aware of their own comprehension failure.” In the same year, Brown and Smiley (Brown & Smiley, 1977) focused on cognitive processing. In their paper regarding metacognition, cognitive process, and self-awareness, they wrote the following:

Metacognition refers to the individual’s knowledge concerning his own cognitive processes, and the development of such self-awareness in children has become a topic of considerable interest. It is thought that with increasing age and experience the child becomes more and more aware of himself as an active agent of knowing (Bransford, Nitsch, & Franks, 1977; Brown, 1975, 1977a) and gradually achieves an increasingly realistic picture of his abilities and limitations as a problem solver (Brown & Smiley, p. 1).

With this definition in the 1970s, Brown and Smiley highlighted the importance of children’s awareness of metacognitive knowledge in order to grow as an individual (active agent) of knowing, who is supposed to be, and needs to be mindfully aware of the knowledge about themselves. In addition to these definitions, Nelson and Narens (1990) defined metacognition as primary and secondary cognition; this definition was later used by social psychologists in developing the idea of social metacognition in general. Since then, through various scholarly work and research studies, metacognition has been analyzed from the following perspectives: comprehending the world, knowing and monitoring our thoughts,

evaluating and revising our goals in light of developing cognitive states, motivating ourselves, developing strategies and heuristics to make ourselves more capable of adapting to changing situations, and understanding others to gain more understanding of ourselves. These notions of agencies became the themes that dominate literature at the beginning of the 21<sup>st</sup> century (Hacker, Dunlosky, & Graesser, 2009), and that are related to this dissertation research.

### **The Components of Metacognition**

Since the first definition of metacognition by Flavell, a number of metacognitive terms and models have been used. Metacognitive awareness, metacognitive beliefs, metacognitive experiences, metacognitive knowledge, feeling of knowing, theory of mind, judgment of learning, metacognitive skills, meta-components, higher-order skills, executive skills, self-regulation, and metacognitive thoughts are just some of the terms that have been widely used and examined in research studies so far (Brown, 1977; Flavell, 1979; Metcalfe & Finn, 2008; Veenman, Hout-Wolters, & Afflerbach, 2006).

In general, an important distinction among these terms is about the type of process by which metacognition is analyzed, as cognitive and control processes. According to Nelson and Narens (1990), cognitive process is defined as primary cognition, metacognitive knowledge or the knowledge of cognition, whereas control process is defined as secondary cognition, a process that involves monitoring and controlling/regulation of cognition (Brown et al., 1983; Flavell, 1979; Pintrich, 2002; Schraw, Crippen, & Hartley, 2006; Schraw & Moshman, 1995).

**Cognitive process of metacognitive knowledge.** Also known as knowledge of cognition, this concept refers to what we know about our cognition. This process was subcategorized into three sub-processes by Paris, Lipson and Wixson (1983). They proposed that adept learners have three sorts of knowledge about strategies: declarative, procedural, and

conditional knowledge. Declarative knowledge includes “knowledge about oneself as a learner and about the factors that influence one’s performance” (Schraw & Moshman, 1995, p.352). It refers to knowing about things. Procedural knowledge refers to knowledge about the execution of a series of actions conducted in a certain manner. Conditional knowledge refers to knowing the time and reasons to apply certain cognitive actions (Garner, 1990; Lorch, Lorch, & Klusewitz, 1993).

**Control process of regulatory skills.** Also known as regulation of cognition, this term refers to metacognitive activities that help control one’s thinking or learning (Schraw & Moshman, 1995, p.354). In their review, Schraw and his colleagues state that even though numerous regulatory skills have been described in the literature, planning, monitoring and evaluation were included in all accounts (Schraw et al., 2006; Schraw & Moshman, 1995). Planning is considered to include the selection of appropriate strategies, allocation of resources, goal setting, activating relevant background knowledge, and budgeting time. Monitoring includes self-testing skills necessary to control learning, whereas evaluation refers to appraising the products and regulatory processes of one’s learning. Regulation, execution, reflection, self-reflective assessment, and revision are used as well as planning, monitoring, and evaluation, to describe the control process of regulatory skills.

***Suggestions for developing students’ knowledge about the nature of science.*** Hogan (2000) highlights the importance of metacognitive knowledge development in science learning. She emphasizes that “distal knowledge of the nature of science is students’ declarative knowledge about professional science, including the nature of scientific knowledge and scientists’ epistemological commitments” (p.51). With this sentence, Hogan explains that basic knowledge of the nature of science is the foundation of students’ scientific epistemology. She

says proximal knowledge<sup>4</sup> of the nature of science is “students’ personal understandings, beliefs, and commitments regarding their own science learning and the scientific knowledge” (p.51). She suggests that viewing these two kinds of knowledge structures within modern information processing frameworks that delineate the roles of epistemological and metacognitive knowledge in learning can help us understand students’ knowledge about the nature of science (Hogan, 2000).

To explain the components of metacognition for this literature review, I examine metacognition in two main categories: primary cognition, which is described as metacognitive knowledge or knowledge of cognition, and secondary cognition, which is defined as the process of monitoring and controlling or regulating cognition (Nelson & Narens, 1990). One can interpret Hogan’s finding that the declarative knowledge that is part of primary cognition is a foundation on which students can develop their initial scientific epistemological and metacognitive knowledge base. In other words, Hogan highlights the importance of developing basic understanding of scientific terms through declarative knowledge building.

Hogan’s work functions as a confirmation of my approach to developing the MCM in terms of paying attention to establishing students’ foundational understanding even though with a slight difference. When developing the MCM, I placed an emphasis on developing students’ metacognitive knowledge initially, specifically focusing on building foundational declarative knowledge in order to avoid both misconceptions and misperceptions due to lack of accurate knowledge or understanding so that students can better develop scientific epistemology.

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<sup>4</sup> Proximal knowledge, based of Hogan’s definition, can also be categorized under metacognitive knowledge, as described by Flavell: “metacognitive knowledge primarily consists of knowledge and beliefs about factors or variables that interact to affect the outcome” (1979, p.907).

When students do not have adequate opportunities neither developing basic understanding through establishing declarative metacognitive knowledge, nor to clarify their misperceptions, they may not be able to progress further ability to understand more complex contents as they lack the ability of comprehending the subjects through connecting the basic ideas or seeing the relevancy or irrelevancy between each other for example. Thus, this dynamic may account for at least some of the reasons many students don't choose to further pursue STEM fields.

Combining previous studies on the subject with my empirical and action research findings as well as field observation notes (Baykent, 2006, 2010), I came up with a conclusion about the definition of primary cognition: that *developing objective self-monitoring capacity* is required to attain metacognitive knowledge. I stress that for metacognitive knowledge to take place, accurate knowledge should be distinguished from the perceived-inaccurate understanding. Knowing the difference between the perceived understanding versus accurate understanding forms *the metacognitive awareness*.

When this awareness is developed, then the knowledge of self-perception, or the metacognitive knowledge of perception takes place in action. Thus, the observer becomes alertly cognizant about the accuracy of his/her understanding. Without this awareness taking place on the other hand, we may tend to take our perceptions more seriously, without questioning their accuracy, we may use them to develop our understanding based on such inaccurate perceptions. I argue that if we develop a capacity of metacognitive awareness toward our thinking mechanism, we can turn things around.

To be able to make this distinction, the observer should be able not only to observe, but also to compare their understanding to reality to truly discern what is going on. The observer

needs to gain the knowledge of reality that is specific, measurable, attainable, realistic, relevant, and timely. For this self-observation to be effective—that is, for the observer to realize the differences between perception versus reality—the observer needs to engage in self-reflection and reality checking in ways that translate to metacognitive awareness. To develop this type of awareness in students, I believe two types of training are crucial: training of the mind by means of awakening students to their responsibilities to mindfully work toward instilling in students the needed intention and willingness to attain the foundational scientific epistemology.

Thus, to develop metacognitive knowledge of cognition in the first place, students must be provided with opportunities to develop *self-monitoring capacity* that can be as objective as a mirror and that can also help them improve the capacity for metacognitive awareness.

Therefore, in the MCM, I developed a training process that includes three initial phases that provide structures and opportunities for students to self-invest by developing these capacities: the ability to discern why their perceptions need to be clear, knowing why they need to *want* to learn scientific epistemology, and why developing theories is initially essential, the next step should be assuming responsibilities to develop genuine understanding.

I also stress that in order for metacognition to work as a process, cognitive and control components should work interconnectedly. Metacognitive knowledge should be the foundation of cognition, yet it should also be supported by monitoring and control mechanisms to not only strengthen the metacognitive awareness capacity, but also develop metacognitive skills and metacognitive regulation. In my further reviews that I will share in the following sections, I examine how these studies used metacognitive approaches.

## **Review of Metacognitive Approaches**

In this review, I first classified research studies that used, examined, or discussed metacognitive approaches in learning, particularly in science focused on monitoring, reflecting, and revising the cognitive processes for the (a) failure in comprehension skills, (b) comprehension monitoring, regulating, reciprocal teaching and read aloud, as well as (c) comprehension control through metacognitive awareness and self-questioning.

Then I focused on instructional approaches proposed to developing awareness, knowledge and skills of the metacognitive process through collaborative learning. In such, (i) thinking aloud and (ii) collective metacognition were explored. For (b) socio-emotional development, (i) individual's metacognitive development; self-questioning, self-explanation research was shared. For (c) scientific inquiry, some relevant works such as (i) Thinker Tools and Reflective Assessment, (ii) Anchored Inquiry, and (iii) Pedagogical practices to support classroom cultures of scientific inquiry were highlighted.

In the following paragraphs, after briefly explaining the main sections (I and II), I illustrate each study with their methodologies to demonstrate what the researchers did and how they proceeded to conduct a particular metacognitive approach through their interventions. Next, I share their findings and implications, including my perspective.

### **Reviewing the Cognitive Process in Science Learning**

Researchers have studied and discussed metacognitive approaches in K-8 science education in various ways: as *monitoring, evaluating and regulating comprehension* (e.g., Otero in Hacker et al., 1998; Markman, 1977; Michalsky, Mevarech, & Haibi, 2009; Otero & Kintsch, 1992; Palincsar & Brown, 1984; Varelas & Pappas, 2006), *metacognitive awareness* (e.g., Michalsky et al., 2009), *knowledge utilization* (Waters & Waters, in Waters & Schneider, 2010,

pp.113-159), *metacognitive knowledge* (e.g., Hogan, 2000; Peters & Kitsantas, 2010), and *cognitive process* (e.g., Mayer, in Waters & Schneider, 2010, pp.160-175). Some research studies were helpful in identifying problems in students' learning, such as failures in monitoring, evaluating and regulating comprehension (e.g., Hammer, 1994; Otero & Kintsch, 1992). Some studies contributed keen analysis and suggestions, such as the necessities of observing students' metacognitive knowledge development in scientific epistemology along with their proximal knowledge development (e.g., Hogan, 2000). The most highlighted approaches to improve learning in science are reciprocal teaching, read-aloud, self-questioning, and prompting a metacognitive process through self-regulation training. These strategies target monitoring, reflecting, and revising the cognitive processing. Below, I briefly cover each of these approaches, explaining the research intervention methodologies and effects.

**Diagnosing the failure in comprehension skills.** Comprehension monitoring has been conceptualized in various ways, such as children's awareness of inconsistencies (Markman, 1977), an error detection paradigm (Winograd, Johnson, in Otero & Kintsch, 1992, p.145), calibration of comprehension (Glenberg & Epstein, 1987), as well as metamemory and meta-comprehension (Maki & Swett, 1987). According to these studies, failing to detect inconsistencies leads to an evaluation problem. One example comes from Otero and Kintsch (1992), where researchers provided an incorrect "Proof of Newton's Second Law" to secondary school students. The students were asked to read the text and request an explanation if they did not understand it. They also had to recall the text in writing. Some of the students didn't notice any problems in the proof, and when asked to recall the text, they restated the information they had read. Reading was used to quickly see students' comprehension ability. In other words, it was a useful way to track whether students have metacognitive monitoring abilities. Otero and

Kintsch concluded that this “failure of structure strategy” was a type of “failure in comprehension evaluation”. This conclusion can be also interpreted to mean that in order to make an accurate evaluation and be able to notice the mistakes in the text, students needed to develop awareness in the importance and necessity of not only cognitive structuring, but reading cognitively through cognitive monitoring, reflecting and revising. Furthermore, I believe, developing awareness capacity on “being an alert reader” is necessary in genuinely understanding scientific texts as this ability in developing scientific epistemology is crucial. Otero and Campanario also emphasized that the adequate readers who can notice a contradiction in a scientific text use various regulation procedures (1990). The researchers noted that for inadequate readers, however, comprehension problems in reading a science text can be frustrating. That frustration may cause students to lose interest in understanding the subject matter. A good example comes from Hammer’s (1994) study. He examined inadequate regulation of comprehension in students’ epistemological beliefs in introductory physics. In his study, he asked questions eliciting students’ reasoning during a hands-on activity. One student calculated two different accelerations for two blocks connected by a cord, when in fact these accelerations are supposed to be the same. The following is the student’s reaction:

*Student: How could one is accelerating faster than the other? That would mean the velocities would have to be different... Yeah, I guess so... Well, I don’t know; I’d check and see if I got the right answer. I am 90% sure.*

The student is noticing the inconsistency between his result and his knowledge of kinematics. Instead of choosing to monitor his comprehension and revise his understanding, the student chooses to look at the solution (Hammer, 1994, p.166).

Along with students’ lack of skills in comprehension monitoring, I sense a partial source of the problem perhaps is a lack of self-efficacy in himself; his belief in ability to understand this

topic (Bandura, 1977). Referring to the previous section's interpretation, the student may also have un-clarified misconceptions that may be contributing to this lack of trust in his ability. Moreover, this belief about himself may be active internally and causing emotional imbalances in his mind, causing him act reluctant to go back to the topic to review it to better understand.

Raising student's awareness should be an initial step to help him. In my view, students need to understand that it is imperative for them to develop comprehension skills at early grades, and for this they must actively monitor and revise their understanding to clarify any misperceptions on the way. Students can reach such awareness level through developing metacognitive awareness. The following two studies focus on some metacognitive approaches that proved useful for comprehension skill development through raising metacognitive awareness.

**Reciprocal teaching and read aloud.** Palincsar and Brown (1984) examined comprehension fostering and comprehension monitoring. They conducted two instructional studies directed at the comprehension monitoring activities of "poor-comprehenders" in K-7 grade levels (p.117). They designed four study activities including summarizing (self-review), questioning, clarifying, and predicting. The selected science-text readings were about "poisonous snakes, solar energy, lightning, and carnivorous plants." Their training method was reciprocal teaching, or adult model guiding, where the tutor and students took turns leading a dialog centered on pertinent features of the text. They found that with this method, students interacted with the text in more sophisticated ways that led to significant improvement in the skills of summarizing, questioning, and clarifying. Therefore, a substantial gain in students' comprehension and knowledge maintenance over time was found, leading to improvement in standardized comprehension scores.

With this study, Palincsar and Brown showed the importance of gaining metacognitive awareness of comprehension monitoring in practice in order to overcome difficulty in understanding a science text. Their metacognitive approach combined the *reciprocal teaching method* with *read-aloud* strategies through four study activities (Palincsar & Brown, 1984).

I believe, through this approach, one reason for students' success was that high expectations were set for them. Additionally, by providing an opportunity to take the place of and model the teacher, students were given reasons to approach their tasks more responsibly. Perhaps these factors, along with the metacognitive approach applied in this study, can support students to develop a habit of mind for a strong study discipline when practiced consistently.

**Self-questioning.** Michalsky and his colleagues investigated effects of metacognitive instruction and metacognitive awareness at different phases of reading a scientific text, working with 108 4<sup>th</sup> grade students in Israel (Michalsky et al., 2009). During the study, the students read "The World of Organisms' Lives: Animals and Plants" (p.365). Four science classrooms read the same texts and completed the same scientific tasks. From these classrooms, three of the four groups received metacognitive instruction before, during and after reading, and a control group received none. The researchers intended to raise students' metacognitive awareness based on the "IMPROVE" method (Mevarech & Kramarski, 1997), in which students are encouraged to use a series of four self-addressed metacognitive questions. The IMPROVE method's "self-questioning" refers to a) comprehending the phenomenon or the problem, described in the text (e.g., "What is the phenomenon all about? What is the problem needing investigation?"), b) constructing connections between previous and new knowledge (e.g., "What do you already know about the phenomenon? What are the similarities/differences between the problem at hand and the problems you have encountered in the past? Please explain your reasoning"), c) using

appropriate inquiry strategies to solve the problem (e.g., “What are the inquiry strategies that are appropriate for solving the problem? What are the main components of the experiment designed to solve the problem? When/how should you implement a particular strategy? Please explain your reasoning”), and d) reflecting on the process and the solution (e.g., “Does the solution make sense? Can you design the experiment in another way? How? Please explain your reasoning”). Researchers found that students who received the metacognitive training significantly outperformed those who did not in domain-specific knowledge and metacognitive awareness.” (Michalsky et al., 2009).

With this study, Michalsky and his colleagues’ metacognitive approach, “self-questioning’ was supported with the reading strategies (before, during, after). It is inferred that as the students were supposed to think back, clarify and analyze their thoughts in order to answer the questions, they paid more attention to what they were reading. Thus, these thoughtful monitoring, reflecting and revising processes were helpful in raising their metacognitive awareness.

This study, like Palincsar and Brown’s “four study activities” (1984) , sets high expectations through a systematic design, the IMPROVE method (2009). The results of these studies confirm that setting high expectations through systematic designs prove useful in supporting students’ comprehension skill development particularly when applied consistently. This is one valuable way for developing metacognitive regulation capacity in students’ comprehensive monitoring.

Perhaps, in these two studies if the teachers don’t follow the procedures as consistently, the result wouldn’t be the same. Hence, in their 1996 paper, Brown and Campione stressed that even though reciprocal teaching has received extensive dissemination and has been reported

successful, there were some cases in which "... the principles of learning it was meant to foster are lost, or at best relegated to a minor position. The surface rituals of questioning, summarizing, and so forth are engaged in, divorced from the goal of reading for understanding that they were designed to serve" (p. 292). Brown and Campione also wrote that, "... if one wants to disseminate a program on the basis of principles of learning rather than surface procedures, one must be able to specify what those principles are in such a way that they can inform practice." (Brown & Campione, 1996, in Schauble & Glaser, 1996, p.292).

One can argue that even though a teaching system is well designed and expected to work in principle, its success depends solely upon the set of capacities teachers possess. A teacher's depth of understanding in all aspects of teaching, as well as personal intention and attitudes, matters immensely. I argue that teachers should be sufficiently trained to adequately deliver any systematically designed instructional models and methodologies and they must be proficient on how to develop situated learning environment to achieve desired results.

In order to ensure the MCM principles' to be followed appropriately, I developed interconnected protocols that are designed to function systematically in a consistent manner. For this, too, teachers' competency is the key to first understand the why, what and how of the model and second to develop the necessary knowledge and comprehension to engage students with it.

Thus, while the MCM principles and protocols are all hidden in the rules of a game, I designed the procedures with clearly guided expectations. Then I presented them in the daily forms, setting high expectations for deliberate individual and team reporting for learning progress and practice of governing SIL status.

## **Developing Components of Metacognitive Competence in Science Learning**

There are numerous research studies on developing components of metacognitive competence such as metacognitive awareness, knowledge and skills for better engagement and improvement in science learning. Some of the categories that have been examined so far are: *planning* (e.g., study strategies, Nolen, 1996), *monitoring* (e.g., strategy monitoring and self-monitoring, Delclos & Harrington, 1991; McGilly, 1994), *regulating* (e.g., strategy use in self-explanations, Siegler & Lin, in Waters & Schneider, 2010, pp.305-346), *reflection and revising* (e.g., Vye et al., monitoring, reflection and revising, in Hacker et al., 1998, pp.305-346), *metacognitive and science inquiry knowledge and skill development* (e.g., Herrenkohl, Tasker, & White, 2011; Slotta & Linn, 2009; White & Frederiksen, 1998), *developing metacognitive knowledge and skills in collaborative learning* (e.g., Goos, Galbraith, & Renshaw, 2002; Hogan, 1999b, 2001; Larkin, 2006, 2010; Varelas & Pappas, 2006), *using metacognition in technology* (e.g., Mayer 2010, in Azevedo, 2005; Linn, Davis, & Bell, 2004; Waters & Schneider, 2010, pp.160-175), and *effects of metacognition in self-regulated learning* (Cleary & Zimmerman, 2004; Peters & Kitsantas, 2010). Some approaches to resolve and improve learning in science are thinking aloud, collaborative knowledge construction, read-aloud for collaborative understanding, self-explanation, self-evaluation for collaborative metacognitive development, Thinker Tools and Reflective Assessment, and Anchored Inquiry. In addition to these approaches, some studies used metacognitive tools to enhance students learning through hypermedia, using active metacognitive prompts to develop students' nature of science knowledge, as well as metacognition and self-regulatory efficacy, among others.

In the preceding paragraphs, I briefly cover each of these approaches, explaining their methodological interventions and their effects. These studies share various metacognitive

approaches that are used to develop collaborative knowledge and skill construction, that help students' social and emotional development, that build students' metacognitive knowledge and skill in scientific inquiry.

Next, I will summarize those studies, briefly sharing my brainstorming process for how I used some practical insights for the development of MCM.

### **Approaches for Collaborative Metacognition Construction**

**Thinking Aloud.** Hogan (1999b) conducted an intervention to foster students' collaborative scientific reasoning in suburban middle school science classrooms, working with 163 K-8 grade level students. The intervention was embedded within a 12-week science unit on building mental models of the nature of matter. She had four experimental and four control classes in this study. In addition, the interactions of 24 students in 8 focal groups were profiled qualitatively, and 12 of those students were interviewed twice. She addressed the question of how to increase students' competencies for regulating co-construction of knowledge when tackling complex collaborative learning tasks, which are increasingly emphasized as a dimension of educational reform (Hogan, 1999b). Hogan's main goals were to raise students' awareness of the cognitive goals of the tasks, to familiarize them with general kinds of thinking, and to provide procedural supports for helping students to regulate their knowledge construction through opportunities to experience the process of building theories and models from primary evidence. A secondary aim was to examine potential relationships between individual differences in students' perspectives on science learning and their learning behaviors and outcomes. During the intervention process, "students were provided with very little direct instruction." They did not use a textbook so that students would have to depend on their own sense-making capacities "rather than on outside expertise" (p.1085). Teachers provided sustained standards for coherent

explanations in order to support students' theory building. The students worked on a four-phase unit, in which they expressed prior understanding while they completed laboratories and demonstrations to gain experience with the characteristics and behaviors of solids, liquids and gases. Next, students worked in groups to construct and then present a coherent set of ideas and diagrams, which they called "mental models," to explain the phenomena they observed. After that, students participated in whole-class discussions and investigations to test and refine their models. Lastly, students used their models to explain new observations.

Her findings suggest that "students who received the intervention, gained in metacognitive knowledge about collaborative reasoning and ability to articulate their collaborative reasoning processes in comparison to students in control classrooms" (p.1085). Therefore, they performed better on a performance assessment of their metacognitive knowledge. However, this enhanced metacognitive awareness did not translate into improved collaborative reasoning behaviors, or into deeper processing of ideas and information that would have been manifest as enhanced ability to apply conceptual knowledge (Hogan, 1999b).

According to the findings in this study, even though it was possible to improve the students' metacognitive competencies to articulate collaborative reasoning, neither collaborative reasoning behaviors nor deeper processing of ideas and information were improved.

Hogan wrote that in the control group, where there was no collaborative structuring, the students did not talk about their group's thinking process until prompted. This group's responses did not represent a collaboratively internalized schema; rather they focused on their personal mental model building process. Hogan provided possible explanations for the gap between metacognitive knowledge and collaborative reasoning skills such as, "a) lack of integration of procedural knowledge and procedural skills due to incomplete implementation of reflection

activities, b) extremely high task demands relative to students' available knowledge, and c) inadequacy of current metacognitive theory to explain the role of metacognition in groups" (p.1101-1102). In her next study she addressed these possibilities.

**Collective Metacognition.** In this study, Hogan (2001) developed new insights into middle school students' collaborative knowledge construction processes by exploring metacognition as a potential nexus for integrating individual, social, and cultural levels of meaning. Participants were 36 8th grade students in 12 target groups. A total of 13 categories of metastatements were identified and described, along with four types of interactive contexts (conceptual, procedural, epistemic, and other) which preceded and followed the metastatements. Collective representations were evident within three of the metastatement categories: referring to goals, needs, and task requirements; setting standards for task performance; and suggesting thinking or communication strategies. Collective metacognition, then, was defined as individual metacognitive competencies, plus group communication processes, plus institutional and cultural norms that are internalized as metaknowledge. The findings of the study suggest that metaknowledge about the cultural norms of science plays a role in the executive control of group knowledge construction and supplements existing rationales for fostering students' understanding of the nature of science.

Hogan (2001) also studied the construction of collective metacognition from an interactive system perspective. In her intervention, a group is regarded not as a collection of individuals, but rather as a whole organism that regulates production of a common knowledge product. "Instead of the neural connections that link nodes of information within an individual mind, they were communication processes and social structures that enabled the flow of information among members of a group, and indeed determine what a group can accomplish."

(p.201). The findings of the research suggest that in group discussion, students can collectively plan, including regulating their task performance; monitor, including comments on the status of groups' understanding; and evaluate, including evaluating others' ideas –positively more than negatively. More specifically, Hogan stated that “neither a grouping of individual students' metacognitive competencies, nor individuals' metacognitive competencies plus their group communication process, constitutes collective metacognition” (p.233). Instead she suggests three interrelated components of collective metacognition: individual group members' metacognitive competencies, plus the communication processes and implicit rules for interaction by which a group shares and works with one another's metacognitive statements, plus the institutional and cultural norms that are internalized by the group as meta (both metacognitive and epistemological) knowledge. She claims that “it is meta-knowledge about the standards and practices of a science that makes metacognition in groups not simply transactive, but collective.” (p.233) It was concluded that cultural norms are dimensions of the meta-knowledge that students use to guide their collaborative construction of knowledge. She found that “as students participate in the practice of science, it is not just the practices themselves that structure their learning, but also their metacognitive representations of the standards embodied within the practices. The interplay of this shared metacognitive knowledge with metacognitive regulation and group communication processes constitutes collective metacognition” (p.236).

Hogan's studies, particularly “Collective Metacognition”, support the assertion that metacognitive regulation of cultural norms/standards can be successfully used when they are embodied within the learning practices. In developing the MCM, I also follow the same approach.

## **Approaches for Social-Emotional Development Using Metacognition**

Over the past few years, an increasing number of social-emotional learning (SEL) studies have been conducted that account for a clear focus on metacognitive strategies and self-regulation (Gutman & Schoon, 2013; Zhou & Ee, 2012). This research has mostly been supported by non-profit organizations such as the Collaborative for Academic Social and Emotional Learning (CASEL), a non-profit organization that has been working to advance the science and evidence-based practice of SEL in the United States since 1994. In 2008, CASEL reported results of three large-scale reviews of research on the SEL programs for elementary and middle-school students, which included 317 studies and involved 324,303 children. Findings showed improvement in children's behavior and attitudes toward school and academic achievement (Payton et al., 2008). There is similar research supporting SEL in the United Kingdom, by the Social and Emotional Aspects of Learning (SEAL) network. This network has also conducted comprehensive, school-wide research in order to foster the social and emotional skills that are thought to reinforce effective learning, positive behavior, regular attendance, and emotional well-being" (Humphrey et al., 2008). This research was first implemented as part of the National Behavior and Attendance pilot in 2003, and the piloted approach has been used in many primary schools across England (Humphrey et al., 2008). Both CASEL and SEAL recommend that well-designed programs that simultaneously foster students' social, emotional and academic growth be widely implemented in schools. The following is one of the studies that was conducted to examine the impact of collaborative group work in small children (at age 5) on the development of their individual metacognitive processing in science.

**Self-Explanation and Self-Evaluation.** Larkin (2006) used qualitative analysis and case study methods to study collaborative group work and the individual development of

metacognition in two five-year-old children, Cloe and Oliver, over an academic year as they engaged in a cognitive acceleration through science education program CASE@KS1. CASE interventions were structured based on Piagetian stage development theory combined with a broad Vygotskian framework emphasizing the social construction of knowledge and thinking. Metacognition was emphasized through group discussion. The children were encouraged to become conscious of, and to reflect on, their own thinking. These interventions were embedded in various science activities such as investigating the cause of shadows, deciding whether bottles filled with more or less rice will roll down a slope more quickly and using this rule to predict the result of other bottles. The teacher's role during the activities was to encourage social construction of ideas while monitoring children's thinking and facilitating negotiated solutions. Larkin's findings revealed that as the year went on, these two students' (Chloe and Oliver) confidence increased in group situations, and their metacognitive processing began to become overt and more influenced by their peers. Both Chloe and Oliver used the group situations to test and explain their ideas, and to evaluate each other's ideas. Larkin found that the collaborative group was an essential condition for this growing awareness. It was within the group situation that Chloe was made to be explicit about her ideas. Thus, she learned that she needs to reflect upon these ideas and to have them clear in her own mind. Chloe also learned that other people's comments and reactions to her ideas could prompt her to clarify and modify them. Realizing that she didn't always understand what she had said was an important aspect of monitoring and controlling her thinking. Larkin says: "asking questions of oneself can begin questioning by others". She adds that the "collaborative nature of the group supports these children in learning the social skills of listening, contributing and sharing, and it also impacts upon their individual ways of thinking." According to her, using qualitative analysis and case study methods

demonstrate how collaborative group work with small children impacts on the development of their individual metacognitive processing.

This study is useful because it demonstrates how very young children can develop metacognitive ability by means of self-questioning, self-explanation and self-evaluation. The author highlights that the metacognitive collaboration played a role in developing social skills, particularly listening, contributing, and sharing. The collaboration also aided in the development of students' placing importance on individual ways of thinking. Such abilities will be useful for them in the future, as they will positively impact their academic and social learning. This information is valuable because it shows how self-metacognition competencies influence students' social action regulation, which positively impacts the quality of learning interaction. The MCM includes such metacognitive questions in its structure because I am interested in helping students develop such metacognitive competencies.

### **Approaches for Metacognitive Assessment Construction**

**Thinker Tools and Reflective Assessment.** In 1994, White and Frederiksen created a technology-enhanced curriculum in an attempt "to transform a science classroom into a research community whose objective is to 'discover' the laws of force and motion"(White & Frederiksen, 1998, p.10). The curriculum was centered around a metacognitive model of research called "The Inquiry Cycle" and a metacognitive process called "Reflective Assessment" in which students reflect on their own and each other's' inquiry. The researchers worked with suburban K-7 and K-9 students, establishing experiment and control groups to compare the effect of the Reflective Assessment process. During the study, students were encouraged to work in teams, using the Thinker Tools Inquiry Curriculum (White & Frederiksen). The students were provided with multiple conceptual tools, such as Thinker Tools software that enabled them to interact with

Newtonian models of force and motion. Using Thinker Tools, the students could also do a variety of experiments and game-like activities to discover the laws that govern the simulated world, and by extension, our own. By providing students the means to gain “Inquiry Expertise” as well as “Physics Expertise,” the researchers aimed to support students to develop an explicit, written conceptual model of how forces affect motion. The students were provided with a “research guide,” with which they were encouraged to follow the scientific inquiry cycle of questioning, predicting, experimenting, modeling, and applying. The research guide included four phases: creating a plan, doing the experiment, analyzing the data, and presenting conclusions. In each phase, the students were asked to be reflective about their understanding of science, the inquiry process, and their productivity in a social context. The result of the controlled comparison revealed that the students’ learning of inquiry was greatly facilitated by introducing the Reflective Assessment Process. This process also fostered an improvement in the quality of students’ research projects and inquiry test performance over that of students in the control classes.

Another important finding of the study was the positive effect of the Reflective Assessment process on lower-achieving students, who were found to score higher on the inquiry test after engaging in this reflective process. White and Frederiksen observed that if lower-achieving students in experiment classes did their research in collaboration with higher achieving students, lower achievers performed as well as the higher achievers; whereas in the control classes, lower achieving students did not do as well as higher achievers. Hence, this intervention proved helpful in closing the performance gap between the lower- and higher-achieving students.

During interviews, classroom teachers reported that through the tools provided in this research study, students acquired an understanding of the Inquiry Cycle, as well as the

knowledge needed to carry out each step in this cycle. Teachers who participated in the project also added that students acquired knowledge of how the development of scientific theories is related to empirical evidence. Furthermore, students acquired the metacognitive skills of monitoring and reflecting on their inquiry. Results of this study demonstrated the accuracy of White and Frederiksen's hypothesis that "the reason students have difficulty with science, particularly with physics, is not that they are too young or lack intelligence, but rather that they simply do not know how to construct conceptual models of scientific phenomena and how to monitor and reflect on their progress" (p.5).

White and Frederiksen provided an engaging science learning environment through the technology-enhanced Thinker Tools Inquiry Curriculum program. By design, students were encouraged to work collaboratively. They applied the Inquiry Cycle in their science activities while reflecting on their academic and social understanding and performance during the Reflective Assessment Process, which created an extensive feedback process. This process was useful for students to monitor their comprehension in understanding the Inquiry Cycle as well as the physics concepts, while paying attention to their social interaction and group dynamics. However, it was reported that while students benefitted from this process in their academic achievement, they complained about "too much reflection," and "too much repetition."

I find this study highly informative for my work and parallel to my perspectives. The authors' hypothesis that students can better understand science, regardless of their age, if they are able to construct conceptual models of scientific phenomena is in complete alignment with mine as I am a formal physics teacher. I strongly believe that developing accurate conceptual understanding of subject-matter is crucial for student progress in science learning. One can argue that constructing an explicitly written-down conceptual scientific model itself can be considered

as a metacognitive process, as it requires monitoring of and reflecting a self-understanding. Additionally, their findings that the Inquiry Cycle as well as the Reflective Assessment process provided students with a perspective to have a better grasp of scientific understanding and help them make the necessary connections between the scientific theories and the empirical evidence confirm my own ideas. Specifically, they confirm the ideas I discussed previously about the importance of how scientific theories, or theory of minds, must be tested, or an accurate source of knowledge must be sought, and how this is an initial step necessary for the following: students to develop further willingness to learn science disciplines.

In addition, White and Frederiksen's study results that showed students' being able to develop better conceptual understanding through the Inquiry and Physics Expertise they gained throughout the process. This result shows that the learning environment evolved out of such processes allowed students to focus on their learning process. Having a chance to examine the Thinker Tools software program myself, I am not surprised that such an inquiry-based, fun, yet, functionally structured curriculum made it possible for students to tune in to collaborative metacognitive learning.

Their finding that the reflective assessment process can be helpful to raise a lower-achieving students' academic achievement through raising their conceptual understanding by communicating with a higher-achieving peer is evidence that highly supportive of my hypothesis as well.

What I find critically useful for my work however, along with the previously summarized significant findings White and Frederiksen provided with their 1998 study, is their finding about students' feedback that they were overwhelmed by the amount of repetition and reflection that they were expected to engage in during the study. This finding is not surprising, considering that

the subjects of the study were composed of students in grades K-7 and K-9, a group who is generally not used to monitoring and reflecting upon their academic and social progress. It is inferred from this finding that such repetitive processes are not yet habits of mind for those students.

I applied this finding to my work to overcome such a situation by asking my Grades 3-5 students, prior to introducing the MCM, to report daily, over the first three weeks in a personal dairy, answering semi structured questions while listening to soft music. In addition, as added incentive, when I introduced the more formal though similar metacognitive assessment process, the purpose of which is to develop metacognitive competence in governing students' SIL, I presented the entry and exit tickets as another form of a personal diary. My aim in approaching the assessment process in this way was to help my students feel like continuing to share their personal dairy, each time we get together. Through presenting students with this mediational personal ritual, I hoped to introduce the notion of how to monitor and reflect upon one's social and academic progress. My ultimate goal was that this process of introduction to repetitive self-reflection would becoming their norm at an early age by internalizing the process incrementally so as not to feel overwhelmed.

In White and Frederiksen's study, along with a similar cycle of planning, doing, analyzing, and performing, students also worked collaboratively and shared self-reflective feedback and peer-feedback. In their research, providing feedback to team members after their presentations created space for students to self-reflect in their interviews. This feedback cycle, called the Reflective Assessment process, was effective in developing students' metacognitive knowledge and skills. Earlier, Brown and Campione (1996) followed a similar approach in the Fostering Collaborative Learners' design by creating the Research, Share, and Perform routine in

research-like science activities that included a cycle of planning, preparing, practicing, teaching, and exhibiting (Brown & Campione, 1996 in Schauble & Glaser, 1996). For my study, I designed a similar feedback process into the execution process, whereby my students are asked to actively work together in a project-based learning environment.

**Anchored Inquiry.** Vye and her colleagues (1998) attempted to facilitate a process of in-depth inquiry by supplementing anchored instruction with SMART environments (Scientific and Mathematical Arenas for Refining Thinking). By providing SMART design resources to 5<sup>th</sup> and 6<sup>th</sup> graders, the researchers aimed “to encourage self-assessment, reflection, and revision by students as they pursue the goal of preparing to function in these environments” (Vye, Schwartz, Bransford, Barron, Zech, in Hacker et al., 1998). The learning goal was understanding rivers as ecosystems, and how and why to monitor their health. The curriculum was divided into four phases. Students were provided with opportunities to develop a mental model of river testing, and then they proceeded to do the testing in a real river environment to decide how to clean up a polluted river. Several purposefully created computer enhanced learning tools were used, including a specially recorded anchor video (“Stones River Mystery”), a software catalog, a “World Wide Web” formative feedback environment, as well as a “Kids online” peer-feedback environment, in which students as a class were asked to provide feedback for other students who worked in the same project. These tools were developed to a) discover what students need to know; b) make students’ thinking visible so they could receive feedback; and c) help students revise their previous plans, after receiving feedback.

The researchers’ findings indicated that the catalogs, which are the guides including the resources, helped students detect gaps in their knowledge and communicate their thoughts with one another. Students treated these catalogs as resources, using them extensively; they read the

catalogs from beginning to end. However, “the students had rarely had occasions to use text resources.” Accordingly, the researchers concluded that it is possible to enhance students’ metacognitive skills if students are provided with greater opportunities to participate in classroom activities that clearly support the use of particular strategies. It was also reported that SMART environments provided multiple opportunities for feedback, reflection and revision. For each phase of the river monitoring project, students could go to the SMART feedback website and then revise their work. Students also had an opportunity to hear the ideas of “Kids Online” participants, and to craft responses to these participants and see what they did with the information. During this process, students were highly motivated to help their peers, which created a rich discussion environment within the class. Vye et al., wrote that “the ‘Kids Online’ provided models of revision that were especially salient and important to the children in the class.” It was also noted that, although teachers were content with the previous river curriculum, after seeing the big picture of what projects could become, they realized how much they had been missing. Interview results with students indicated that students had done some revision and were able to specifically cite at least one change they had made during and as a result of the project. While the interview results suggested that the feedback had helped students revise, it was reported that the teacher thought “the feedback was not specific enough to enable students to know what to do.” Researchers noted that they deliberately designed the feedback in this way, as they aimed to place some of the assessment responsibility in students’ hands. In order to check if the students were provided with “a sufficient scaffold” for this to happen, another interview was conducted, this time focused on the feedback. Also, students’ actual feedback data was compared to what students had reported. These data indicated that “students were reading and thinking about the feedback they have received, contrary to teachers’ impressions.” Based on the overall

interview results, it was reported that “revision had been made very salient for students, and that the classroom was ‘information rich’ in supporting the process”. Furthermore, “all students were able to use some aspect of their feedback to improve their work” (p. 346).

Vye et al. (1998) report that they did not explicitly prompt to engage students in reflection. They conclude that it is possible that the scaffolds and feedback support in SMART made it unnecessary to also engage in structured self-assessment, but they left open the question of whether adding structured self-assessment might make the effect of SMART even stronger (Vye et al., in Hacker et al., 1998, pp.305-346).

This study was effective in implicitly encouraging students to share their thoughts and receive feedback from each other and from the “Kids Online” program. This caused the students to fill in their knowledge gaps by using the purposefully structured catalog, in which they could find directions to follow. This project provides a significant information about how peer and online feedback promotes such a dedicated metacognitive monitoring and revision cycle in students’ learning process.

It is also inferred from this study that through SMART environments, students were highly involved and engaged in team learning. I strongly believe that including self-assessment procedures as a core process will further strengthen the overall collaborative learning process. The self-assessment procedure, when used adequately, enables students to self-monitor and self-question about their own academic and social progress, while checking their team’s progress at the same time (Baykent, 2002, 2010). This aspect is also necessary in developing a healthy metacognitive self-awareness capacity.

## **Pedagogical Practices to Support Classroom Cultures**

Herrenkohl, Tasker and White (2011) also used the Thinker Tool, later named Web of Inquiry (WOI), to develop students' scientific inquiry and metacognitive knowledge and skills. Through this web-based inquiry project environment, students were aimed to engage in scientific inquiry projects to develop and test their theories and alternative hypotheses. The study took place in two K-5 classes in the Pacific Northwest. Teachers introduced the WOI, and the classes conducted projects on the following subjects: landforms, pulleys, and solar energy. Most students worked in pairs or in groups of three, all sharing one laptop. Teachers worked with students in a combination of whole-class and small groups. Students kept science journals in addition to the WOI online notebook. Peer feedback was included across classes.

The researchers' findings indicated that the WOI self-assessment and peer-feedback practices supported meta-level thinking. Both teachers required their students to make connections between theory building, alternative hypothesis, experimental design and data analysis. According to the researchers, this "supported students' deepening understanding of the nature of science inquiry" (2011). Herrenkohl et al. also added that throughout the process, the teachers continuously interacted with their students via asking questions about their ideas, probing further with key questions, verifying that they understood student ideas, and immediately using the information to help guide instruction. It was reported that this routine often involved meta-talk, and through such language that encouraged students' metacognition (Leinherdt & Steele 2005, in Herrenkohl et al., 1999b). They also noted that an intellectual climate arose from these teacher-students' interactive practices, in which any question served as an opportunity for thinking. In addition, as students were providing required peer-feedback, they were engaging in meta-talk. This was a similar outcome of Herrenkohl's earlier studies

(Cornelius & Herrenkohl, 2004; Herrenkohl & Guerra, 1998). In Herrenkohl's and her colleagues' earlier work, the researchers analyzed the different strengths that the teachers brought to their instructional practices. For example, one teacher was privileging the work of nature scientists and focusing on developing epistemic doubt in her students, while the other teacher, by regularly re-voicing her students' comments, created an intellectual climate that valued and respected everyone's opinion. Researchers claimed that "these pedagogical practices supported student thinking, including students who initially needed the most support as well as students who started at a proficient level" (2004).

Herrenkohl et al. (2011) did not make any specific claims about what more helpful aspects of the instruction for student learning would be. They emphasized the importance of each aspects' being helpful when functioned in concert. This learning environments being systematic in nature also fit the FCL approach. They concluded that it may be the model of inquiry together with effective teachers, as well as a range of pedagogical strategies which included students in providing feedback to one another could have proved to be successful, and thus, they stated that it is not possible to isolate particular practices as inherently more effective than others (Herrenkohl et al., 2011).

This study provides a valuable insight with how self-assessment and peer-feedback can engage students in scientific discourse metacognitively, by means of meta-thinking, and meta-talk. During the study, students were engaged in thinking about their thoughts (meta-thinking) as well as thinking about their talk (meta-talk). This was supported by means of the environment created by the WOI self-assessment and peer-feedback structure. This situation sets another good example that shows the advantages of providing students with a structured-scaffolded science discourse environment. In the structure of the MCM, I included self-assessment and peer-

assessment protocols for helping students to govern their actions in a way that helps them tune their attention into their learning and their further engagement with scientific discourse.

### **Metacognitive Approaches in Developing Self-Regulated Learning**

Please note that as I highlighted in the introduction paragraph, I attempted to examine self-regulation concept to better understand the development of metacognitive control mechanism, which is considered metacognitive regulation, or secondary cognition. As a result of my research, I strongly believe that to develop metacognitive competence particularly for governing SIL, metacognitive awareness, and knowledge construction should be well-established prior to attempting to develop metacognitive regulation. Then the regulation capacities are built on such a strong foundation through well-structured practices in the light of such awareness and knowledge.

I chose to use Zimmerman's four-phased SRL training model in order to establish such metacognitive regulation (explained in below sections). It is because the model embedded various metacognitive tools and strategies that are helpful such regulation capacity built.

Therefore, in the following sections, I share my research review about the SRL from this point of view. I also share my search on how SRL is used for coregulated learning as the broader objective of this dissertation seeks for a convenient methodology to reach for co-empowerment through self-empowering individuals.

Thus, I include the definition and brief history of self-regulated learning (SRL), where I examine the studies (i) prompting active metacognition through SRL training, (ii) the effect of nature of science metacognitive prompts on science students' content and nature of science knowledge, metacognition, and self-regulatory efficacy, as well as (iii) self-regulation empowerment program: a school-based program to enhance self-regulated and self-motivated

cycles of student learning as well as (iv) effective self- and co-regulation in collaborative learning groups.

Research on self-regulated learning (SRL) initially focused on students' development of metacognitive processes such as self-monitoring, self-evaluating, and strategy-use (Borkowski, 1985; Brown et al., 1983). The metacognitive processes directly affect SRL (Boekaerts & Cascallar, 2006; Schwartz and Metcalfe, 1994, in Metcalfe & Shimamura, 1994). According to Zimmerman (1989), metacognition provides a mechanism for students to regulate their cognition and learning. Research suggests that reaching of high-levels of academic achievement requires a self-regulatory dimension of competence in addition to metacognitive competency and high-quality instruction (Zimmerman & Kitsantas, 2005). Zimmerman suggests a Four Phase Developmental Model, with which the following self-regulation skills can be proactively developed: observation, emulation, self-control, and self-regulation (Zimmerman, 2000a). The observation phase occurs when a student notes the process of a model throughout a specific task, whereas the emulation phase occurs when the student attempts to be like the model and receives support. The self-control phase occurs when the student independently uses the strategy in a similar context, and the self-regulation phase occurs when the student can adapt the use of strategy across changing conditions. Empirical tests of the four-phase model have supported the notion that each phase should be developed in order (Zimmerman & Kitsantas, 2005).

### **Prompting Active Metacognition through Self-Regulation Training**

Based on a claim about the most of the research in the field of metacognition and science being focused on listening to a group conversations or students' talking aloud about their thinking (see Blank, 2000 in Peters & Kitsantas, 2010), this research study focused on a proactive approach to using metacognition for SRL training.

In this study, Peters and Kitsantas (2010) examined the effectiveness of a developmental intervention, using “Embedded Metacognitive Prompts based on the Nature of Science (EMP NOS). EMP NOS consists of checklists and questions organized into four developmental phases, which are strategically placed into lesson plans. Each set of metacognitive prompts represents ideas from one of the seven aspects of the nature of science; module one focused on empirical data, module two focused on laws and theories, module three focused on peer review and data collection, and module four focused on creativity.

It was hypothesized that students who used explicit metacognitive strategies could evaluate their thinking to determine if it aligns with the rigorous requirements of science. It was also hypothesized that there would be positive correlations among content knowledge, knowledge about the nature of science, metacognition, and self-regulatory efficacy. Another hypothesis was that students exposed to EMP NOS would report a higher level of content and nature of science knowledge, metacognition, and self-regulatory efficacy. The experimental group was given the metacognitive prompts that explicitly required them to check their work for alignment to the chosen aspect of the nature of science. The control group was not excluded from learning about the nature of science, but the intervention was designed so they could learn implicitly, in the following ways: by basing summaries on the evidence (empirical), by making the cognitive leap from observations to conclusions (creativity), through discussion of ideas in groups and comparing ideas across groups (social), through the use of tools to measure and collect data (technology), by changing their ideas based on other students' evidence (tentativeness), and by developing their own data tables and methods of organization (habits of mind). All participants were asked to respond to several tests (content and nature of science knowledge) and surveys (metacognition and self-regulatory efficacy). Along with the tests,

participants were interviewed. The researchers hypothesized that the experimental group would outperform the control group in all measures. They found a partial support for the hypothesis, including significant gains in content knowledge and nature of science knowledge of the experimental group over the control group. Qualitative findings revealed that students in the comparison group reported scientific thinking in similar terms as the scientific method, while the experimental group reported that scientists were creative and had to explain events using evidence, which is more closely aligned with aspects of the nature of science. Peters and Kitsantas suggest that EMPNOS may be a useful classroom tool in guiding students to monitor their thinking for alignment with the nature of science.

Utilizing Zimmerman's four phase model was effective in Peter and Kitsantas's study, as it provided a solid framework for SRL training with embedded metacognitive tools/strategies. However, the metacognitive process could be incorporated in more engaging and perhaps capturing ways for students to better adapt and improve their self-regulatory efficacy, like in the previous studies (Hacker et al., 1998; Herrenkohl et al., 2011; Hogan, 2001; White & Frederiksen, 1998).

This study, however, very well highlights the importance of metacognitive knowledge development in SRL by embedding the aspects of nature of science as the expectations in the metacognitive prompt approach. With this approach, researchers provided a set of questions and checklists that encouraged students to think like scientists in their responses, and to monitor by means of observation, emulsion, control, and regulation phases. This in turn allowed the researchers to understand how students learned what they learned. Students were required to reflect on their thinking and learning progress. This reporting aspect in students' progress is similar to White and Frederiksen's 1994 study, with which they structured the content and

teamwork base reflective assessment questions for the 7th graders in the web of inquiry science classes.

While developing the MCM, for the part in developing metacognitive control, I referenced Zimmerman's four-phase metacognitive model particularly the observation, emulsion, control, and regulation phases. Like Peters and Kitsantas (2010), I also embedded the nature of science (NoS) aspects into the application of my curriculum by asking students to not only show evidence when they re-state their understanding of a content-matter, but also provide reference, and I asked them to include anecdotes from their daily lives if they need to provide a report or presentation (culturally, scientifically and socially embedded learning aspects of NoS). When the content is appropriate, I engaged my students in collecting data and measuring to prove their findings and understandings using mathematical and scientific technological tools (empirically and technology aspects of NoS). I provided an environment for them to use their creativity in sharing their progress as well as creating final presentations by using various technology tools that I was teaching along with the science subject-matter in this after-school STEM program. These tools included the Scratch software animation program, PowerPoint, web development, Word-doc practices, and robotic programming. I encouraged students to prepare their presentations in an artistic as well as attention-and joy-capturing way to reflect their care and joy in learning these subject-matters (creativity as well as human inference aspects of NoS).

Meanwhile, by training and engaging students to regulate their learning and social actions, I fostered a number of positive learning interactions. These included rich discussions of ideas in groups as well as the comparison of ideas across groups, and the exchange of ideas based on each other's evidence (social aspect of NoS). In this exchange of ideas, I stressed the importance of being resourceful, of checking the accuracy of their ideas with other references

such as an internet search, the teacher, or books before saying that they know a particular subject (tentativeness aspect of NoS). By allowing students to use such a variety of methods and guiding them developing their own data tables and methods of organization (habits of mind aspect of NoS), I allowed them to develop their own authentic individual and team products. I provided a game-like environment (using role-giving, role-playing) which gradually turned into more disciplinary engaged learning community by means of these methods.

For the MCM, I extended the observation phase of Zimmerman's by adding three levels of layers to it, in an attempt to provide a structured scaffolded pathway for students to develop self-awareness capacity. Through the protocols I developed throughout the model, I aimed for my students be able to pinpoint accurately whether they are on the correct learning path or not and be able to make the necessary shift to get back into a genuine mood for learning within our dedicated time as much as possible.

During the phases of the model, I also included various content focused quizzes, tests and presentations, as well as surveys focused on metacognitive self-assessment to elicit students' understanding of science content and to capture the level of students' awareness and metacognitive regulation/self-regulation capacity in their learning actions.

### **Self-Regulation Empowerment Program**

This program is based on Zimmerman's Cyclical Model of Academic Self-regulation. It pursues empowering middle-school students by fostering positive self-motivational beliefs, increasing their knowledge base of learning strategies, and helping them to apply these strategies to academic-related tasks in a self-regulated manner. The program has a self-regulated learning coach, who is "the change agent" that provides explicit training in the cyclical, feedback loop of self-regulation developed by Zimmerman Zimmerman (2000b).

In their Self-Regulation Empowerment Program (SREP), Cleary and Zimmerman develop a training program based on social-cognitive theory and the problem-solving-model with key self-regulation processes from Zimmerman's (2000) dynamic feedback model of self-regulation. This program "focuses primarily on empowering students to become self-directed problem solvers whereby they proactively set goals, monitor performance processes and outcomes, evaluate their performance, and then make strategic adjustments to improve their performance" (Cleary & Zimmerman, 2004, p.549). It aims to help school professionals to use empowerment in order to engage middle school and high school students in more positive, self-motivating cycles of learning.

In the interventions, graphing, cognitive modeling, cognitive coaching, and structured practice sessions are included. In their two-part approach, self-regulated-learning coaches help students to use micro analytic assessment procedures to assess their self-regulation beliefs and study strategies, and train students to use these strategies in a cyclical, self-regulation-feedback loop. Their actual study took place in a math class. As a result, this training helped students to set goals, select and monitor strategies effectively, make strategic attributions, and adjust their goals and strategies. They suggest that this program may have positive effects on students' achievement and motivation. Along with the other outcomes, the authors note that "empowering students to become more self-directed learners and helping teachers and parents further develop these skills in their children can significantly increase students' motivation and achievement in school" (in Cleary & Zimmerman, 2004, p.549; Zimmerman, 1989).

This study is an excellent example of self-empowering students through developing setting up goals and selecting and monitoring study strategies by means of self-regulation-and-feedback loop.

## **Metacognitive Approaches in Developing Co-Regulated Learning**

In this section, I first include a study about co-regulated learning. After that I briefly define co-regulated learning (CRL) and shared-regulated learning, where I comparatively examine self-, co- and shared-regulation as well as the coaching approach I followed in MCM to support collaborative learning.

### **Effective Self- and Co-Regulation in Collaborative Learning Groups**

This study analyzes how students regulate their problem solving of authentic interdisciplinary tasks (DiDonato, 2013). While it focuses on developing use of self- and co-regulation of cognition, engaging students with collaborative interdisciplinary authentic tasks as a context, it does not examine behavioral regulation process as it is included in the Zimmerman (2000) and Pintrich (2000) study. DiDonato worked with 64 middle school students. Students were engaged in teamwork to design and carry out an authentic, disciplinary project over a nine-week period. Before the project began, the students participated in team building activities to build cohesion and interdependence among group members as described by Cohen (1994). In the following week, students constructed a group collaborative collage by sharing their interests and deciding on a common possible subject for their projects. They also received group binders, in which supporting materials to structure the development of their projects were provided. The expectations for group members using those materials were to (1) describe their projects in narrative form, (2) help students identify their learning goals for their learning projects, and (3) keep a record of their long-term plans as daily, weekly and monthly calendars were included. Students were given SRL and CRL questionnaires. For the SRL questionnaire, Goddard's method of changing the self-efficacy scale to a collective efficacy scale by replacing "I" with "We" was followed. For example, "Before we started working on our project, I set goals to guide

what steps I will take” was restated as “Before we started working on our project, we set goals to guide what steps we would take” (DiDonato, 2013, p.34).

Co-regulation is about interactions between two or more peers that coordinate the SRL (self-regulated-learning) process (McCaslin, 2009; Volet, Summers, & Thurman, 2009). This process has been studied over a range of interactions, from students acting as others’ regulation to shared regulation (Panadero & Jarvela, 2015; Rogat & Adams-Wiggins, 2014). The idea of co-regulation is derived from Vygotsky’s internalization concept (Vygotsky, 1962).

Palinscar and Herrenkohl highlighted Vygotsky’s observation notes, which reveal that thought manifests itself within socially mediated activities, and the purpose of inquiry is to examine how the learner internalizes processes learned in social activities (in DiDonato, 2013; Herrenkohl et al., 1999b). According to Vygotsky, cultural objects, language through social interactions provides opportunities to interact with more knowledgeable others (MKO), and which provides opportunities for the transfer of knowledge or skills (1962). Rogoff, on the other hand claims that knowledge and skill development are not transferred to learners; rather, learners are guided and participate in the process (1990). Rogoff extended Vygotsky’s theory by introducing the term “guided participation,” which is a construct which assumes that “both guidance and participation in culturally valued activities are essential to children's apprenticeship in thinking” (p. 8).

I tried to create a guided participation as Rogoff describes. To do so, for the MCM practices, I developed protocols as guidance for the students to participate in consistently and regularly as possible to develop knowledge and skills to govern the SIL.

As they are not accustomed or used to otherwise, I strongly believe that students must be guided to learn how to turn their spotlights onto themselves in order to check the accuracy of

their standpoints, their perceptions, their understandings on not only for the concept matters but also for their thoughts, feelings, understandings and actions. This is for the time being, while students are developing the required habit of mind, and will power to utilize the knowledge and capacity they are gaining, in an utmost level. I believe, once this knowledge and understanding harmonized with the periodical practices that are required ( which aspect should be also considered as guidance), eventually students be able to better refer to their own perceptions to make more meaningful assessments as well as connections with their prior knowledge and thus better associate with their peers while brainstorming, inquiring any subject matters through debates and discussions.

This way, students will appreciate their own and others' theories, ideas and sense making processes, also better perceive scientific thinking as an ongoing mechanism to improve their understanding at a time. This approach should help them to be more scientific thinkers, and be useful in developing a self-assessment mechanism, through which they can refer to before acting upon any of their thoughts during learning individually and collaboratively.

To elaborate, when using various tools that are related to one occurrence, you may be able to observe your perception difference as well as validating your analysis.

To help my students be more accurate on knowing how they think, act and interact, via the MCM, I tried to help them leave their negative pre-judgements aside while learning. I also introduced them about possible internal and external stimuli (see Chapter 1), may be influencing them against their individual and/or team learning.

In sum, I needed to develop a systematically functioning tool to help students first *discern how they perceive the world around themselves* and then *realize what is really going on*. *Then, notice if their perceptions are consistent with what the enacted reality*. Next to help

developing the needed mechanism that help them *to develop the necessary will-power* to act upon it to improve their learning potential at a time within and others. Thus, I developed the protocols to fulfil this aim.

Finally, I tried to create an engaging environment where they can *learn to become a gracious mirror for their own and for their peers*. I included self- and peer-coaching in the protocols of the MCM. According to those protocols, coaching is about becoming a gracious mirror of oneself and of others in order to inform each student about the way that thoughts manifest in action and interaction. This approach aims to provide other pairs of eyes to make each student aware of themselves and their peers to support team success by taking charge of their responsibilities more carefully while self-governing their learning influences, through regulating their mood, goal framing and academic and social actions.

For the interaction part however, I tried to follow exactly what is described in Vygotsky's approach and formed teams of students by mixing more knowledgeable and less knowledgeable students, so that each student was teamed with MKO and LKO. For this model, as the focus was training students to appropriately govern their learning influences, I determined which students were in the MKO and LKO categories based on their current capacities for regulating their learning influences. Higher capacity in this area was usually associated with being an academically higher achiever. I placed students in these categories using surveys, interviews and field observation notes as well as the pre-academic test results that I conducted my two classes before the application of the MCM.

The goal of self- and peer- coaching was to provide friendly feedback as well as self-assessment tools to find out about themselves, and most of all to regulate the self-actions. While self-coaching functions for the students to develop a capacity to observe themselves as if they

were outsiders, peer-coaching serves as a friendly yet realistic, objective and thoughtful mirror to make the other party realize how they were actually acting. Peer-coaching assumes that many actions are due to the force of habit, that their origin is almost subconscious, and that people are not necessarily aware of how they are acting (Medina, 2008).

The coaching approach in some ways is similar to the idea of shared regulation, which is when group members assume responsibility to jointly regulate activities. Didonato says that “(it) is conceptually similar to co-construction of knowledge” (2013, p. 29). As examined by Vauras et al. (2003), when the authors applied shared-regulation within high-ability fourth grade students who were working on solving mathematical problems collaboratively in a computer-supported-gaming environment, they found that effective high-quality learning took place as the students made use of deep-level of strategies on the nature of the task at hand as well as transfer of learning. Although they conducted different studies later on (Rogat & Linnenbrink-Garcia, 2011, 2013), in their 2007 studies, Kempler and Linnenbrink-Garcia examined the shared regulation approach among sixth-graders working on mathematics units collaboratively. In it, they stressed that although the groups employed strategies to regulate each other’s cognition and behavior, the quality of those processes were predominately low-level. For example, they found out that a brief reminder to re-engage in the task or efforts to take over a fellow team member’s task responsibility without providing explanation or feedback did not help deepen the students’ understanding of their responsibilities. Hurme and Jarvela also found similar patterns (2005), and Didonato also found that the co-regulation was mediating the self-regulation (2013).

These studies were highlighting that high-quality co-regulation may not be guaranteed. In the MCM, allowing participants to go through a four-week training process that aims to raise awareness in students’ minds as well as ignites the development of a conceptual understanding of

how a successful learning community is established, how it works, why it is important to their learning, and what each participant's role is, is crucial.

*Participant* in this case refers to both students and teachers – a critical element in my argument. During this process, helping students well-define their *learning orientations*<sup>5</sup> is vital. Particularly helping them become “self-referenced”, proactive learners, while also helping them become aware of the consequences of being "other-referenced," dependent learners, is a crucial element in the training part of the MCM.

As a result, my goal was that, this deeper understanding would help students to be more willing in taking responsibility for developing environments in which participants are able to truly focus on their own learning and grow as more effective learners, while also supporting each other's learning by allowing space for one another. Moreover, by communicating and inquiring about their understanding with each other, I hope to help students improve their learning both individually and collaboratively through the application of the MCM.

### **Further Learnings from the Previous Studies**

Thus far, I outlined the metacognitive approaches in terms of their effects on cognitive and regulatory knowledge and skill development in learning, particularly in science and scientific inquiry in STEM field. I highlighted their contributions in my understanding in developing the MCM. These research studies indicate that through various technology enhanced designed systems, it is possible to engage students in science and scientific inquiry while developing their metacognitive knowledge and skills (e.g., Vye et al., in Hacker et al., 1998; Herrenkohl et al., 2011; Slotta & Linn, 2009; White & Frederiksen, 1998). I covered some

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<sup>5</sup> I classified learning orientations under two categories: *self-oriented learning* and *others-oriented learning*. In *self-oriented learning*, one focuses on bettering ones' capacities for the purpose of achieving overall well-being and self-empowerment in the long run. In contrast, in *others-oriented learning*, one focuses on learning as a means to feel content in the short run by “winning” via grades, credits or rewards, or beating others for the top spots.

studies that targeted not only students' individual metacognitive knowledge and skill development but also their collaborative knowledge construction in social-cultural learning settings (e.g., Cornelius & Herrenkohl, 2004; Herrenkohl, 2006; Herrenkohl & Guerra, 1998; Herrenkohl et al., 1999b; Hogan, 1999b, 2001; Varelas & Pappas, 2006). Some focused on improving students social-emotional development within collaborative science learning environments by means of metacognitive development (Larkin, 2006, 2009, 2010). There were also studies focused on developing nature of science and inquiry through SRL training using metacognitive strategies (e.g., Azevedo, 2005; McKeachie & Sims, 2004; Peters & Kitsantas, 2010).

In the light of previous research studies so far, the latest studies have been shifting from looking at science knowledge and skill acquisition to how this knowledge and these skills are developed. As Herrenkohl and Mertl state:

“Our accounts of learning lack explanatory power when we focus only on knowledge and skills and neglect aspects of students' development as participants who actively negotiate the scientific process.” (Herrenkohl & Mertl, 2010, p.6)

Researchers claim that in order to more fully explain students' actions in the world, there is a need to engage in the processes of development while students, as participants of their learning communities, actively negotiate the scientific process, between interests, motivations, emotional commitments, values, and ways of knowing and doing.

This shift may be occurring due to the observation of teaching practices, in which students tend to participate less when not prompted, and this happens despite the fact that teaching practices are carefully designed to engage students in science. This is illustrated in Herrenkohl and Guerra's study, which examined the complex interrelations among student

engagement, scientific thinking practices, and student role taking and social interaction. Their findings indicate that offering students intellectual roles such as, “predicting and theorizing; summarizing results; and relating predictions, theories and results” as a set of cognitive tools alone was not enough to ensure a high level of engagement in whole class scientific discourse. In order to increase student-engagement, researchers found that it is necessary to re-organize the classroom participant structure, guiding whole class interactions to facilitate a shift in student engagement. Such a shift was elicited by adding a specific audience role assignment during reporting that corresponded to the intellectual roles and required students to check other students’ work (Roles + Audience Roles). According to Herrenkohl and Guerra, combining guidance on the social and the intellectual level worked more effectively to encourage student engagement than only providing the cognitive tools.

It was also noted that with the reorganized structure, the teacher’s role shifted to act more like a mediator who monitors collective understanding within the classroom. In this way, understanding was collaboratively constructed and examined by all members of the classroom community. Therefore, the model that conducted both on a social and intellectual level was considered an example of “distributed cognition and expertise”. There was one more finding of this study: “when specific instructions regarding student audience roles are absent, students tend to assume a more traditional passive stance during reporting” (p. 468).

This study was effective in terms of highlighting the needs for re-structuring science classes, including more socio-cultural interaction to engage students in science discussion. Whereas, when there was no social role, there was not much student engagement. It can be inferred from this finding that students may find the social-interaction aspect engaging, but not

necessarily feel comfortable with commenting on a scientific idea upon which they may not feel knowledgeable enough. Hence, when they don't have to, they may avoid raising their voice.

Science can be considered as a field that requires a keen focus and comprehension to be fully grasped in many cases. Students, particularly at later ages (K-7, K8, and older) may be more conscious due to their lack of declarative, and proximal knowledge, which, according to Hogan can be considered metacognitive knowledge as it includes students' personal understandings, beliefs, and commitments regarding their own science learning and the scientific knowledge (2000). Perhaps, this feeling of inadequacy and inefficacy may be both keeping students from raising their voice in science, and pursuing STEM fields in which understanding scientific concepts is mandatory.

However, in their 2004 study, Herrenkohl and Cornelius examined the participant structure in terms of power in social and disciplinary relationships in a science class. They examined the power structure between students and teachers, among students, and between students and materials such as books, encyclopedias, and online tools. Three cultural tools that were used in the PATHS project with K-6 students found greater success in encouraging discussion around scientific ideas and theories: an audience role, question charts, and the "Sense Maker Board" online tool (Bell & Linn, 2000). These tools also aided in making the process of thinking like a scientist highly scaffolded for students. The "question charts" allowed students a reference in order to figure out what kinds of statements and questions make for better scientific conversations. In addition, "the Sense Maker Board" online tool help student laid out a process for creating students' own theories. Researchers' findings indicate that "these cultural tools gave students important information on how to talk about theories and what the status of a theory truly is as an ongoing scientific conversation. It was also stressed that the new relationships of power

in the classroom (both social and disciplinary) created opportunities and even motivation for students to explore scientific concepts in depth.

### **Developing a Model that Uses Metacognitive Coaching Approach**

Through the applications and findings of the research studies covered in this chapter, I laid out the various metacognitive approaches that were successfully utilized to develop students' metacognitive knowledge and skills in science and scientific inquiry. Reciprocal teaching, read-aloud, self-questioning, and summarizing approaches have been proven effective to improve students' comprehension skills particularly in reading/understanding scientific texts. Thinking aloud and collective metacognition approaches can be useful tools in collaborative knowledge construction, particularly when collective metacognition is established through developing cultural norms and shared meta-knowledge with metacognitive regulation, as well as group communication process. Additionally, self-questioning and self-explanation strategies work well in developing young children's individual metacognitive awareness, and they are effective when applied in a group environment that considers children's sociocultural and social emotional well-being.

For scientific inquiry development, Thinker Tools, a technology enhanced science inquiry curriculum, is effective in helping students learn science through engaging with inquiry projects. The embedded Scientific Inquiry Cycle and Reflective Assessment aspect of the program provides a structured learning environment, in which students and teams are required to plan, execute and report their progress throughout their project. During the process, they are also required to reflect on their understanding and performance. This way, students practice metacognitive skills effectively, while being engaged with the project construction and production. Anchored Inquiry is also an effective system design that supports technology

enhanced collaborative group inquiry by means of adventure-like projects. It was shown that through peer feedback, students can be engaged to monitor, reflect and revise their understanding of the scientific inquiry process as well. In addition to these, there is also a Four-Phase Model that uses metacognition as a tool in self-regulation training. This model is incorporated with metacognitive prompts in each phase in order for students to monitor, reflect and question their thinking and understanding of nature of science while implementing the aspects of the nature of science in their metacognitive prompts (Zimmerman 2001, in McKeachie & Sims, 2004; Peters & Kitsantas, 2010). The tool (EMPNOS) Peters and Kitsantas developed was partially helpful in guiding students to monitor their thinking for alignment with the nature of science.

So far, these metacognitive approaches have been proven effective. They improved comprehension skills, metacognitive awareness, and collaborative metacognition in co-construction of scientific knowledge. Monitoring, self-questioning, reflecting, and revising approaches supported students' understanding during the learning process, and scaffolded activities created a socio-cultural, engaging scientific discussion environment.

The co-regulation study of DiDonato (2013) demonstrated that as learners develop, daily use of collaborative interdisciplinary authentic tasks as a context increased the SRL over the course of the project while the co-regulated learning (CRL) moderated the change in SRL.

In addition to the already mentioned approaches, team metacognition can be used as an approach to help participants “learn to be team members and to function not merely as a collective of individuals, but rather as a cohesive team that learns to learn” (McCarthy & Garavan, 2008, p.510). This is a newly developing area in HRD (human resource development), and it can be an effective tool to support student team work allowing students to produce a common science project.

There is one more aspect that can be effective particularly when combined with SRL, CRL and blended with team-metacognitive process, which is a coaching approach, taken from professional life coaching. Coaching provides “an ongoing partnership designed to help individuals enhance their thinking and decision making skills, improve their interpersonal effectiveness, and increase their confidence in carrying out their chosen work and life roles” (Nixon-Witt, 2008, p.2). Incorporating coaching in a science learning environment can support individuals’ social-emotional and socio-cultural well-being within small groups, as well as in a whole class setting. This in return can increase the engagement in science learning (Cornelius & Herrenkohl, 2004; Herrenkohl & Guerra, 1998; Herrenkohl & Mertl, 2010).

Through the MCM, by means of its’ training and the practice process, I aim to develop “metacognitive self- and peer- coaching capacity” in students. This capacity should help students engage in governing their self-influences through regulating their moods, goal frames as well as learning actions and interactions in the background so that the synergistically positive learning environment created cumulatively by the efforts of each students and each team will help them attain higher achievement academically, socially, emotionally.

In sum, my background theory and passionate goal in developing such a model is to build an adequately guided participation structure in students’ learning environment to help re-activating the potential capacity that each student has for the self and co-empowerment. With this model, I also aim to help students gain the capacity for co-empowering teams through self-work based self-empowerment.

## **Chapter 3: Metacognitive Coaching Model (the MCM)**

### **Overview**

For this dissertation project, I envision students who are metacognitively competent in governing their self-influence on learning (SIL). In order to practice such skills adequately, they are not only equipped with a self-awareness capacity, a robust metacognitive knowledge and an understanding about their SIL, but also, they have well-developed strong self-assessment and peer-coaching capacities to truly channel an effective regulation over their SIL. I will further depict such students describing the following capacities:

1. Students, who Developed Dynamic Responsiveness to Profound Meaning of Self-Empowerment.

They acknowledge that in order to truly self-empower themselves, during their learning process, they need to develop a meta-cognitive capacity through placing a closer look at their own thoughts and action processes. They are also aware that this way, they can better realize their strengths and weaknesses. Thus, they choose to focus on strengthening their understanding of themselves and at the same time the world around them, both academically and socially, through developing a strong sense of self-awareness, social-awareness, study discipline, scientific epistemology, and critical-thinking capacity, as well as a strong work ethic to improve society.

2. Students, who Developed Understanding of the Process of Co-Empowerment that Comes through Self-Empowerment.

These students are strongly aware that, by self-empowering themselves through the ongoing practices of such capacities, they can co-empower their teammates in their collaborative learning, and thus they can better contribute to their team success in return.

They have *a strong sense of self- and social-awareness* that creates in them a keen awareness of how they act and interact while learning individually and collaboratively. They also have such *a strong sense of social cognition* with which they act with awareness and understanding of how an effective social community works, and what each individual's role is to maintain its success on an individual and collective level, and why it is important.

Thus, while they recognize their vital responsibilities for their learning individually, they also are thoughtful team-learners as they are highly aware of their learning actions' that ignites their social interactions and thus this impact their own and others' learning. Therefore, they put effort to set forth their best actions to better contribute to theirs' and others' learning.

3. Students, who Developed Understanding of Objective-Metacognitive Self-Assessment as a Process.

Through the practices of metacognitive self-assessment, they better understand what it means to become an objective observer of themselves to realistically discern their own strengths, gifts, as well as weaknesses that may arise through misperceptions, misunderstandings and sometimes lack of knowledge or understanding. So, with this awareness, to truly help themselves they make sure to compare their perceptions of anything with multiple resources. They will still keep in mind that they need to update their understanding based on the changing scientific and technological improvements. This entire foundation will help them to become a genuine critical thinker and alert learner who discerns the differences between perceptions versus solid knowledge building.

4. Students, who Developed Understanding of the Importance of Being at Peace with themselves and others.

Being objective observers of their self-understanding of the world gives these students such leverages, through which they fairly feel at peace with themselves as they recognize that their true focus is topping themselves which does not involve any comparison with others. Thus, they can be also effortlessly at peace and supportive of others' in order to truly focus on doing what contributes the most to the collective good. For this, as they act well-disciplined, well-mannered, confident, reliable, and a proactive learner, their peers find them pleasant to learn alongside with. Thus, they put forth genuine effort to gain such qualities, as they realize that this is the optimum way to self-empower themselves for learning.

#### 5. Students, who Developed Meta-Emotional Regulation Capacity

They are cognizant that the way they act directly influences their own and others' moods and actions, and thus the collective learning. They are also aware that they need to find ways to navigate their emotions instead of being navigated by their emotional mood in order to better practicing metacognitive regulation. So, they purposefully pay attention to their moods and *choose to grow to better discern what kind of a thought stream and associated emotional impacts may be influencing their mind.* Thus, they can adjust their moods, regardless of their current mood, in order to be progressive contributors of their learning community.

#### 6. Students, who Developed Metacognitive Thinking Capacity

Out of practicing metacognitive awareness, knowledge and using those mindfully in their action regulation practices, as they continue to become more aware metacognitively about their own actions toward learning these students eventually develop capacity to self-observe/monitor and regulate their own thoughts even before they turn into actions while learning individually and together with their teams.

Because of this strong awareness and understanding, such students are willing to learn how to govern their thoughts by overcoming any mental barriers that may be distracting them from effectively working and learning, both individually and together with their teams. Through their well-developed understanding of these concepts, these students are highly aware of the importance of becoming more mindful of and alert to what they are thinking in a given moment, and how to react to those thoughts to shape their actions appropriately. In this way, they can better contribute to and allow the development of a supportive learning environment for their learning community. Thus, they are willing to assume responsibility to govern their overall self-influence toward learning by taking ownership of gaining regulatory control over their self-action regulation for collaborative learning (SaR-CoL).

These students develop this capacity by paying a great deal of attention to first mindfully monitoring and capturing their current thoughts and acts and second metacognitively regulating them in the desired direction by means of planning, monitoring, executing, improving, and reflecting on their own “academic and social actions.”

I name these actions as “the learning actions” to specifically highlight the need to improve the quality of the learning environments through academic and social acts of every individuals. The intention is that as a result of becoming metacognitively competent in governing these learning actions as an extension of the SIL, these students can better focus on individual and collaborative learning processes. They can better discern that once they empower themselves in this way, they are able to not only improve their own learning capacities and lives accordingly, but also improve in their societies through blending their improved study discipline and solid work ethic with those of their team-mates for better learning outcomes and products as well as leveraged life qualities.

In order to support individual and collaborative learning in this way, I developed the proposed Metacognitive Coaching Model, or the MCM, to help students gain self-action regulation skills for collaborative learning (SaR-CoL). This model aims to help students develop metacognitive competence in self-influence on learning by means of gaining metacognitive assessment skills as well as self- and peer-coaching capacity.

### **The Process Goals of the MCM**

To achieve this vision, I investigated an approach through the MCM that aimed to develop metacognitive competence in SIL. Figure 1.1 (on p.15) indicates the process goals to be achieved through the use of this model. I initially guided students in developing a profound metacognitive awareness of and metacognitive understanding (through metacognitive knowledge development) about their self-influences on their own and others' learning. Then, through this understanding, I intended to help students in developing self- and co-regulation capacities to govern their self-influences that affect their academic and social actions, or their learning actions.

### **The Outcome Goals of the MCM**

Figure 3.1 shows a systematic pathway with outcome goals (i.e., the expected initial benefits) at each step in developing metacognitive competence. The goal of each step is to help students learn how to contribute to establishing a collaborative learning community through regulating their learning actions. At each stage, students become better tuned into their own knowledge construction and development. Better communication evolves from a community of such students, who are then able to engage in social learning processes with their peers.

By promoting such social learning processes evolved through this environment, I also aim to help students make further progress in their own understanding as well as developing

shared understandings of complicated problems/projects that are necessary to achieve success, particularly in STEM disciplines.

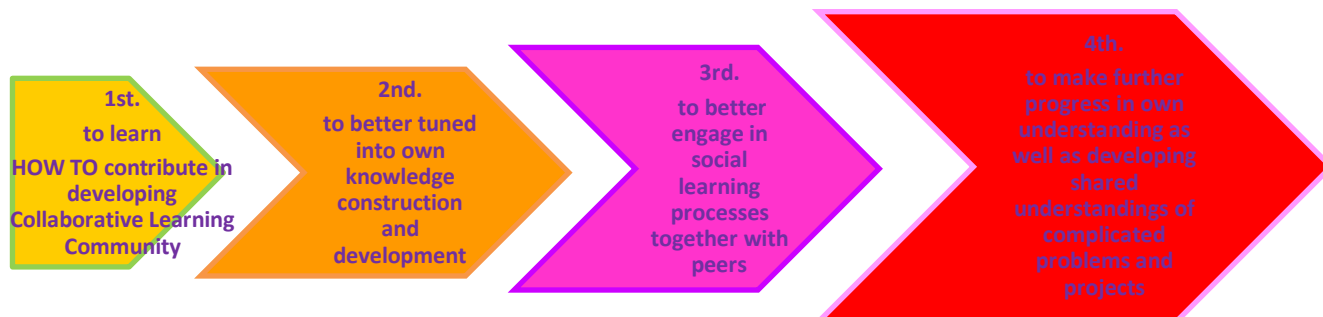


Figure 3.1. The outcome goals of the proposed MCM

### Design Principles of the MCM

The MCM is a model designed to help students govern their self-influences during learning processes by gaining the capacity of Self-Action Regulation for Collaborative Learning (SaR-CoL). As shown in Table 3.1. it is a process of becoming metacognitively competent governing the Self-Influence on Learning (SIL).

### Establishing Self & Peer Coaching for Co-Empowering Teams

In their studies when they promoted inquiry-based learning skills development in science learning, in order to foster “metacognitive expertise,” White and Frederiksen (2005) argue that “everyone in a learning community needs to speak and do metacognition” (p. 212). Researchers also highlight the importance and necessity of developing metacognitive knowledge and skills in order to develop scientific knowledge through inquiry (Frederiksen & White, 1997, 2005; Georghiades, 2004; Hogan 1999; Kuhn & Pearsall, 1998; White & Frederiksen, 1998, 2000). Similarly, I believe that in order to develop not only strong scientific inquiry skills, but also a strong educational foundation in STEM subjects, *providing a well-structured pathway for Students to develop metacognitive knowledge and skills along with metacognitive awareness is*

*crucial*. In this project, I focused on helping students to develop metacognitive competence in SIL through teaching STEM classroom. I strongly believe that by developing such metacognitive competence in SIL as a foundation, we can help students not only progressively increase their academic success in STEM, but also their teams' and communities' success by helping students better assume their individual responsibilities by regulating their influences toward learning.

Table 3.1.

*Design Principles of the MCM*

<b>Phase I</b> Teacher's Monitoring	<b>Phase II</b> Teacher's reflections & Students' initial monitoring & reflections	<b>Phase III</b> Introduction of the MCM and its Protocols & Co-developing the Principles	<b>Phase IV</b> Modeling	<b>Phase V</b> Practicing	<b>Phase VI</b> Performing	<b>Phase VII</b> Internalizing	
<b>DEVELOPING METACOGNITIVE AWARENESS of SIL</b>		<b>DEVELOPING METACOGNITIVE KNOWLEDGE in SIL</b>		<b>Observation</b> Cognitive Acquisition of skill from modeled and verbal instruction	<b>Emulation</b> Demonstration of skill with social guidance and feedback	<b>Self-Controlled</b> Demonstration of Skill and its independent demonstration	<b>Self-Regulated</b> Adaptation of skill to changes in personal and contextual conditions
<p>After developing metacognitive awareness and knowledge adequately, students go through series of phases to <b>DEVELOPING SKILLS of REGULATORY CONTROL OVER the SIL.</b></p> <p>For this process, using the MCM's protocols, I referenced the phases Zimmerman proposed in his social cognitive model for developing self-regulation. His four-phased model includes observation, emulation, self-controlled, and self-regulated phases.</p>							

Thus, for example, in order to develop adequate metacognitive knowledge and understanding about the SIL, I helped the students develop self-assessment skills in learning actions. For this to happen, initially I provided scaffolded tools to shift their “thinking of actions” as a metacognitive process. Once this understanding was established, I helped them develop “self-monitoring capacity” as well as “peer-coaching capacity.”

Upon developing students’ basic metacognitive knowledge about *what* the SIL is, *why* it is important to know, and *how* to make use of this understanding for self- and others’ learning, I provided periodical application opportunities for students to gain regulatory control skills on the SIL through practicing basic principles in developing a successful, supportive, friendly, collaborative learning community.

### **Developing Self-Assessment Skills in Learning Actions**

To develop students’ metacognitive competence in SIL, the MCM includes steps that help students develop metacognitive awareness, metacognitive knowledge, and regulatory control through its protocols by following relevant regulatory activities such as planning, executing, monitoring, improving, and reflection. To do so, *the MCM promotes metacognitive self- and peer-coaching approaches for co-empowering teams through metacognitive-assessment-centered self-empowerment.*

To “co-empower teams through self-empowering individuals by developing self-assessment skills in learning actions,” students need to be trained to develop both self-monitoring and peer-coaching capacities. Moreover, for students to develop adequate self-assessment skills for their learning actions through this training, they need to be educated throughout this process to become metacognitive about their learning actions in the first place.

In the following sections, after sharing my insights about “thinking of actions as a metacognitive process,” I will briefly explain my approaches through the MCM for developing self-monitoring and peer-coaching capacities.

### **“Thinking of Actions” as a Metacognitive Process**

Based on the learning out of this research preparation, I examined through constructing ways in which that help translating *thinking of actions* into *a metacognitive process* rather than simply considering a thought process as a cognitive process. In other words, in order to practically help students, govern their learning actions, I tried to develop metacognitive competence through not only having my students trained to become metacognitively aware and knowledgeable but also provided them scaffolds and environments for them to practice governing their learning actions through thinking of their learning actions as a metacognitive process. I aimed to help them to gain regulatory control over their SIL as a skill.

Due to such training, it can be expected that students will not only become more aware, alert, sharp, and knowledgeable about their thought mechanisms, but also be able to govern their own thinking processes before their thoughts translate into any actions. If used appropriately, this training can provide invaluable opportunities for students to be more ethically sophisticated, thoughtful, and scientifically critical thinkers, and they can act more considerately and selflessly as thoughtful team participants.

Throughout the MCM, students are supported in approaching the thought process as a process in which random thoughts, feelings, impressions, fears, barriers, blockages, or current conditions play roles as inputs, and students demonstrated academic and social actions play roles as outputs of a refined thinking process. The MCM process helps students to understand that when they do not have adequate awareness, knowledge, or regulatory control over how to govern

a stimulus, such thought streams quickly pass through and affect their minds, and actions appear as an immediate impulse to those stimuli. As they develop more metacognitive assessment capacity in this area, students can be more mindful in monitoring, filtering, and revising any input that goes through their mind while learning. Hence, they will come to see their executed actions as initial output that is subject to further practice and improvement.

### **Developing Self-Monitoring Capacity**

To provide students with the tools necessary to develop such self-monitoring capacity, through the application of the MCM, I aimed to help students first develop an ability “*to focus on their own thoughts and actions to improve their academic and social qualities in action.*” I created opportunities for students to discern the differences (or the extent of similarities) between their real actions versus their perceived actions. For example, students are helped to develop a capacity for objective self-monitoring of self-actions, which is about “observation of one's own actions” or “the students' observations of their own actions.” In order to do this, I developed activities around the curriculum to help students “turn their spotlights toward themselves” and become “a self-referenced learner,” rather than being “other-referenced learner.” The purpose of these activities is to first help students primarily take their thoughts as a metacognitive process and pay attention to what they thought while acting in a certain way. Second, these activities help students focus on trying to be their best rather than trying to be better than others.

### **Developing Peer-Coaching Capacity**

Next, I try to help students “*develop a peer-coaching capacity in elevating a desired dynamic within the teamwork.*” For this step, I initially try to shift students’ perspective from having a subjective to an objective point of view toward learning actions. This step is about learning to focus primarily on the action itself, rather than on the person performing the action.

For example, I asked the students to pay attention to present actions that may be affecting their own or the team participants' learning process. I then ask them to practice helping their peers detach from such undesired actions at the time that they demonstrate the distracting behavior.

To make this shift, I used a metaphor that I called "You are a gem." I put forth the idea that every person should be perceived as a "gem in essence to be solely valued and should be unconditionally supported to shine through rather than letting any dust dim its light that is unique and diverse." With this idea, I aim to bring a realization that any undesired action should be brought to a person's attention appropriately to support the changes necessary for desired behavior to take place. The essential idea is to help students be able to eliminate any undesired behavioral elements and tune into their learning processes by means of developing such action-filtering mechanisms. As a result, the entire team is empowered by means of such peer-coaching at work. Thus, to protect students from developing habits that repeat such undesired actions, I help students learn to redirect their peers by means of the MCM. The goal is to produce a supportive, empathetic environment, instead of singling out any person by making accusations, back stabbing, criticizing, distancing, or gossiping about his/her possibly unintended or inadvertent actions that may arise from a lack of awareness.

In order to effectively address self-assessment as well as the self- and peer-coaching processes, I developed two protocols within the MCM, namely the "self-influence-regulation protocol" (SIRP, see appendices A) and the "self- & peer-coaching protocol" (SPCP, see appendices B). In Table 3.2, I briefly lay out the concepts covered within these two MCM protocols. Next, to help students use these protocols, I encouraged my students to co-develop core principles that combine their common choices of some actions they want to work on regulating. My aim in using these MCM protocols is to foster development of such

metacognitive competence in students' learning actions, in order to positively influence their learning communities. My hope is that the learning environments can be "transformed into self-aware, self-improving systems; that is, they [students] will only and truly focus on their learning through creating theories about what they are doing and why as they constantly engage in cycles of planning, monitoring, reflecting and improving" (White & Frederiksen, 2005, p.211). Hence, I have integrated systematically structured practice cycles into the design of the MCM to help students not only pay close attention to the kinds of actions they determine it is necessary to perform, but also to raise their awareness of how they do perform despite their perceptions of how they think they should act.

### **Constructing Metacognitive Competence through the MCM**

With this project, I focused on helping students develop their metacognitive competence on self-influence. As I broadly examined in Chapter 2, looking at its very basic definitions in the literature, metacognition can be described as "an ability to reflect upon, understand, and control one's learning" (Schraw & Dennison, 1994, p.460). One can infer from this that awareness, knowledge, and control of one's thoughts and actions are closely related to the learning process. The design principles of the MCM reflect these fundamentals in order to develop such competence as depicted in Table 3.2.

As shown in Table 3.2, the model is designed to develop metacognitive competence in SIL by means of first raising the metacognitive awareness of the SIL, then developing the declarative, conceptual, and procedural knowledge on the SIL, then developing self-regulatory control by initially constructing procedural knowledge of how the MCM works to govern the SIL, and finally learning how to make use of the MCM and to practice to internalize governing the SIL. In the next sections, I will briefly explain each of three consecutive steps in more detail.

Table 3.2.

*One way of Developing Metacognitive Competence*

The MCM Protocols for the processes	DEVELOPING METACOGNITIVE COMPETENCE for REFINING LEARNING ACTIONS THROUGH THINKING METACOGNITIVELY		
	<p><b>INPUTS</b></p> <p>Developing metacognitive awareness through realizing and recognizing the followings and take them as the inputs of mind:</p>	<p><b>CATALYZERS</b></p> <p>Developing metacognitive knowledge and comprehensive understanding through Restructuring and Redefining those inputs by using some techniques as catalyzers</p>	<p><b>The Initial OUTCOMES</b></p> <p>Developing metacognitive control over practices through Revising and Regulating The learning actions that are executed as a result of extensively planned of actions understand the necessity of approaching</p>
The self-assessment process: <i>Self-Influence-Regulation Protocol (SIRP)</i>	<ul style="list-style-type: none"> <li>• Jockeying for a position</li> <li>• Social stressors, mood changers</li> <li>• Lack of planning/organization</li> </ul>	<ul style="list-style-type: none"> <li>• *Learning Orientation</li> <li>• *Mood Orientation</li> <li>• *Goal-Framing Orientation</li> </ul>	<ul style="list-style-type: none"> <li>• Self-Referenced Learner</li> <li>• Meta-Emotional Learner</li> <li>• Individually &amp; Collaboratively</li> <li>• Responsible Team Player</li> </ul>
The self- & peer-coaching process: <i>Self- &amp; Peer-Coaching Protocol (SPCP)</i>	<ul style="list-style-type: none"> <li>• Everybody is a “gem in essence”</li> <li>• We are in the same boat</li> </ul>	<ul style="list-style-type: none"> <li>• Coaching through impersonal, thoughtful, kindly observations &amp; reminders</li> <li>• Making sure keeping the self and others be accountable in action at a time to truly focus on learning</li> </ul>	<ul style="list-style-type: none"> <li>• Help raising self- &amp; others’ awareness about one’s actions kindly &amp; genuinely</li> <li>• Understanding the fact that both ours and others’ actions affect the whole team cumulatively.</li> </ul>

## **Constructing Metacognitive Competence through the MCM**

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As shown in Table 3.2, the entire model is designed to develop metacognitive competence in SIL by means of first raising the metacognitive awareness of the SIL, then developing the declarative, conceptual, and procedural knowledge on the SIL, then developing self-regulatory control by initially constructing procedural knowledge of how the MCM works to govern the SIL, and finally learning how to make use of the MCM and to practice and internalize governing the SIL. In the next sections, I will briefly explain each of three consecutive steps in more detail.


### **Steps in Developing Metacognitive Competence for Governing the SIL**

#### **Developing Metacognitive Awareness of the SIL**

Phase I and Phase II are the processes of the first step, which is developing metacognitive awareness of the SIL. In the following Table 3.3, I briefly depict the theoretical and conceptual connections and how these reflect on teachers’ and students’ instructional practices.

Table 3.3.

*Developing Metacognitive Awareness of the SIL*

Phases of the MCM		THEORY AND CONCEPTUAL FRAMEWORK BEHIND PHASES	TEACHERS' TOOLS	STUDENTS' TOOLS
		TO FIND OUT the upbringing/the current INPUTS OF MIND	THE PROCESSES OF Realizing & Recognizing the INPUTS OF THE MIND	
<b>DEVELOPING METACOGNITIVE AWARENESS of SIL</b>	<b>Phase I</b> Teacher's Observation	1. To find out students' own perceptions on how they act while learning individually and as a team member  2. To elicit/find out how students' naturally act academically and socially while learning	BASED ON THE PRE-QUESTIONNAIRE (appendices B)  1. to distribute the pre-questionnaire questions to gather students' perceptions on how they think they approach their individual and team learning BASED ON THE SEMI-GUIDED STUDENT OBSERVATION FORM (appendices C)  2a. to observe and take notes students' academic and learning actions by focusing on how they approach toward their learning task  2b. to observe and take notes students' social learning actions by focusing how they act and interact within their teams with their team-mates	-During this phase, students are taught the requirements of the current curriculum traditionally.  -No MCM procedure is introduced in this phase.  -Because the aim is to examine the differences and/or the extend of similarities of their perceived actions versus their enactments.
	<b>Phase II</b> Students' observation and Reflection & Teacher's reflection of her observations	To raise awareness of students about their academic and social actions by  1. letting students observe themselves and others' learning actions 2. comparing students' observations with the teacher's findings of her observation in a friendly discussion environment. 3. to discuss about possible thinking mechanism behind their acts	BASED ON THE SEMI-GUIDED STUDENT OBSERVATION FORM (appendices C)  1. to let students, observe their own learning actions 2. to let students, observe others' learning actions 3. to let students, report their observations during the semi-structured discussion 4. to ask probing and clarifying questions to better define perceived actions versus enactments 5. Teacher to share her/his findings by comparing and pointing out the differences and the similarities of the observations and students' survey results 6. to guide semi-structured Class Discussion to better help students, realize that the level of their awareness of their very own actions on how they actually act	The SEMI-GUIDED FORM INCLUDES:  1. My reflections about my observations on -my own learning actions and -my class-mates' learning actions 2. While completing a learning task: -What am I really thinking? How am I really acting? 3. My thoughts on ideal learning actions -while working on a task -while working with others

**What are students' natural learning actions and are they aware of them?** Phase I, teacher observation, takes place before the application of the MCM and after conducting a pre-survey and individual interviews, as well as a pre-test for academic achievement, which I called the Pre-Assessment process.

This phase provides an opportunity for teachers to not only observe students' natural learning attitudes, before presenting the MCM or any intervention, but also to compare these observation results with the students' responses in the pre-survey and the interview. This provides the teacher with a comparative perspective of how aware students are of their learning actions.

The Pre-Assessment process is imperative to the MCM process, as it informs the teacher of the students' baseline learning attitudes, their perceptions about these attitudes, and their initial academic level.

This process also helps develop a social-emotional bond between teacher and students. During the Pre-Assessment process, students are asked to write personal diaries at the beginning of each class. They are asked to write about what happened during the day *before* coming to this after-school class, how they feel about it, what their plans are for the rest of the day, and so forth. This task functions as a warm-up exercise. Students also have the opportunity to practice their writing skills using word documents on the computer, and to get used to sharing their daily activities as well as their emotional moods while developing a self-reflecting routine about their feelings, plans, and so forth. This exercise is purposefully continued until the students are introduced to the MCM. In this way the teacher gets to know her students better while being more informed about their learning actions. In the beginning of the MCM intervention, when students are asked to reflect on their feelings, plans, and thoughts, it feels to them like an

extension of the diary that they were keeping in the Pre-Assessment process because of the similarities in the questions.

**How do I function in shaping my learning community?** During Phase II, after students are asked to observe and share their own observations, the teacher shares her overall observations and compares her perspective to that of the whole class in general to provide a soundboard for students to become aware of the differences and the extent of similarities of their own observations of learning attitudes. This phase is intended to help students to better see differences in their perceived actions versus their enactments. This phase continues as a class discussion to further help students raise their awareness of their positions while learning, and to help them determine their present learning orientations (i.e., self-oriented versus others-oriented), where their spotlights are, and how much they are *jockeying for position* instead of focusing on genuine learning. This phase is beneficial in revealing to students their present learning actions and helping them discern whether their actions are consistent with their perceived actions in a particular situation.

### **Developing Metacognitive Knowledge of the SIL**

Throughout this step, students develop their skills in metacognitive knowledge construction and are introduced to declarative/factual, conceptual, and procedural knowledge about SIL. In Table 3.4, I briefly outline the theoretical and conceptual connections made in Step 2 and summarize how the teachers' and students' instructional practices reflect the material learned in this step. All the concepts mentioned in this chart will be explained in the last section under the terms and components of the MCM.

Table 3.4.

*Developing Metacognitive Knowledge on the SIL*

<b>METACOGNITIVE KNOWLEDGE CONSTRUCTION/DEVELOPMENT ON SIL</b>				
Phases of the MCM		<b>CONNECTING TO THEORY AND CONCEPTUAL FRAMEWORK</b>	<b>CONNECTING TO TEACHERS</b>	<b>CONNECTING TO STUDENTS</b>
<b>D E C L A R A T I V E / F A C T U A L &amp; C O N C E P T U A L</b>		Defining Learning Orientation: -Self Referenced Learning -Others Referenced Learning	Are you jockeying for a position, or are you into developing a mastery? What are your criteria/your reference point?	Where is my spotlight directed to?
		Overcoming Social Stressors: -Social stressors -Mood changers	Mood regulations through role-playing class game: Establishing a Company	Is my current mood helpful to me and my company?
		Individual and Collaborative Goal Framing: -My academic learning responsibilities -My social learning responsibilities	Helping to assume responsibility for the self and for the team	How to run a successful Company?
		Developing Self-Empowerment Concept (as a process)	Guiding students to help themselves	You are a GEM, I am a GEM, WE ARE GEMS
		Developing co-empowerment concept (as a process)	Helping students see the interconnectedness between each other	We are in the same boat
		Introducing the MCM through its Protocols	-For the self-assessment process: SIRP <i>self-influence-regulation protocol</i> -For the self- & peer-coaching process: SPCP <i>Self- &amp; peer-coaching protocol</i>	Company filing, reporting – The policy on captain selection and their roles
		Introducing Possible Team-Empowering Learning Principles	Co-determining & co-developing such principles	Study discipline principles & work ethic principles

The above-mentioned metacognitive knowledge construction takes place throughout Phase III. Next, I will briefly explain this phase.

***What do I know about Self-Influences on Learning?*** Phase III continues with semi-guided discussions/arguments to help students further understand the concepts that may be playing roles in their learning actions. As this phase is the second step, which is the metacognitive knowledge development phase, students are undertaking a series of processes to develop self- and co-empowerment through constructing declarative/factual, conceptual, and procedural knowledge about possible jockeying for position, social stressors, and mood changers, as well as lack of planning for teamwork and how to take precautions against these forces. For this step, the concepts of “learning orientations,” “mood orientations,” and “goal-framing orientations” as well as “you are a gem” and “we are in the same boat” are introduced, examined, and discussed through semi-guided debates and discussions.

After that, both teacher and students share their learning expectations based on the established understandings and examined reflections that took place during the previous phase. Then teacher and students work together to co-determine/co-develop *their academic and social learning principles*. These principles are composed of loaded “action-verbs” that are to put into practices during the daily learning tasks. Once co-developed, students are required to use these core principles and protocols in their learning action planning, monitoring, executing, and reflecting. In the following sections, I will further explain this concept.

***Developing those principles takes place in two steps.*** Ideally, students will come to understand that forming a well-functioning learning community is closely related to *how they govern their self-influences in learning* through shaping their academic and social actions, or their learning actions. During Phase II, students have opportunities to discuss such actions. In

order to come up with core-principles, the students and the teacher share their insights about what actions and interactions can be useful in strengthening their learning community. Then the teacher combines and classifies these responses and identifies one loaded verb to encompass them. Both an academic and a social action can be classified under their respective loaded verbs. These verbs can translate into actions that ignite desired interactions. For example, actions such as showing kindness, paying attention, and looking at the person who is speaking, being considerate of the needs and interests of peers, asking permission before using someone else’s materials, thinking before speaking out loud, and providing space to one another would all be classified as *being respectful*. As a result, similar loaded verbs become the main learning action and interaction principles for the students’ learning processes while students are completing learning tasks. Table 3.5 lists some items of individual and teamwork principles in the form of action, or loaded, verbs.

Table 3.5.

*Team-Empowering Core-Learning Principles*

Academic Actions For Students as “Individual Learners”	Social Actions For Students as “Team Participants”
<p><b>Study Principles:</b>  <i>During my learning activities, when working on my tasks, I choose to</i>  <b>-stay focused</b>  <b>-practice being efficient</b>            (by working in a timely, clean, tidy, and organized way, completing my task by carefully following the instructions, etc.)</p>	<p><b>Work Ethic Principles:</b>  <i>While performing our task with my team, toward my team partners, I choose to</i>  <b>-be supportive</b> (by acting positively, helping each other, assisting each other when necessary, etc.)  <b>-be respectful</b> (by being open to one another’s ideas, providing space for them to share their ideas, listening to each other, being open to consensus and improving and developing common meanings through thoughtful, careful, meaningful discussions, etc.)</p>

After co-determining their core-learning principles, students are introduced to the intervention of the *MCM*.

## **Introducing the MCM Intervention Process**

The teacher introduces the MCM Intervention Process by sharing the application protocols and clarifying the corresponding practices with respect to the team-empowering core-learning principles. The detailed implications of the intervention are provided under the section on instruments of the MCM in this chapter.

The main protocols are the SIRP and SPCP. The SIRP allows each student to follow procedural practice cycles to plan, execute, monitor, revise, and reflect on their academic and social actions to gain self-action regulation skills for collaborative learning (SaR-CoL). The SPCP is intended to help team members coach themselves and each other appropriately. The coaching is twofold:

The first aspect of coaching takes place at in the moment when undesired actions take place, by focusing on transforming undesirable actions into desirable ones, or to highlight (by thanking, etc.) when the desired action is supportive of learning. The goal is for each team participant to be helped to practice following a higher path and to contribute to the development of a supportive learning community.

The second aspect of coaching occurs in the moment when desired actions take place. This step involves highlighting the attitude by saying “I noticed/witnessed that you are being focused, efficient, effective, respectful, supportive, etc.” to strengthen the desired attitude without any exaggeration. The purpose is simply to let the individual know that hers/his being on the right track or “doing the right thing” is apparent and is appreciated. This protocol is meant to encourage team participants by showing appreciation based on their attitudes to each other, and by simply stating the observed fact and avoiding any exaggeration. The purpose of avoiding exaggeration is to discourage students from acting in the desired way just to receive praise or

outside reward. Seeking outside reward is examined and defined under the “Learning Orientation” section in more detailed. Students have already examined this topic in earlier phases. Thus, they already know that even inadvertently focusing on seeking outside reward can be a cause for developing power-seeking habitual acts. Such acts are one of the elements that may create barriers and mind laziness towards learning.

**Developing Metacognitive Regulation over the SIL**

After coaches help students adequately develop metacognitive awareness and knowledge and the MCM interventions are introduced appropriately, team members are able to establish their companies and share their roles. In this step, students go through a series of phases to develop regulatory control over the SIL. Concurrently, company members use role playing to strengthen their companies through solid learning process and outcomes.

Table 3.6 shows the MCM Regulatory-Control Steps that demonstrate the phases adapted from Zimmerman’s Social Cognitive Model of the Development of Self-Regulation.

Table 3.6.

*Phases for Development of the Self-Regulatory Control Over the SIL*

<b>The MCM Regulatory Control Processes (Phases IV-VII)</b>			
<u>Phase IV</u> <b>Modeling</b>	<u>Phase V</u> <b>Practicing</b>	<u>Phase VI</u> <b>Performing</b>	<u>Phase VII</u> <b>Internalizing</b>
<b>Observation</b> Cognitive skill acquisition from modeled and verbal instruction	<b>Emulation</b> Demonstration of skill with social guidance and feedback	<b>Self-Controlled</b> Demonstration of skill and its independent demonstration	<b>Self-Regulated</b> Adaptation of skill to changes in personal and contextual conditions
Above is the Zimmerman’s four-phase metacognitive model (also called as Social Cognitive Self-Regulatory Development Model)			

Looking at Table 3.6, it can be observed that by adapting Zimmerman's well-structured social cognitive model into the MCM, I provided opportunities with the students to better develop regulatory control over their SIL. In this environment, students can develop cognitive acquisition of skill through modeling and verbal instructions in sequential phases, as in Zimmerman's four-phase model. For example, students learn by observing short sketches in which teachers demonstrate how to implement the protocols (Phase IV). Students then have the opportunity to demonstrate their developing skills with social guidance and feedback (Phase V). Next, they internalize their developing skills through self-controlled opportunities (Phase VI). Finally, they are provided opportunities to adapt their new skills to changes in personal and contextual conditions by gaining self- and co-regulatory control over the SIL (Phase VII).

**Why Adapt Zimmerman's Four-Phase Model?** When developing the MCM's protocols, I referenced the phases Zimmerman proposed in his social cognitive model for developing self-regulation, as metacognitive competence is described as the ability to reflect and exhibit self-regulation over one's thinking (Zimmerman & Kitsantas, 2005). Through my research studies and educational experiences (Baykent, 2002, 2010; Baykent & Esme, 2007). I found that developing regulatory control over SIL can overlap with the process of developing self-regulation in learning. By means of his four-phase model, Zimmerman "attempts to help learners transform their mental abilities into academic skills as the self-directive process" (Zimmerman, 2002, p.65). The MCM, on the other hand, attempts to help students developing metacognitive awareness and knowledge in the SIL. By blending Zimmerman's four-phase approach into the MCM protocols during Step 3 of the MCM, students are guided toward gaining self- and co-regulatory control over the SIL. While I referenced Zimmerman's model in general

for this third step of the MCM, I made some changes as necessary during the application. In future sections, I detail those changes while sharing the specifics of each phase.

Another reason I chose to adapt Zimmerman's model into the MCM is because his model is designed from a social cognitive perspective that is influenced by Bandura's social cognitive learning theory (Bandura, 1986). According to Bandura, behavior is shaped by the environment, but that behavior also shapes and changes the environment in a reciprocal way. The MCM protocols require students to shape their own individual academic and social actions that affect the type and quality of their social learning interactions; this in turn shapes their learning environments into successful learning communities.

Based on Bandura's social cognitive theory, it can be inferred that both the type of environment and the actions of students play roles in shaping the learning community. With this in mind, I adapted Zimmerman's social cognitive model in the regulatory control step of the MCM in order to providing a well-structured social cognitive path for the students to allow them to better tune into their practices of regulating their learning actions individually and collaboratively. Thus, the aim is that through such an environment, students will realize they can actually better contribute to developing their own positive, friendly supportive learning communities together with their peers.

Zimmerman's four-phase model includes observation, emulation, self-controlled, and self-regulated. For the MCM, I adapted these four phases into modeling (Phase IV), practicing (Phase V), performing (Phase VI) and internalizing (Phase VII). Through the MCM protocols, these phases are specifically designed to foster skills in regulatory control over the SIL. Thus, students are expected to gain better self- and co-regulatory control over the SIL one step at a time.

In the following sections, I will briefly lay out each phase in order to provide a clearer picture.

**How Should I Practice the Co-Developed Learning Principles?** Phase IV and Phase V allow students to first observe and then practice the MCM with their co-developed social learning principles.

Phase IV is a *modeling/observation* phase, where cognitive acquisition of self-assessment of the SIL as well as student-student and teacher-student self-coaching skills from modeled and verbal instructions take place. The teacher acts as a coach in this phase by modeling for students how they can begin paying attention to their academic and social learning actions. The protocols are modeled together with students. Students take roles in some short descriptive sketches, and interactive question-answer semi-structured debates takes place afterwards. During this phase, after modeling, students begin making use of the protocols, and the teacher actively coaches students, confirming and correcting their understanding of the protocols.

Next, in Phase V, the *practicing/emulation* phase, the students demonstrate the learned skills, and the teacher provide social guidance and feedback. During this time, the coaching support from the teacher fades and students are given opportunities to practice self- and peer coaching using the SPCP (Self- and Peer-Coaching Protocol) while continuing their planning and reflecting via the SIRP (Self-Influence Regulation Protocol) within their teams and on their own.

**Can I Carry on My Self-Coaching Regulation Practices on My Own?** In Phase VI, the *performing/self-controlled* phase, students demonstrate their newly developing skills in independent demonstrations. For this phase, students are expected to take charge of their individual and collaborative learning practices while carrying out a new class project without any formal coaching.

In this phase, it is expected that students can implement their understanding through the self-application of regulatory control and begin to show signs of internalizing the MCM's application. It is also expected that students will demonstrate better learning conversations with their team members while performing learning activities, and produce better quality of learning products/outcomes, as observed in their work artifacts as well as reflected in their conversations.

***Phase VII.*** This is the phase; the teacher can expect to observe *Internalizing of Regulatory Control Over the SIL*. Phase VII has two sub-phases:

**How much awareness have I gained? *Phase VII-Sub-Phase 1.*** The first sub-phase takes place in the post-assessment process, which takes place at the end of the (fall) quarter. During this time, students take a post survey to share their understanding of the overall MCM and their latest perceptions about their learning actions. This survey evaluates how much more metacognitively aware the students become in terms of being more alert, present, and mindful in monitoring their own learning actions.

The other aspect of this sub-phase is portfolio-sharing in the Open-House meeting. Both students and teachers follow set protocols throughout the quarter to prepare and present the portfolios. Making use of open-house meetings to share students' portfolios plays an important role in terms of allowing students to share their learning outcomes with their parents, as well as with some administrators of the after-school program. End-of-year portfolio sharing during the open house is an informal version of the authentic assessment of Linda Darling-Hammond and her colleagues (Darling-Hammond, Ancess, & Falk, 1995).

**Am I able to carry on the applications of the MCM/ Am I regulating my learning actions on my own by governing my SIL? *Phase VII-Sub-Phase 2.*** The second sub-phase process takes place in the (spring) last quarter of the same school year, four months after the intervention. During this time, there is no MCM implementation. During this sub-phase, teachers and students can observe the extent of metacognitive competence developed and reflected through students' learning actions when there is no formal implementation of the MCM.

## **Chapter 4: Methodology**

### **Introduction**

In previous chapters, I defined the MCM and provided the theoretical background for this model and described in detail of the procedures involved when implementing the MCM. The focus in this chapter is to highlight the data collection and analysis process that I conducted to answer the research questions, before, during, and after the intervention.

In the following sections, I will first share the rationale for my research approach. After detailing the research setting that includes the curriculum, implementation process of the MCM throughout the school year, I will share research participants, research design including data collection, instruments and procedures. Next, I will share data analysis method including instruments that were used to answer each research question. I will then give information about the validity and reliability of the instruments.

### **Rationale for Research Approach**

This dissertation project is conducted in the form of an action research (Ferrance, 2000; Lewin, 1938, 1946; Mills, 2000). I am the researcher and the instructor of the two classes in which I conducted the research project. Action research approach through metacognitive assessment cycles I used such as planning, monitoring, reflecting and improving of the instructions as well as the project implementations to help generate specific just in time solutions. This focused engagement not only allowed increase the effectiveness of the learning environment, but also provided opportunities with me as an active researcher, and as a practitioner to be able to implement changes required for my small learning communities' learning needs as well as their social improvement (Hine & Lavery, 2014; Lingard, Albert, & Levinson, 2008; McNiff & Whitehead, 2011; Mills, 2000; Stringer, 2013). In other words, this

action research empowered me as a researcher to develop a more functionally systematic approach for effective progressive changes that evolved out my teaching practices (Hine, 2013; Holter & Frabutt, 2012).

I used mixed methods in measurement paradigms /traditions. I used quantitative measurement to answer the research questions 1, 2, and 3. These research questions seek for answers whether students' metacognitive competence is in progress towards governing their self-influence of their own learning actions (SIL). To this end, the questions specifically seek for significant patterns to examine whether there is any MCM association for the necessary shift of metacognitive awareness, and knowledge take place, and if so, whether the expected metacognitive consistency in accuracy of executions on planning and reflections on execution occur as an outcome. Thus, the nature of the data was collected based on field observations, and recordings of students learning actions as well as pre-survey results that asks students about their perceived learning actions. To see the consistency of students answers and their observed enactments, the observation criteria and the students' responses were compared based on a coded scale by means of the SPSS paired-t-test analysis method. To examine the development of metacognitive competence, the data is compared between "Before the Intervention" (BI) and "During the Intervention" (DI) as well as "Follow-up of the Intervention" (FI) that was a process took place after the four months of the intervention.

Pre- and post-academic achievement test scores were also used to examine possible correlation between students' academic gains and their engagement in and attainment of self-empowerment and collaborative-empowerment academically (RQ 4).

For RQ4, I also used qualitative measurement in the form of case studies to find out some more detailed answers particularly to see if there was any observable pattern in students'

responses about governing their self-influences particularly through the practices of reorienting their moods as well as individual and team goal framing. Looking at the daily reports written by the students, I was interested in seeking for any correlation between these reorientations and regulation of learning actions.

For the RQ5, I used qualitative analysis, seeking for any observable pattern in students' learning communications during FI that indicates improvement that may be correlated to the MCM intervention. FI was a period, through which, no MCM Practices were formally applied. This was an opportunity to examine, whether students embrace and developed any habits of mind of off those learning actions we practiced DI via MCM applications.

As D'Andrade states, the qualitative data essentially refers "to the values and attitudes that structure the behavior pattern of a specific group of people" (D'Andrade, 1992, in Merriam, 1998, p.13). The qualitative data from multiple sources was useful to discern process changes through various aspects. For example, to answer how and in which way students demonstrated the change of their awareness level on their learning actions, I classified and coded the pre- and post-survey responses and compared them with their written responses (they were also coded in the same unified way with the surveys) to further see the development level of my students' metacognitive competence toward their SIL through the implementations of the MCM.

For the qualitative analysis of RQ4, before reading students' written reports, I examined their achievement test scores through SPSS paired t-test statistical analysis tool. After finding out that there is a significant difference between the pre- and post-achievement scores of the all six teams, I listed my students' individual academic achievement and gain scores under their teams. Using the patterns appeared based on the similarities, or differences of their scores. The patterns I observed in this clustered list helped me better discern possible correlations between students'

academic gains and their engagement with MCM in developing self- and co-empowerment. Upon pinpointing what I should take a closer look to further seek for such correlation, I formed three case studies to analyze in detail: *Case study One* focused on an individual's journey (code named Purple2) on developing self-empowerment throughout the entire project. In *Case Study Two* I looked at the journey of a team (code named Team Green) in terms of their transformation from having apparent power conflict into such positively synergistic teamwork dynamics. In *Case Study Three*, I examined the conflicted academic outcomes of a team (code named Team Red) and examined a possible correlation with the MCM they were practicing throughout the project (Please see Ch5 for detailed analyses).

Next, I made my case analyses through tracking students' daily planning and reflection forms they submitted as part of MCM practices. I also looked at their work artifacts and relevant video recordings as needed. I took note out of these recordings through careful analyses by watching those multiple times. I transcribed the most relevant sections to use as supportive evidence. Then I compared this data with the field observation notes. I found that this enriched data provided me with a broader perspective. This way I had an extensive and detailed evidence about my students' learning actions individually as well as their interactions within their teams.

Next, I comparatively analyzed the data. I was seeking any sorts of correlation such as to any type of (either positively or negatively) developed dynamics that may also relate to teams' academic achievement scores. Meanwhile, I was also simultaneously seeking for any pattern of self-empowerment and co-empowerment development due to establishing the metacognitive competence out of practices of such MCM tools.

As a result, while this comparative analysis of such data provided me with a deeper understanding on the process changes, it was also helpful to see many emerging patterns. While

these patterns showed me the type of learning dynamics and synergy developed out of this individual and team concerted effort as part of these process changes, it functioned as an initial step in further interpreting the association of the MCM on an individual and team bases.

## **Research Setting**

### **School Site**

The study took place in the Northwest region of WA, in an informal learning environment where there are many opportunities for STEM learning. While this is considered as part of the informal learning environment category, it is an on-site-training (OST) program. What is unique about this OST program is that is not a “play” environment but rather “fun and engaging learning environment”, more like an extension of a school in terms of programs’ offerings (Bell, Lewenstein, Shouse, & Feder, 2009). I applied the MCM in this OST program, which is a year-long after school program for students in Grades 1-8. This program has been running since 2000. The focus of the program is providing STEM enrichment to underserved children of color through project-based learning and advanced technology tools. The primary goal of the program is twofold. (1) academic success: to increase competencies in core academic subjects and to promote college as a viable option, particularly in STEM fields; and (2) socio-cultural success: to develop essential life skills, like critical thinking, problem solving, teamwork, and presentation skills.

In this after school program students attend to class two days per week. Each lesson takes 90 minutes. Through its curriculums, the students are fostered to project-based learning environment where they used science, technology, engineering and mathematics topics actively embedded in the curriculum. The general learning culture is different from daily school format. Students are engaged with hands-on-fun STEM related activities while developing some

computer related skills. They are encouraged to work individually as well as a team, yet there is no policy. Teachers are kept responsible creating most of the classroom culture and routines.

Teachers have been incorporating science, mathematics and engineering related units into technology-based activities, where students gain academic and technological skills. The students have been learning to create websites, animations, 3-D animated movies, online games, movie making skills, power-point shows, robotics, along with learning science and mathematics concepts that are well-blended to these tech-activities.

I have been developing and applying self-influence-regulation projects in STEAM formal and informal STEAM fields since 1998. I selected this site particularly because this OST Program welcomed and embraced my approach since 2007. Throughout the years, I was able to apply many of my pilot projects informally that are related to help students develop self-action-regulation. For the 2011-2012 school year, the further developed version of such project, which is about helping students develop metacognitive competence in SIL (self-influence-on learning) was approved.

Another reason that I chose this site is, my dissertation project design also reflects the academic and socio-cultural goals and expectations of this OST program. I aim at enhancing and improving the process, progress and outcome of this after school program that functions in a complementary way, improving awareness, knowledge and skills of young children, particularly in the STEM fields (Bell et al., 2009). I had found well-supported opportunities for blending my passion, experience and new learnings into my teachings while working with my students in this program. To that day, the love of this OST program including all my students along with their parents and its esteemed administrators is truly dear to me.

## **Curriculum**

For this dissertation, the OST program curriculum, which focuses on teaching STEM to 3-5th grade students, was used. The MCM intervention was only applied during the 2011 Fall Curriculum. It is named “Science of Light with Scratch.” Light is the scientific content of the curriculum, while the technology part covers an animation making software program, called Scratch. The same students returned for Spring 2012 were not implemented the MCM. They were informally observed to see the level of the MCM skills integration if at all. Spring quarter’s curriculum content was about robotics applications. LEGO MINDSET education tools were used to teach students how to build and program robots, and students subsequently joined this OST program’s Robotic Contest with their robots representing their teams in the end of this quarter.

In the following, I will first share how I implemented this dissertation project into the “Science of Light with Scratch Unit”, by sharing how I blended the science and technology while implementing the MCM. Next, I will briefly share the scratch software program as well as the LEGO Mind Robotic Programming Kit.

## **Implementation of the Dissertation into the STEM Teaching**

The MCM is designed to be integrated into any curriculum. It is aimed to help students get the best out of the curriculum in terms of fostering enhanced individual and collaborative learning. Blending the MCM intervention with the OST program “Science of Light with Scratch Unit”, I planned to help students develop the SaR-CoL. It is about developing self-action regulation skills to enhance collaborative learning through the MCM as described in detail in the Model chapter (Ch3). During the fall quarter, I helped students in developing such skills through the protocols of the MCM. The protocols not only include tasks to do, but also have scaffolded tools. These tools comprise some daily forms that enable students to incorporate metacognitive

strategies, and some forms that enable students to self- and peer-coach using metacognitively arranged principles. This scaffolded application was the development of the model, which took place in the *Fall Quarter*.

Once they had gone through this process, in the same quarter (fall), they went through another process in which the transfer of the model took place. This time, the students were given a chance to informally execute the model in different conditions (meaning neither using any scaffolded tools, nor following any protocol) while performing a team project. During this time, I was an observer to see how much the students internalized the model and how the MCM influenced students in their individual and team work, if at all. After that I also collected data that is mostly composed of field observation notes and students' work artifacts as well as video recordings made during the Spring Quarter. This process was the informal follow-up of the model, because there was no formal application of the MCM. Examining this process gave an opportunity to see if there was any shift in students' individual and team learning process that can be tied to the MCM. The same students participated in the Spring Quarter.

**The Fall Curriculum: Science of Light with Scratch Unit.** For the fall quarter, the following Table1 is the suggested weekly science and technology curriculum of the fall quarter.

**The Spring Curriculum: The Robotics Unit.** While there was no formal implementation of the MCM, as I informally observed my students' learning action pattern throughout the spring quarter, in the following, I will briefly share about the Robotic unit. That is to provide the reader a broader picture.

Table 4.1.

*OST Program Fall 2011 & Spring 2012 STEM Curriculum*

Weeks	Fall 2011 Curriculum The Science of Light with Scratch <i>MCM implementation takes place</i>	Spring 2012 Curriculum The LEGO Mindstorms <b>NO</b> MCM implementation takes place
Week 1	Introductory Activities and pre-assessment	Introductory Activities and pre-assessment
Week 2	History of Animation and How we See	Kit Inventory
Week 3	Scratch Introduction and How we See	Gravity Car and Build a Rover
Week 4	Electromagnetic Spectrum	Build a Rover
Week 5	Visible Light and Wavelength	Ultrasonic Distance Sensor
Week 6	Wavelength and Colors	Robotic Arm
Week 7	Mixing Colors	Gears
Week 8	Speed of Light	Final Project
Week 9	Final Project	Final Project
Week 10	Final Project and Open House	Final Project

**Framing the instructional implementations**

The MCM is practiced through previously structured and shared protocols. These protocols provide guidelines of the daily-progress reports that students are asked to use as well as instructions on how to self- and peer coach. They help students to be metacognitive about their academic and social actions by planning, executing, monitoring and reflecting. These tools also help them understand how to maintain self- and peer- metacognitive coaching when they are working on a learning task. Those protocols explain that the students coach each other through interactive feedback processes with gradually increasing responsibility. During the process, through the MCM, students are guided to produce cohesive and authentic work, both individually and collaboratively.

Students are given the roles of company members. They are given daily or weekly tasks to accomplish both individually and collaboratively. *Task complexity* changes in each phase. Table 4.2 also depicts the instructional implementation, by means of task complexity for each phase. As explained in each column, the complexity of tasks slightly increases in each phase. The arrangement is designed to help students focus on the task at hand while learning to appropriately follow the protocols of the MCM. For example, each company (team) is responsible for presenting one part of the electromagnetic spectrum among the following waves: radio waves, gamma rays, x-rays, microwaves, infrared, ultra-violet waves, and visible. For this project, each company member (student) must choose one dimension of that particular wave to become an expert in and must represent their company on this topic during the company presentation that takes place at the open house. During this presentation students are asked to briefly explain each part of one electromagnetic wave referencing their work artifacts (i.e., if a company chooses to study radio waves, each team member needs to study some concepts of the radio waves. These concepts can be: the range of the radio waves, the importance of radio waves, the reason we need to know about the radio waves, etc.). This process is like portfolio sharing of Linda Darling-Hammond (Darling-Hammond, Ancess, Falk, 1995).

### **Blending Science and Technology with the MCM**

The Light and Scratch Unit is blended with MCM. As part of the curriculum, students are first given scientific contents with related activities to develop basic understanding on the subject-matter. Then they practice how to develop an animation that can prove their understanding of science content using Scratch. This is such an effective way for the students to comprehend using the software program while building a deeper understanding of the “Light” concept throughout this experience. For example, in the “What are the Wavelengths” topic,

students do an experiment that creates the visible light section of the electromagnetic spectrum. Then, through some scaffolded instructions (via worksheets, videos, and a PowerPoint slide deck) students discover how the frequencies of wavelengths change across the spectrum, which affects the colors we see. Last, students create a project in Scratch that demonstrates their understanding of the electromagnetic spectrum of the visible light. In the below Figure 4.1, one of my students is illustrating the visible spectrum with a Scratch animation. Once the animation page is open on your computer, you need to use your cursor to move the banana on the colors to see their frequency values and their significance of each color in the spectrum.

<https://scratch.mit.edu/projects/2216733/>

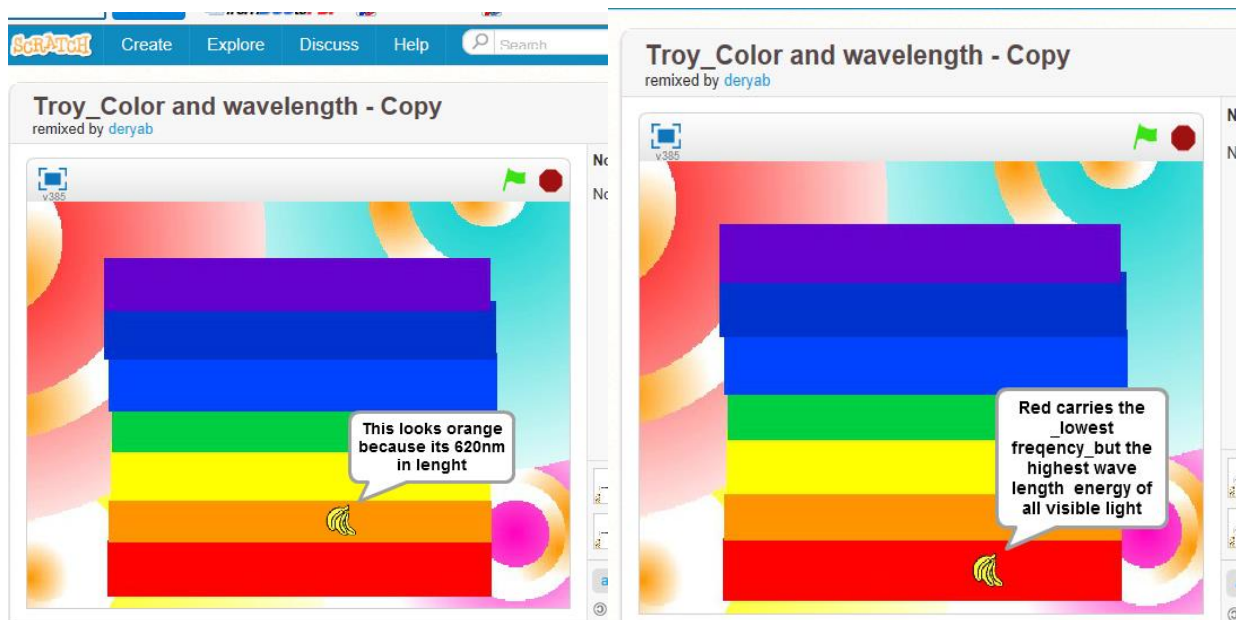


Figure 4.1. Scratch animation, illustrating the connection between colors and wavelength.

Table 4.2.

*The Implementation of the Task Complexity*

The Metacognitive Competence Development STEPS	STEP 1		STEP 2	STEP 3			
The MCM Implementation PHASES	Phase I Teacher's Observation and Reflection	Phase II Students' observation and Reflection	Phase III Introduction of the MCM and its Protocol & Co-developing the Principles	Phase IV Modeling	Phase V Practicing	Phase VI Executing	Phase VII
Task Complexity	Very simple task for students to individually and collaboratively accomplish on their own without any MCM guidance	Simple task that requires a collaborative group work	Similar task as Phase II	Task for each week that gradually gets more complex	Group Project To plan, prepare, rehearse, share-revise, perform	Execution: i.e. to create a project of their own about light- and demonstrate their understanding through scratch animations	
The weekly unit: Learning Tasks	History of Animation, Making Flipbook	Scratch introduction and How light travels	How we see: What is light? & What are the light sources -Continue working on the scratch: inputs and the outputs of the scratch system	What is the Electromagnetic Spectrum? -Using Scratch animation software, Creating a diagram of the electromagnetic spectrum	What are wavelengths? Mixing of Colors.	Students will Create a project in Scratch that demonstrates their understanding of light.	
Learning Resources	-Animation graphic organizer -a reading passage about history of animation -BrainPOP video that describes a short history about animation and how animation works	-How light travels worksheet Review of how light travels to the eye so that we can see. Then, students will use Scratch to animate the flipbooks they created in lesson1.	-Comprehension of the Light topic via discussion and further worksheets -sources of natural and artificial light worksheet -further studying scratch	-Electromagnetic spectrum worksheets -Video on the internet to research the parts of electromagnetic spectrum - making a diagram using the scratch animation	- Studying the parts of Electromagnetic Spectrum with worksheets & Studying the visible light		

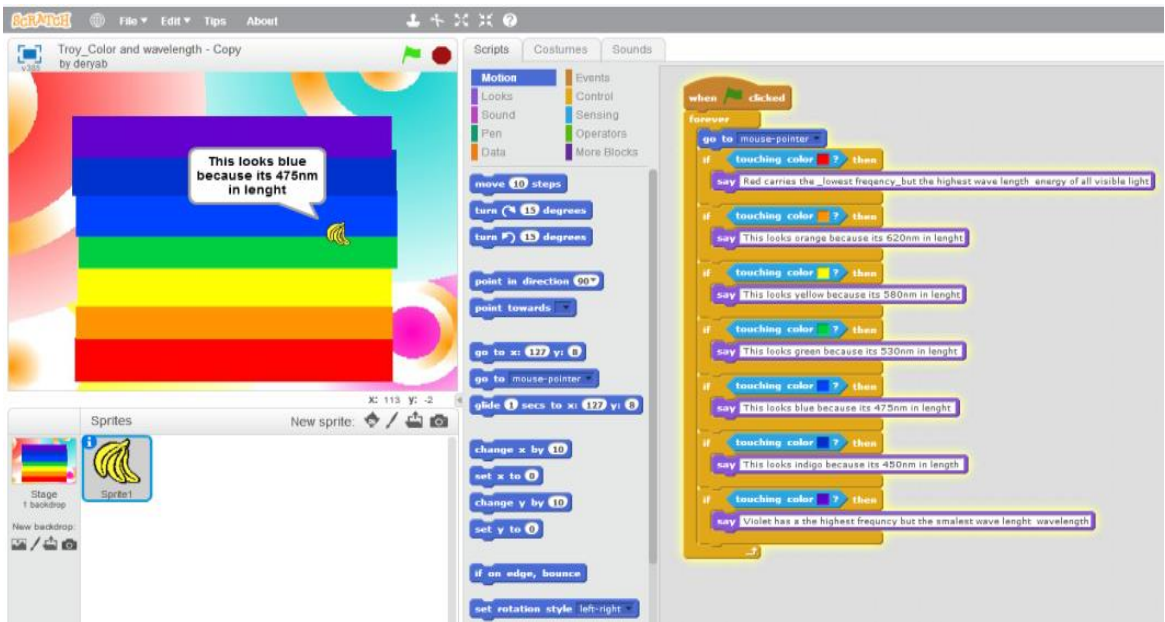


Figure 4.2. Color and wavelength scratch animation programming illustration.

**Scratch Software Program.** Scratch is a programming language that is used to create interactive stories, games, and animations. Scratch was developed by the Lifelong Kindergarten research group, led by Mitchel Resnick, at the MIT Media Lab in 2003 (<http://llk.media.mit.edu>). This group develops new technologies that, in the spirit of the blocks and finger-paint of kindergarten, expand the range of what people can design, create, and learn. The development of Scratch has been supported with funding from the National Science Foundation, Microsoft, Intel Foundation, Nokia, and the MIT Media Lab research consortia. Scratch allows users to use event driven programming with multiple active objects called "sprites." Sprites can be drawn - either as vector or bitmap graphics - from scratch in a simple editor that is part of Scratch, or can be imported from external sources, including a webcam.

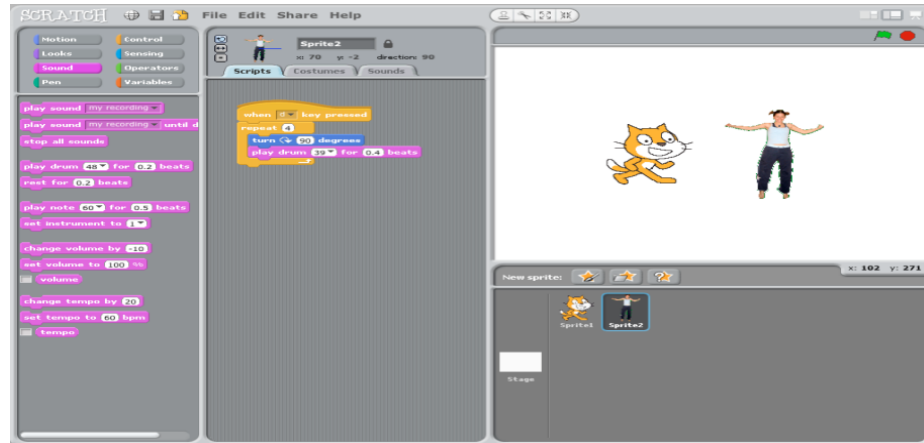


Figure 4.3. Illustration of scratch screen including its programming environment.

**The Lego Mindstorms Robotic Making and Programming Software.** The

LEGO MINDSTORMS Education Kit tool was used during the Spring 2012 curriculum.

With this tool, students can build robots and use its software to plan, test and modify sequences of instructions from a variety of real-life robotic behaviors. They gather and analyze data from sensors using data logging functionalities such as graph view.

Robotics is an exciting way to bring STEM education to use in Technology Access Foundation.

LEGO MINDSTORMS has powerful, easy-to-use software for programming and data logging. The software incorporates a comprehensive digital user manual and is based on LabVIEW. Key Learning Values of this tool includes using input and output devices and producing a simple set of sequential instructions linking cause and effect, developing and testing a system to monitor and control events, using intuitive prediction tools to get first-hand experience with making hypotheses, using the scientific inquiry process when gathering and analyzing data sets as well as integrating math and science using physical

constants, units of measurement, coordinate systems, min, max, mean and linear formulas.

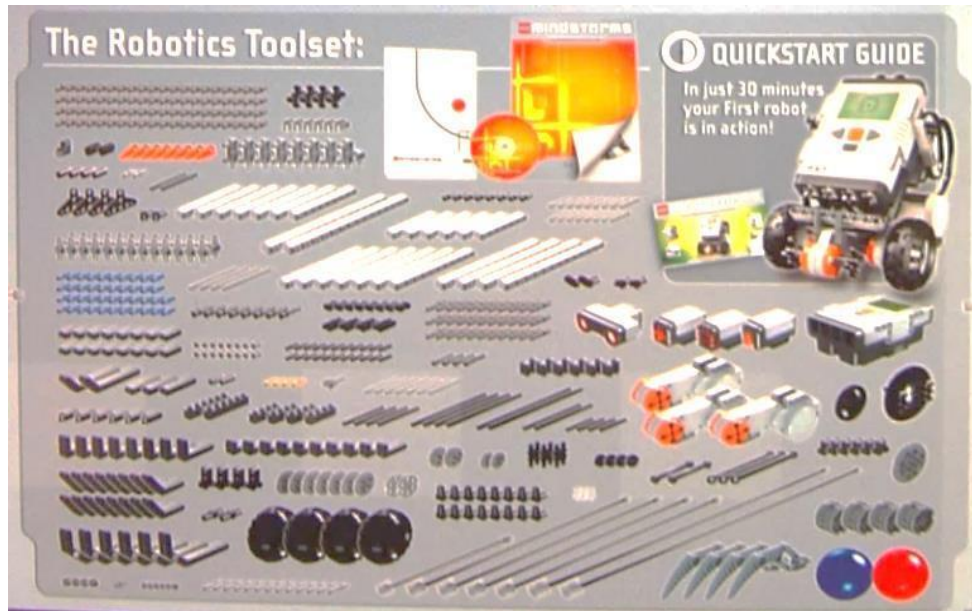


Figure 4.4. The Lego tools in the LEGO MINDSTORMS KIT.

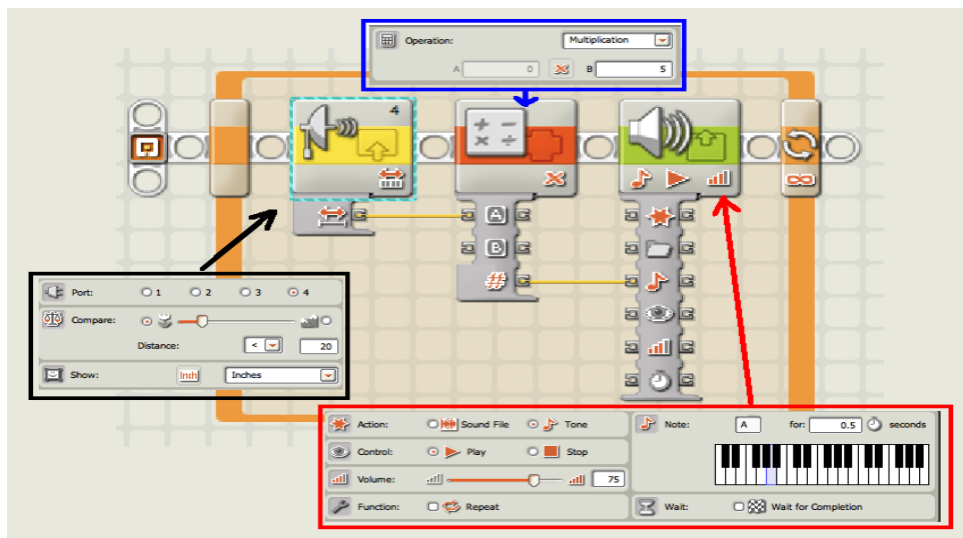


Figure 4.5. The LEGO MINDSTORMS programming environment.



*Figure 4.6.* An example of a complete robot that has a sensor.

## **Research Participants**

### **Participants**

I was the only instructor and an active researcher in this project. I taught two classes named Coppers and Nickels that were composed of grade 3-5 students. The students were highly diverse racially, ethnically and socio-economically. Based on the student population who registered for these classes, there were a total of 23 students, with the student population having been 47.83 % African American, 39.13 % Asian, 8.70 % Hispanic, and 4.35 % European. There were 15 female and 8 male students. There was no ELL or special need students.

All copies of data had the participant's name replaced with a unique study code. Videotaped data were transcribed and any references that directly identified subjects were either removed or replaced with the study code.

**The Volunteer Assistants.** The volunteer assistants were assigned to each class by the OST program, the after-school institution. They agreed that these assistants take part in the project as well. The volunteer assistants were informed and briefly trained about the project, but not given detailed information about it. They were explained that students' learning enactments and their written planning and reflections were to be measured for the project. For this they were asked to take field observation notes and interview the students during the project using the pre-designed forms and a uni-dimensional Likert scale designed by the researcher (see Appendix D and Table 4.6). They were also asked to video record the general class activities, focusing on teams and or student at a time. The volunteer assistants worked with the teacher and students as part of a team during the social coaching process, but they didn't take part in academic instruction. Parents were invited to stop by the classes anytime and contribute to the project as observers. Some parents served as volunteer assistants, along with some UW graduate and undergraduate students, high school students and employees of Microsoft and the Bill Gates Foundation. While the volunteer assistants' presence was based on their availabilities, I always had some assistants who work with me throughout the entire project I only had two or three assistants who worked with me continuously throughout the quarter.

### **Sampling of Participants for the Case Studies**

In answering the research question 4, to explore any emerging patterns of students' self- and collaborative empowerment in relation to their learning outcomes, I

chose to develop case studies. Case study “is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 1994, p.13, in Merriam, 1998, p.27). It “is an end product of field-oriented research” (Wolcott, 1992, p. 36, in Merriam, 1998, p.27). This methodological approach gives me a leverage of looking at the emerged patterns with a keener eye.

I developed three case studies. The reason I chose those three cases is because I noted three cases that stood out among the general categorization of the emerged patterns.

To sample participants, I sought for any relevant pattern. For this, I calculated each individual student’s gain score, and placed students under their team in another chart. Upon examining each team’s and their team members’ gain scores, I hypothesize three clear patterns that may be an indication of the expected connections:

- a. Repeating pattern of high self-academic gain score of individual students in different teams as a possible indicator of self-empowerment due to the MCM practices.
- b. Repeating pattern of similar or homogeneous high academic gain scores within the same team as a possible indicator of co-empowerment due to the MCM practices.
- c. The conflicted, heterogeneous gain scores within the team as a possible indicator of dis-functioned/malfunctioned MCM practices.

### **Research Collection and Analysis**

In this section, after sharing the data collection process of the MCM throughout the school year, I will describe about the measurement instruments, along with the

measurement methodology including how, when, where and by whom the data were collected. Then I will share about the data coding as well as coding and reliability processes.

### Context of Data Collection

There are five data collection processes; pre-assessment, training, practice, post-assessment and follow up as shown in Table 4.3.

Table 4.3.

*Data Collection Procedure within the Sequence of the Project*

BEFORE (BI)	INTERVENTION (DI)					AFTER (AI)	FOLLOW UP (FI)
Pre-assessment	Training Process of the MCM		Practice Process of the MCM			Post-assessment	Follow up Process
	Scaffolding		Fading		Transfer		Informal
Phase I <i>Observation</i>	Phase II <i>Reflection</i>	Phase III <i>Intro: MCM</i>	Phase IV <i>Modeling</i>	Phase V <i>Practicing</i>	Phase VI <i>Performing</i>	Phase VII <i>Presenting</i>	Phase VIII <i>Internalizing</i>
<ul style="list-style-type: none"> <li>• Pre-questionnaire</li> <li>• Pre-achievement test</li> <li>• Field observation notes</li> <li>• Video recordings</li> </ul>	<ul style="list-style-type: none"> <li>• Field observation notes</li> <li>• Video recordings</li> </ul>		<ul style="list-style-type: none"> <li>• Field observation notes</li> <li>• Video recordings</li> <li>• Entry and exit forms as written reports of students' individual and social progress of planning, executing and reflecting of their actions</li> </ul>			<ul style="list-style-type: none"> <li>• Post-questionnaire</li> <li>• Post-achievement test</li> </ul>	<ul style="list-style-type: none"> <li>• Field observation notes</li> <li>• Video recordings</li> </ul>
Week 1  1 week 2 classes October 10 <sup>th</sup>	Week 2  1 week 2 classes October 17 <sup>th</sup>	Week 3  1 week 2 classes October 24 <sup>th</sup>	Week 4&5  2 weeks 4 classes Oct 31 <sup>st</sup> - Nov 7 <sup>th</sup>	Week 6&7  2 weeks 4 classes Nov 14 <sup>th</sup> - Nov 28 <sup>st</sup> Thanksgiving break	Week 8&9  2 weeks 3 classes Dec 5 <sup>th</sup> - Dec 12 <sup>th</sup>	Week 10  At the end of the day on the Dec 12 <sup>th</sup> Open House	After four months of the end of the Intervention  The entire spring quarter of 2012

During the data collection process, the primary source of the data was pre-questionnaire, field observation notes, students' process forms such as entry and exit forms, individual and social progress reports, pre- and post- achievement tests as well as students' work artifacts. Video recordings were also taken for the activities, to serve as secondary sources of the data to support the primary evidence. Audio recordings were also made, but there never was a need to refer to them, and they were not used as a source of evidence.

The data collected were used for the measurements only in the following processes: the pre-assessment that took place before the intervention (pre-assessment-BI), the practice process for the Self-action Regulation Protocol (SARP) that took place during the intervention (Practice-DI), post-assessment that took place in the end of the intervention (Post-assessment-AI), and the follow up of the intervention that took place four months after the intervention (Follow-up-FI).

Please note that even though it was part of the practice process, Self and Peer Coaching Protocol (SPCP) was not included in the measurement of this project. It is because the focus of this project is to find out about the development process of self-action regulation for collaborative learning. Due to the high volume of its data content and the complexity of the entire project, I kept the SPCP protocol out of the measurement.

In the following section, I will explain the data collection process within the MCM intervention processes as also shown in Table 4.3.

The theoretical part of the MCM alone includes two sections: *training*, where the metacognitive awareness building and the knowledge construction take place, and *practices*, where the regulatory control process takes place. The application of the project, however, blends with the model and the measurement process. Thus, the entire application of the project takes place in five stages namely pre-assessment, training, practice, post-assessment and follow up.

### **The Data Collection Processes of the MCM**

**Pre-Assessment Process.** Pre-assessment process took place before the intervention (BI), and included *Phase I*. The objectives of the pre-assessment process of the MCM is:

1. Learning from students about their perceptions about their learning performance:
  - a. Via pre-survey questions
2. Learning students' initial academic scores on the subject matter:
  - a. Via pre-test for the academic achievement (21<sup>st</sup> century Assessment Tool)

(The subjects: Light, color, electromagnetic spectrum and its application, blended with scratch programming, fractions, and algorithm applications).

3. Learning from students' enacted learning performance:
  - a. Via field observation notes
  - b. Via video recordings

4. Develop social-emotional bond with students, via diary keeping, and preparing them for the metacognitive planning, monitoring and reflecting process.

**The Training Process.** The training process began with the beginning of the Intervention. This process is composed of scaffolding sub-processes, which focuses on first developing metacognitive awareness for each student of what kind of learning community they naturally form. Second, upon building such awareness, construction of metacognitive knowledge and understanding in answering questions like; “What can be done to better their current learning environment, and form a better learning community, and how to work toward this goal? What are the individual and collective responsibilities to assume for?” The scaffolding sub-processes cover *two phases; Phase II and Phase III.*

The following is an outline of the training process of the MCM:

1. Sharing the observation results that took place in the Phase I, BI.
  - a. Letting students know the overall observation results in general.
  - b. Comparing those results with students’ perceived learning performances.
  - c. Having a discussion to help students develop awareness/social cognition of their own learning actions.
  - d. Letting students briefly observe themselves and others as practice.
  - e. Discussion about kind of learning community they naturally form currently.

2. Introduction of the model:

- a. Discussion about the possibility of creating a successful learning community: how can it be possible, what and how each of us can contribute to it.
- b. Asking them to co-develop some principles that will become our main learning actions to practice during the learning processes.
- c. Bringing the necessary scaffolded tools, some in the form of metaphor:
  - i. “You are a Gem” metaphor. This is to explain students on how they can use these principles to develop more nurturing attitudes toward themselves and others (see Chapter 3, for more detail).
  - ii. “We are in the same boat” metaphor. This is to explain how our individual impacts affect others while directly affecting ourselves.
  - iii. The Self and Peer Coaching protocol (SPCP) and the Self-Influence Regulation Protocol (SIRP). These are the protocols of the MCM, which are introduced in this period to prepare students for use during the Practice Process (see Chapter 3, for more detail).

**The Practice Process.** The practice process took place in the rest of the Intervention including Phase IV, V, and VI. This is the process where students had a

chance to practice the MCM protocols. Please note that the students only attended to classes twice per week for ten weeks as this was an after-school program. Yet, they practiced those protocols for each activity uninterrupted during the overall six weeks period of *Phase IV, V, and VI*.

The following is the layout of this process, which is the foundation of the protocols:

1. Planning: Planning forms are presented to the students in the beginning of each activity. They were asked to plan the following items in written form:
  - a. Mood Regulation: Adjusting the daily mood into the learning mood
    - i. Making connection with individual's impact on the team participants' learning
  - b. Goal Framing: Framing the individual and team goals connected to one another. Students were expected to write their responsibilities both to their individual task, and to their teamwork
    - i. Writing individual task planning
    - ii. Writing the individual's contribution plan for the team
  - c. Learning Actions Planning:
    - i. Individual action planning (planning of the academic actions)
    - ii. Social inter-action planning (planning of the social actions)
2. Execution: Practices of the Protocols

3. Reflection:

- a. Metacognitive reflection about the overall execution of the planned process during the activity.
- b. Metaemotional reflection about emotional effects on the success of the regulation
- c. Metacognitive Reflection about the teamwork

**The Post-Assessment Process.** *Phase VII* takes place in the post-assessment process, where students were given a post survey to share their understanding of the MCM and their perceptions of their current learning attitudes. The following is the outline of the post-assessment process of the MCM:

1. Learning from students' about their latest perceptions on their learning actions
  - a. via post-survey questions
2. Learning students' post academic scores on the subject matter
  - a. Via post-test for the academic achievement (21<sup>st</sup> century Assessment Tool)
3. Letting students present their expert topics and share their portfolios with their parents via portfolio sharing during the open house.

**Follow-Up the Intervention Process.** Am I able to carry on the applications of the MCM/ Am I regulating my actions and interactions on my own?

*Phase VIII* takes place in spring quarter of the same school year, four months after the intervention. Phase VIII is an important phase to see if students show any pattern that indicates whether metacognitive competence in governing their self-influence for their

learning actions was internalized when the formal implementation of the MCM has ended four months ago.

During this phase students were learning about robotics. Students first learned about the introduction of robotics, which includes the LEGO Mind NXT Robotics Kit and its software, in order to program their robots. The students were asked to work as pairs. They were sub-teamed based on their original teams that they formed in the fall quarter. With their team-mates, they were expected to complete some complex tasks. For example, students were asked to calculate inventory in order to have some ideas about the correct names of more than 60 types of LEGO pieces. Each team of two students had a kit, and there was a different amount of each type of LEGO. They were expected to classify, add, and calculate their costs. Then they made gravity cars for a race, built a few sample models, and practiced programming their robots. After that, the teams chose to build a robot to participate in a specific competition. They used what they learned during the previous lessons to create robot that can complete a particular task. In the end of this quarter (spring), the teams represented their classes with their robots at the end-year EXPO Competition. One of the teams received the first-place trophy in one field. As an action researcher, I took field observation notes, and collected some data composed of some videos, photos and artifacts related to these activities. These data are relatively limited compared to the intervention data, but sufficient to track some patterns in students' learning actions.

## **Instruments**

**Pre-questionnaire.** Pre-Post questionnaires, lasting approximately 25-30 minutes and using a semi-structured questionnaire protocol were administered to participating students. The questions were seeking students' perceptions about their learning actions. Students were asked how they approach their academic and social learning. For example, students were asked to describe how they behave in a team, whether they feel they are supportive and respectful while working in a team, how well they focus when working on a learning task, and whether they feel that they are efficient or not. Students' responses indicated their perceptions of their own learning actions towards being focused, efficient, supportive, and respectful (see Appendix B).

**Pre-Post Academic Achievement Tests.** Pre- and post- academic achievement tests were administered to participating students, lasting approximately 45 minutes. These tests were prepared by 21<sup>st</sup> Century Assessment Protocol, a private company. They prepared the questions for the OST program classes using the curriculum material for each quarter. The questions were prepared in the form of multiple-choice question. There were in total 17 questions. I requested their use for the dissertation project as supportive evidence (see Appendix C).

**Field Observation Notes (FON).** The observations took place within the context of routine project-based learning activities. The participating students' learning actions the actions that translate demonstrations of being focused, efficient, supportive and respectful were observed during these activities.

I was the main field observer, as the teacher and the active researcher. I wrote my observation notes both during and after the class. The supportive field observers were the volunteer assistants. Their textual observation notes were gathered and used as supportive evidence of the data. I prepared a semi-structured protocol for the volunteer assistants to follow in their observations, which was a form for them to fill out and submit to me in the end of each activity. Based on our review together with my volunteer assistants, I made some revisions of those forms in the beginning of the process to make them more effective (see Appendix D).

**Video Observation Notes (VON).** Usually there were at least one or two video recordings for the same activity for the Copper class. Although for the class Nickel I had fewer video recordings, I made sure gathering sufficient data for each class via recording.

Upon transcribing each of them; I watched these video records multiple times and took further notes in detail in each time. This way I was able to capture additional supportive evidence on students' learning actions and interactions.

Sometimes, multiple videos were taken in the same class activity from different perspectives. Watching at least two such videos was extremely helpful to better pinpoint where students' spotlights were. This opportunity provided a broader perspective for me and allowed me to better observe and understand students' enacted performances on their academic and social learning actions. There were some behaviors that I saw only while watching the second video from a different perspective. There were some conversations

between me and my students. I could better pinpoint where my students' focus was when I examined through comparatively watching and listening to both recordings.

VONs were used as complementary sources of the evidence to more accurately detect students' real enactments, or students' interactions with each other, subject matter, and with their teacher during the activity.

**Work Artifacts.** Work artifacts were used as supportive evidence particularly to further examine how efficient and focused the students were during their learning process. I used "Work-Artifact Protocol" as a reference for further examine my students' comprehension level. This protocol was developed as part of "Critical Friendship Group Protocols" of Harvard Project Zero in 2003 (Given et al., 2010; Kline, 2008; Little, Gearhart, Curry, & Kafka, 2003). I had a chance to practicing these protocols while assisting the teacher candidates at the University of Washington. Students' work artifacts as the expression of students' understanding says a lot about their learning approaches and orientations as well as their academic levels (Ruiz-Primo, Li, Ayala, & Shavelson, 2004; Ruiz-Primo, Li, & Shavelson, 2002). Even though I collected this data as a secondary supportive evidence, I referred to it particularly for the case studies I conducted to answer RQ4 and RQ5.

### **Measurement Methodology**

In the following paragraphs, I will share my aim, and hypothesis of each research question for each measurement processes, as well as explaining what instrument I used to answer each research question. The overall process is depicted in Table 4.4.

Table 4.4.

*Sources of Data and Analytic Method*

RQ	Aim	Data Collection and Intervention process	Instrument used to collect data	Analytic Method
RQ1	To test the initial metacognitive awareness of student in terms of their self-influence toward their individual and team learning (SIL) before the MCM	Pre-Assessment BI	Pre-questionnaire Field-observation notes Video recordings	Quantitative SPSS- paired t-test
RQ2	To examine whether metacognitive competence of SIL is in progress in terms of developing accurate consistency in (a) execution of plan of actions (b) reporting the execution of planned actions	Practice DI	Field-observation notes Video recordings	Quantitative SPSS- paired t-test
RQ3	To examine the overall relation of the MCM in terms of any change in students' observed enactments between BI-FI	Practice and Follow-Up BI-FI	Field-observation notes Video recordings	Quantitative SPSS- paired t-test
RQ4	To examine the possible effects of the MCM tools that were used periodically via its protocols in terms of developing metacognitive competence in SIL and its correlation with the academic test scores.	Pre-Post Assessment & Practice BI-AI- DI	Pre-Post Academic Test results Field-observation notes Video recordings Work Artifacts	Mix; Quantitative & Qualitative:  SPSS-paired t-test & Case Studies
RQ5	To examine any observable pattern in students' learning communications that indicate improvement that may be correlated to the MCM intervention DI, four months ago.	Follow-up FI	Field-observation notes Video recordings Work Artifacts	Qualitative

**In order to answer RQ1**, students were given a pre-questionnaire and asked how they approach their academic and social activities. After this pre-questionnaire, the students' classroom interactions were observed. This observation was important to accurately compare *students' perceived actions (their beliefs) versus enacted learning (observed actual learning actions and interactions)*. Data were collected and turned into

numerical values using a coding system, which will be explained later in this chapter.

*The aim was* to find out if students were aware of their own learning actions and interactions. *The hypothesis* was that students do not have a high awareness level of how they act or interact in their academic and social learning processes. When there is no accuracy in pinpointing self-acts in those areas, this can be also interpreted as a lack of metacognitive competence in governing of actions for SIL. It is, otherwise, most likely that students do not pay adequate attention to how they act or interact while learning. Thus, they are not aware of the crucial need of developing a capacity and will-power to effectively govern their thoughts and emotions to balance their academic and social acts as an outcome to better contribute at a time in developing collaborative learning communities. *The measurement methodology* was to compare students' questionnaire results that show their perceived learning actions, with the combined data of field observation notes (FONs) and video recording notes (VONs). *The testing instrument* was paired-t-test. The analysis result to answer research question one will be shared in the next chapter (Chapter 5: The Analysis Results & Findings).

**In order to answer RQ2**, the data that students textually reported on the planning forms that they submitted were used to compare students' planning versus their real performance (students' learning enactments). *The aim* was to see if the students' learning enactment matches with their self-reports about how they acted and interacted with an accurate consistency. This was also to test if planning is helpful for students to pay more attention to their learning actions. This comparison was important to see if students were

developing self-action regulation skills and becoming more metacognitive thinkers about their learning actions and interactions. *The hypothesis* was that students would become more aware of their academic and social learning actions after the experience with the model. *The measurement methodology and testing instruments include*; the paired-t-test SPSS analysis tool to see whether there is a significant difference between the planning and the learning enactments of the students, as well as consistency in accuracy measurement through the comparison of the means for one randomly selected learning action. For this measurement, each team members reported planning and reflections as well as their observed executed enactments were compared for three to four consecutive weeks.

**In order to Answer RQ3**, students' enactments that were video and field recorded during BI, DI and FI in random activities were compared. *The aim* was to find out the overall association of the MCM in terms of any changes in students' observed enactments between BI and FI. *The hypothesis* was that as a result of dedicated practices that blended with metacognitive awareness and knowledge, it is expected that observed enactments of students DI should be different than BI while DI is expected to be similar to FI as an extend of habitual act is expected after the intervention. Both the SPSS paired-t-test and bar graph analysis were used as *the testing instrument*.

**In order to Answer RQ4**, the pre-and post-achievement test results were used and out of general categorization three case studies were examined. *The aim* was to examine possible self- and co-empowering association of the MCM through students'

consecutive use of MCM tools and its possible correlation with the academic gain scores. *The hypothesis* was that successive use of MCM tools may have an association both on student's self- and co-empowerment processes in forming successful learning communities, and consequently the way the students make use of this process may reflect on their academic achievement.

**In order to answer RQ5**, students were informally observed in their learning activities via video recordings and field observation notes FI. *The aim* was to understand if students demonstrated the same learning actions when there is no formal requirement like in the model application. *The hypothesis* was if students developed self-action regulation skills, then they can still regulate their academic and social learning actions four months after the intervention. I tested students' enacted learning data results between BI (before the intervention), DI (during the intervention) and FI (Follow up of the Intervention) by using the paired-t-*testing instrument*.

### **Data Coding**

Coding is the most important part of the analysis as it plays a significant role in shaping the analysis and thus the results (Foss & Waters, 2003, February 6). For this project, I was able to collect sufficient evidence from multiple data sources, including written pre-post questionnaires, extensive field observation notes taken by the teacher and volunteer assistants, for the same activities. In addition, I have multiple video recordings taken from different angles of the same activities as well as students' written reports and their work artifacts for each activity.

## **Unit of Analysis**

The primary unit that is the subject of statistical analysis (Salkind, 2010) for this project is *student's learning action*. The data was collected to analyze students' perceived versus enacted learning actions. While the focus was student's learning actions, specifically two concepts of interest were analyzed. One is academic learning actions, and the other one is students' social learning actions.

## **Coding Scale Developing Process**

Using the qualitative data, I first classified the patterns of pre-determined learning actions. Next, I developed themes from this data. Then I developed a conceptual schema defining the coding scale as shown in Table 4.5, after that I turned the interpretations of the leveraged patterns into numerical codes using the Likert Scale (Foss & Waters, 2003, February 6). Once I compared the students' responses versus their observed enactments, I could easily examine whether students were accurate in their perceived learning actions or not. Likert scale was also useful in more precisely pinpointing the level of accuracy.

Please note that in this project, while before the intervention (BI) students' natural enactments were observed and gathered as data, during the training, students were trained and helped understand how to develop or improve capacity on any learning actions through putting conscious effort and determined dedication, and periodical practices of pertinent performances. Then during the intervention (DI), which is after the training, the

data was collected through observing students' enactments examining whether consistent effort is demonstrated through such actions.

Students were also helped through semi-structured debates and discussions to name possible essential performances to build the needed capacities, particularly on being focused, efficient, being supportive and respectful. It was noted to both the students and the observers that any relevant performances, which signal developing those learning actions in students' behaviors would count and can be also used as data. Some of the definitions are illustrated that defined as the coding scale as shown in Table 4.5 (see Appendix E).

Table 4.5.

*Defining the Coding Scale*

<i>Type of Action</i>	<i>Specific action</i>	<i>Definition of the Specific Actions</i>	<i>Indicators of Actions</i>
<i>Academic Learning Actions</i>	<i>Being Focused</i>	<i>actions of "being focused" refer to demonstrated intentions through prioritizing practices of primary tasks by balancing the acts</i>	<p><i>through putting effort:</i></p> <ul style="list-style-type: none"> <li>• by not getting scattered (or not allowing any distraction to act responsibly, or controlling to eliminate any distraction,</li> <li>• by appearing focused and making progress with an evidence (for this, look at their work artifacts, and their progress when they are at work),</li> <li>• by visually getting busy with their tasks such as reading quietly, looking at the screen and continuing working, writing, etc.,</li> <li>• by asking relevant question(s) or talking thoughtfully about the relevant topic.</li> </ul>
<i>Social Learning Actions</i>	<i>Being Supportive</i>	<i>actions of "being supportive" refer to demonstrated intentions through paying attention to both own and others' actions by balancing the acts</i>	<p><i>demonstrating sympathy and encouragement toward team-mates through putting effort:</i></p> <ul style="list-style-type: none"> <li>• by assisting them when needed, or providing space,</li> <li>• not being argumentative,</li> <li>• by rather having a positive attitude toward any team issued &amp; team learning,</li> <li>• by acting like a contributing team-player, while being able to act independently as an individual learner.</li> </ul>

Before the beginning of the entire project, I had developed a Likert scale coding system when I designed the students' metacognitive planning and reflection forms (as daily entry and exit tickets). Using this initial Likert Scale scoring system, to examine the entire data uniformly, I developed a more detailed uni-dimensional coding scale as shown in Table 4.6.

In order to make use of this Likert scale as comparable across various sources of the entire data, I categorized and classified the learning actions in the form of action verbs based on this numerical scale. That way, I identified each numeric value with detailed description. Consequently, myself, or any of my volunteer assistant eventually learned how some actions fall into some specific numerical values. Students were also asked to rank their intention using these numerically coded data.

This coding system was helpful to look at different data and be able to interpret them with the same coding scale. That allowed me to see the level of students' engagements with the relevant principles throughout the entire process.

Seeing the level of students' determination and how it functioned in their performances was a strong indicator to provide an insight on whether the training process was helpful in terms of raising their awareness, building the necessary understanding metacognitively that was planned to trigger the necessary willpower for students to assume their responsibilities through taking charge of governing their SIL overall.

Table 4.6.

The Uni-Dimensional Coding Scale

<i>Likert Scale Coding for the MCM Project</i>		
score	The Inferred Proficiency/Ability /Aptitude Level in Acting with Awareness	Students' responses
<b>0</b>	Not aware at all	Don't know, N/A
<b>1</b>	May be aware, yet no action is taken	No, never
<b>2</b>	Actions may take place from time to time but not on a regular basis; not predictable	Rarely, sort of, sometimes, often
<b>3</b>	Actions occur on a regular basis; moderately predictable, but not yet habitual	Usually, generally, frequently
<b>4</b>	Actions appear to be habitual routines/as a habit of mind driven by automatic /motor-skills; highly predictable	Yes, always, I care a lot

**Indicators of the Learning Principles.** Upon careful examination of the co-developed principles, I reclassified the learning actions as the learning principles into four umbrella/main indicators. They are namely: being focused, efficient, supportive and respectful. Using the action-verb-indicators for each principle, (I will explain in later sections), I collected the overall data. Later, I interpreted the field observation and video recording data based on those indicators in order to measure all the research questions both qualitatively and quantitatively. For the quantitative ones, I used the Coding scale to interpret the level of those indicators being performed by my students.

As being focused, efficient, supportive and respectful are loaded words, and neither easy subjects to describe and identify, I followed a special procedure to pinpoint

these actions accurately. For example, when I observe that a student is paying attention to another team-mate by listening to him/her, and asking thoughtful questions, and so forth, I listed the following indicators “listening, making eye contact, asking thoughtful questions, providing space” under being respectful (See appendix E). These indicators were *action verbs*, when successively and attentively used they may take role in developing such learning actions. Thus, I sought for such small-actions in my observations to pinpoint the willingness, determinism, and will-power to develop any earlier defined learning actions. Seeking for these action-verb-indicators were helpful for accurate scoring during the video recordings.

I watched the video records many times after transcribing them. I took lots of notes under each category, and for each student. I also referred to the field observation notes (FONs), and work artifacts (WAs) to ensure the accuracy of the data.

While some actions were very clear and appeared consistent across records, others were less so. On some occasions, having multiple video perspectives showed those students' actions could be interpreted completely differently, given more information. For example, there were times when I looked at one video sample; I scored a student being very efficient finishing her work fast. Then I looked at the other video, in which I captured my verbal conversation with the same student looking at her work artifact and saying “*but sweetheart, you may have finished it very fast, but you didn't do it right. Did you not read the instructions; did you not listen to me?*” Had I not had the second video recording for the same lesson, I could have missed this important detail and I could have

scored her action as efficient. To avoid such situations, even though most of the video recordings were quite time-consuming as each of them were around 90-minute long, I watched, took notes, and transcribed the necessary pieces in multiple video recordings during data gathering.

There were many other examples. When I just thought the actions of the students were referring to being focused, efficient, supportive or respectful, I found out that their work artifact was not yet reflecting this or was showing me slightly different evidence.

Please note that, in order to analyze such different aspects of students' learning actions throughout the phases of the project, I applied the same coding scale (Table 4.6) particularly for the FI phase to answer RQ5. Using the same scale, I generated codes depending upon the new circumstances. For example, this included evidence based on observation of students working together:

- a. Are students making explicit attempts to follow the model? (what are those attempts, how do they believe, what is their reaction toward model?)
- b. What type of learning dynamic occurred during the process of daily planning and reflection processes?

### **Ensuring the Interrater Reliability of Coding**

Rater 1 is the researcher, who is also the teacher. Rater 2 is a software engineer and a professor, who is interested in research, math and analysis. He was given a set of artifacts that have been coded by Rater 1 and were given the task of learning how to make these coding judgments in order to establish the reliability of the coding judgments. There was a sample data layout on an Excel sheet that was ready for the analysis. The

rules for coding were also given in written form for each type of artifact on the data layout. Rater 2 reviewed the coding layout and rules in the written form and then used them in coding a training set of cases for each artifact. After coding of each type of the artifact using its coding rules, and before discussing them with Rater 1, Rater 2 were asked to suggest changes in the coding rules for an artifact if he thinks it is necessary. Then Rater 1 and 2 discussed the results as well as any proposed changes in the coding rules and the coding rules were revised accordingly. This process was to make sure that the coding methodology is the best fit for analysis of each of the artifacts, which in return should increase the reliability in coding the full set of artifacts. Rater 1 then analyzed the full set of cases of each type of artifact and Rater 2 was asked to analyze a sample of cases (20%). The average 90 percentage of agreement between scorers for the sample provided a measure of reliability for each coding category.

## **Chapter 5: Findings and Analysis**

In this chapter, findings and data analysis are laid out after a summary and rationale for how data were collected and analyzed for each research question.

### **RQ1-Are Students Aware of Their Own Learning Actions Initially?**

#### **Hypothesis and Source of Data for RQ1**

During this time, students' academic and social actions (their learning actions) were observed through field observation notes as well as video recordings while everyday curriculum was carried out. No information was shared about the Metacognitive Coaching Model (MCM). The main goal of this process was to find out whether students were aware of their own acts during their learning process.

**Research Question 1 (RQ1).** Before the intervention (BI), that is, before undertaking the training and practices of the MCM intervention, how aware were students of their social and academic actions during individual, and collaborative/team learning?

In other words, before the MCM intervention, what is the level of students' initial metacognitive competence regarding the ability of regulating learning actions in general through governing SIL? More specifically, are students initially able to accurately monitor and reflect upon their learning actions before the training and the application of the MCM intervention?

**Hypothesis 1 (H1).** H1 states that most students' perceived self-thoughts about how they act as individuals and team learners don't necessarily match with how they act

in the learning environment. In other words, most students are not able to accurately monitor and reflect on their learning actions. For this reason, most students are not aware of their real learning enactments.

**Hypothesis 1a (H1a).** H1a states that due to students' lack of awareness of their actual learning actions they are not completely aware of their self-influences on their and others' individual and team learning processes.

H1a states that students have *lack of adequate awareness* of their actual learning actions. This is not only a lack of alertness, attentiveness, consciousness, attention, or focus on the way they truly enact while learning, but also a lack of discernment and knowledge of the importance of paying attention to how they may be naturally acting (responsively) versus how they should be acting (responsibly), and what to do in order to do so. This realization and knowledge along with its needed skill training on acting in a balanced way possible at a time is crucial due to its direct and indirect impacts onto the selves and others while learning.

Thus, because of this missing foundational understanding, what is observed in most students is the lack of *importance-giving* for the needed willingness to apply the necessary will-power. Through such self-control students can consistently be aware of their-self-emotions-thoughts flow, which is an essential step needed to develop capacity for governing SIL to stabilize and filter out thoughts and emotions to produce balanced acts at a time. By means of *developing ability to be an observer of the self*, in return

further help them better contribute their own and others' learning environment with their best performances in a responsible way.

As a result of such gap in understanding, the actions come out responsively, as reactions of those mixed impacts resulted with unfiltered products of action. Unless they are provided with adequate training processes that help them raise their awareness, build knowledge and develop capacity to become metacognitively competence in governing their SIL, it is more likely that students may not choose to pay a primary attention to it. Thus, they don't pay attention to it.

To answer RQ1, and to check H1, and specifically H1a, during the BI process, I administered a pre-survey and pre-interview to students asking how they approach their academic and social activities. Then I designed a unidimensional Likert scale which I used to convert the data into numerical values (see Table 4.6 for the Uni-Dimensional Coding Scale). Next, I took field observation notes and video recordings of the students' work during six consecutive activities focusing on the defined *action verb indicators*, which addresses the learning principles that are the so-called *learning actions* (see Chapter 4 for more details).

### **Findings for RQ1**

For the first layer of the analysis, the average of students' responses about their perceived enactments for each action was compared with the average level of observed enactments in order to visually observe the tendency of students' responses and to find any emergent patterns. The findings are shown in Figure 5.1.

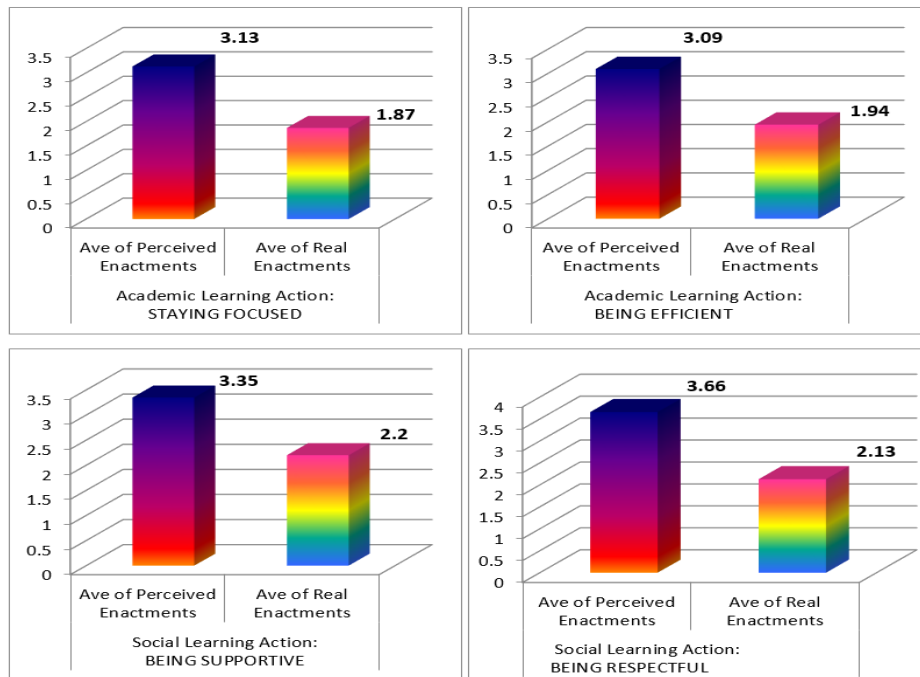


Figure 5.1. Students’ perceived versus enacted actions.

As observed in Figure 5.1, students’ perceived versus enacted academic (being focused and efficient) and social learning (being supportive and respectful) actions that took place Before the Intervention (BI) was compared.

For the question “How focused, efficient, supportive, and respectful do you think you act while working on a learning task?” the students’ average responses do not match the cumulative field observation and video recording results. The average responses of students about their learning actions ranged between 3.09 and 3.66 out of 4. Given the 4-point Likert Scale-Code Chart in Table 4.6, we can say that the average students’ response indicates that they believe they are either “usually, generally, or frequently” focused, efficient, supportive, and respectful, which is represented as a value of 3 on the

chart. Students perceive that they engage in these actions on a more regular basis, so these actions' occurrence is more consistent and predictable, but not yet habitual as they still do not occur automatically.

Looking back at Figure 5.1, contrary to students' reports based on their own perceptions about their approach toward their individual and team learning, the average of the observed values for real enactments for the students vary between 1.87 and 2.2. Students were observed as going back and forth between having no focus at all and being rarely, sort of, sometimes, or often focused (see Table 4.6). This may mean either of these actions may not be taking place at all, or that students engage in them sometimes, but not on a regular basis.

**Students are not metacognitive about their learning actions.** The above chart analysis results indicate that students are not accurately aware of their learning actions. We can also conclude that students may not be able to correctly pinpoint their overall actions, and thus they are not able to think back on what they do and recall precisely. That means they are not able to think metacognitively about their learning actions as accurately as needed, because they are not metacognitively competent of thinking back and recalling their actions as they are. Thus, they neither are aware of their self-influence on theirs', nor others' learning.

### **An Emergent Finding about Self-Perception**

One of the emergent findings based on the above result is that students consistently overestimate their performance. In the psychology literature, this tendency is

called the *overconfidence effect*, in which a person's subjective *confidence* in his or her judgments is reliably greater than the objective *accuracy* of those judgments. According to the results of relevant studies, overconfidence has been defined in three distinct ways such as overestimation of one's actual performance, over placement of one's performance relative to others, and over-precision in expressing unwarranted certainty in the accuracy of one's beliefs (Dunning, Griffin, Milojkovic, & Ross, 1990; Moore & Healy, 2008; Pallier et al., 2002).

Research indicates that students perceive their actions and the appropriateness of those actions while learning as better than what they actually are. Students generally believe that they are much more focused, efficient, supportive and respectful than what they actually are.

**Are Students' Perceived Enactments Consistent with their Actual Enactments?** Based on the paired t-test results for RQ1, in order to determine whether there is any significant statistical difference between students' self-belief and real enacted learning actions during the BI process, I continued the data analysis by performing the SPSS paired t-test analysis to compare the students' perceived versus enacted learning actions in terms of Academic Learning Actions (ALA; staying focused, being efficient), and Social Learning Actions (SLA; being supportive, being respectful). Table 5.1 reports the paired t-test results. Across the four aspects of learning, students' perceived proficiency level was significantly higher than the level of the observed enactment.

Table 5.1

*Paired t-test Results for Perceived versus Enacted Learning Actions*

Outcome	Pre-survey		Observation		n	95% CI for Mean Difference	r	t	P (T< = t) two-tail
	M	SD	M	SD					
Focused	3.13	1.58	1.87	0.51	23	0.58, 1.94	-0.14	3.50	0.002
Efficient	3.13	1.56	1.87	0.66	23	0.57, 1.95	0.11	3.35	0.003
Supportive	3.09	1.56	1.95	0.66	23	0.45, 1.83	0.11	3.35	0.002
Respectful	3.66	1.15	2.13	0.97	23	0.54, 2.52	0.21	5.43	<.001

These differences in the results show that students' perceived enactments based on their responses in the pre-survey do not match the cumulative real enactments that were gathered from the field observation notes as well as video recordings. Students are not accurately aware of their learning actions. Indeed, students consistently overestimate their performance, which is consistent with research findings in psychology. They perceive their actions and the appropriateness of those actions while learning as better than what they actually are. Students generally believe that they are much more focused, efficient, supportive and respectful than what they actually are.

We reason that students may not be able to correctly pinpoint their overall actions, and thus they may not be able to think back on what they do and recall precisely. This means they may not be able to think metacognitively about their learning actions as accurately as needed, because they are not metacognitively competent (yet) of thinking back and

recalling their actions as they should be. Thus, they are not aware of their self-influence on their own, or on others' learning. In addition, this lack of awareness may hinder students from discerning how they truly act in their academic and social learning.

## **RQ2-Are Students Developing Metacognitive Regulatory Control over LAs?**

### **Hypothesis and Source of Data for RQ2**

In order to not only raise students' initial awareness, but also develop the capacity of metacognitive competence that includes building metacognitive awareness, metacognitive knowledge and regulation capacities, I developed a training and a practice process in the MCM. The following question is to examine after *the training process*, during *the practicum process*, whether metacognitive competence is developing through practices of planning-execution-reflection protocols (During the Intervention).

**Research Question 2 (RQ2):** During the intervention process (DI), is the metacognitive regulatory control over learning actions being developed in students as they practice and perform the MCM protocols using the planning, execution and reflection assessment cycle, and if so, do students (a) demonstrate any consistency in executing their plan of actions or (b) demonstrate any consistency in reflecting their executed plan of actions?

***The Hypothesis 2a (H2a).*** During the practicing and performing of the MCM protocols, students are expected to develop a ***consistency*** between their planning and executions of their plan of actions. This ***consistency*** can be a sign of student progress in developing metacognitive regulatory control in terms of being able to execute their plans

of action during the performance phase. Thus, if there is no significant difference between the students' planning and the execution of the performance phase report analysis, then it can be inferred that the students are developing *consistency* in executing their plans of action.

This can also be interpreted as evidence of students developing awareness, specifically about being more mindful: of planning what to do, knowing what to do, and being more thorough and thoughtful of thinking about what to do and how to act. In other words, this will be an evidence of students becoming metacognitive/thinking metacognitively about executing their plans of action (in our case learning actions).

*The Hypothesis 2b (H2b).* During the practicing and performing of the MCM protocols, students are expected to develop *an accuracy* in reflecting their executed plans. Thus, this *accuracy* can be a sign of development of not only metacognitive regulatory control, specifically of students' being able to reflect on their executed plans, but also development of metacognitive competence out of accurate reflections of these executions as a result.

Hence, if there is no significant difference between the execution and the reflection data in the performance phase report analysis, then it can be inferred that the students are developing more consistency in accurately reflecting their executed plans, thus metacognitive competence out of consistent planning and execution and accurate reflection of those.

This can also be interpreted as students developing sharper alertness, *which is an improvement of awareness in becoming more conscious in plans of action, and their execution and reflection*, by being more mindful, thoughtful, and profoundly informed and knowledgeable of what they have done. In other words, this is evidence of students becoming metacognitive and, or thinking metacognitively about reflecting an executed plans of learning actions.

In order to test H2a, the numerically coded results of the students' self-written plan of actions are compared with the average of the cumulative sum of the field observation and the video recording evidence of students' enacted actions, and this data was coded in the same unidimensional way to make the comparison possible.

Regarding H2b, students' self-written reflections of their execution are compared with the cumulative sum of the field observation along with the video recording evidence of students' enacted actions. Then this data was coded in the same unidimensional way to make the comparison possible.

A 2-tailed paired t-test was used in order to check the three conditions: entire classes' consistency and accuracy measure on the planned versus enacted actions as well as enacted actions versus reflected actions. For this, only the Performance phase (Phase VI) was used as during this phase there was complete data of the whole class, with no absences or incomplete submissions.

## Findings for Comparing the Planned versus Enacted Actions

In order to test Hypothesis 2a, I performed the paired t-test to examine whether students could execute their planning through making conscious efforts to better execute their plans for being more focused, efficient, respectful, and supportive within those dedicated consecutive weeks. The t-test results are reported in Table 5.2.

There are no statistically significant differences at the .05 significance level in planned and enacted learning attitudes for being focused, efficient, supportive, and respectful. The results show that students can execute their plans successfully, at least during those three weeks DI. Thus, there is no evidence to reject H2a. Results indicate that students are successful at executing their plans.

Table 5.2

*Paired t-test Results for the Accuracy between Planned versus Enacted Learning Actions DI*

Outcome	Planned Actions		Enacted Actions		n	95% CI for Mean Difference	r	t	P (T< = t) two tail
	M	SD	M	SD					
Focused	3.73	0.45	3.59	0.43	23	-0.11, 0.39	0.42	1.51	0.14
Efficient	3.59	0.54	3.78	0.42	23	-0.47, 0.09	0.47	-1.84	0.07
Supportive	3.78	0.52	3.85	0.36	23	-0.33, 0.19	0.12	-0.53	0.60
Respectful	3.83	0.49	3.85	0.36	23	-0.27, 0.23	0.17	-0.19	0.85

It can be interpreted that the planning section of the MCM functioned successfully in helping students to become more mindful of their individual and social actions during

the learning process. It can be also inferred that students are in the process of developing their metacognitive skills for planning and executing of their actions.

### **Findings for Comparing the Enacted versus Reflected Actions**

This paired t-test analysis attempts to compare between the students' beliefs about their actions versus their demonstrated actions. Therefore, if students' reflections of "what they think they did" matches with the observed execution of students' enactments, this indicates that the intervention has a positive effect. In other words, this indicates that students are capable of pinpointing their execution as a result of developing metacognitive regulatory control over their individual and social actions. Table 5.3 reports the t-test results.

As displayed in Table 5.3, for the "being focused" responses, there is a significant difference between the enactments versus students' self-reflections. This shows that students were still not successful in pinpointing the extent to which they were able to place a closer focus on their learning or not. Students are still perceiving themselves doing better ( $M=3.78$ ) than they do in being focused ( $M=3.59$ ). In other words, "*overconfidence effect*" is still at work.

Yet, no statistically significant differences at the .05 significance level in enacted and reflected learning actions were observed for being efficient, supportive and respectful. The results show that, except for the reflection of being focused, students are able to pinpoint how they performed in their reflections successfully during the intervention. Specifically, the results suggest that for the most part, students were

becoming more aware of how they behaved individually and socially in a collaborative learning task as a result of the MCM training.

Table 5.3

*Paired t-test Results for the Accuracy between Enacted versus Reflected Learning Actions DI*

Outcome	Enacted Actions		Reflected Actions		95% CI for Mean Difference	r	t	P (T< = t) two-tail
	M	SD	M	SD				
Focused	3.59	0.43	3.78	0.42	-0.44, 0.06	0.55	-2.30	0.03
Efficient	3.59	0.54	3.74	0.62	-0.49, 0.19	0.81	-2.01	0.05
Supportive	3.85	0.36	3.96	0.21	-0.28, 0.06	-0.09 <sup>6</sup>	-1.21	0.24
Respectful	3.85	0.36	4.00	0.00	0.003, 0.30	n/a	-2.03	0.05

It can be concluded that for the most part there is no evidence to reject H2. Students seemed to be partially successful at being able to accurately reflect their executions. It can be inferred that students' metacognitive competence on learning actions are in progress. I will also discuss in the conclusion chapter, probably the definition of "being focused" needed to be re-visited for students to better understand and act more consciously.

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<sup>6</sup> The value of R is -0.0923. Although technically a negative correlation, the relationship between the variables is rather weak.

## Consistency in Accuracy Chart Analysis

In order to see the detailed level of consistency in accuracy, the mean scores of each teams' "being focused" action were analyzed as observed in Table 5.4. For the chart analysis, consecutive *three or four weeks*<sup>7</sup> of data out of DI phase (based on students' complete data) including their planning, field observed enacted executions and self-reflections' mean scores were compared.

Looking at the chart in Figure 5.2, it is observed that there is a level of fluctuation particularly between observed versus reflected learning actions confirmed by the statistical results in Table 5.3, as the p value is greater than  $< 0.5$  for being focused in enacted versus reflected actions;  $0.3 > 0.5$ .

However, looking at the overall chart, students' fluctuations mostly appears between the score range of 3.0 to 4.0 based on the unidimensional Likert scale (Table 4.6). That means the action-verb-indicators (see Table 4.5) were observed while students were performing those learning actions between the range of score 3 and 4.

According to *Score 3*, it was observed that students were performing those learning actions usually, generally, frequently, and that the inferred proficiency is interpreted in the scale as *actions occur on a regular basis; moderately predictable, but not yet habitual*.

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<sup>7</sup> Please note that for the analysis of **RQ4** Week 6,7,8, and 9 data were examined. These weeks are corresponding to the Phase V, Practicing and Phase VI, performing phases of the intervention (See Table 4.3). While students began practicing the MCM tools in Week 4 and 5, that was a modeling phase and they received plenty of support. Thus, this phase was not included in the measurements.

According to *Score 4*, while students were performing those learning actions it was observed that they were always demonstrating the action-verb indicators of such learning actions. Thus, those actions appear to be as habitual routines / a habit of mind / driven by automatic, motor-skills, and highly predictable.

The line chart results (except Team Red) with the range of scores between 3.0 and 4.0 indicate that students can be considered being in progressive consistency, or an increased persistence (Burgess, 2012) is in progress in developing such a habit of mind, even though students' advancement for totally adapting this learning action in their attitudes for "being focused" is slower than the other learning actions. Looking at the chart, within this minimal fluctuation between 3.0 and 4.0 score range, still a level of *confidence effect* (Pallier et al., 2002) can be observed while *lower expectations of the self* (Oliver, 1977) is also obtained, even though in a lower level.

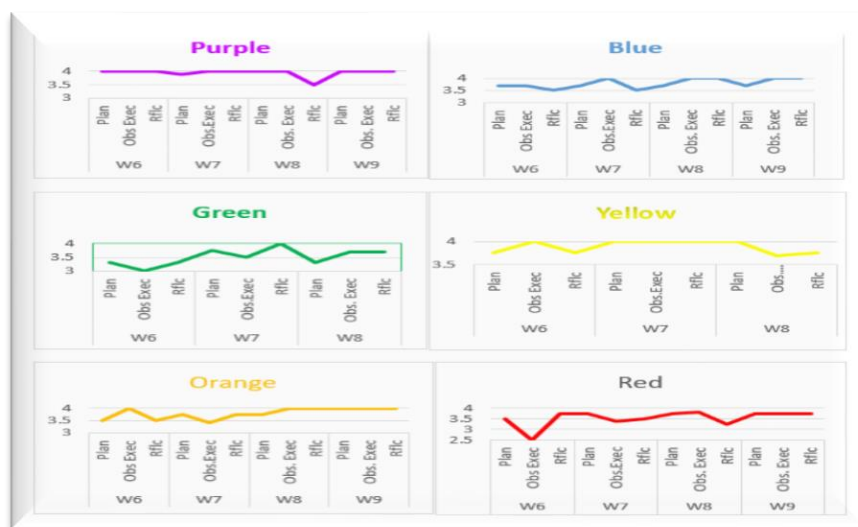


Figure 5.2. The mean of scores for each teams' "focusing" action out of 4.0.

### **RQ3-Are Students Enacted Learning Actions Altered Compared to BI and FI?**

#### **Hypothesis and Source of Data for RQ3**

Research Question 3. What is the association between the MCM application and students' metacognitive competence for regulating their learning actions/governing their SIL after four months of the intervention, within spring quarter (FI-follow-up Intervention where there was no formal MCM protocol applied) when compared to before the intervention (BI) that took place in the fall quarter?

**Hypothesis 3.** During the intervention (DI), the MCM significantly supports students in developing metacognitive competence in governing their SIL through providing systematically designed pathways, where they can continuously practice regulating their overall learning actions.

As a result of dedicated practices that blended with metacognitive awareness and understanding, it is expected that students' observed enactments DI should be different than BI; and it is also expected to observe an extent of similar enactments in the observed enactments of students' in FI, even which is after the four months of the end of the MCM practices.

This comparative statistical analysis aims to test if there is a significant difference in students' regulation of their learning actions before the MCM intervention (BI) versus the follow up intervention (FI) which took place after the four months of the project application.

### Findings for RQ3

As shown in Table 5.4, paired-t-test results reveal a significant difference in students' observed enactments BI (Before the Intervention) and FI (After the four months of the Intervention) for all four learning actions.

Table 5.4

*Statistical Results for the Differences in Enacted Learning Actions between BI and FI*

Outcome	BI Enactments		FI Enactments		n	95% CI for Mean Difference	r	t	P(T<=t) two-tail
	M	SD	M	SD					
Focused	1.87	0.26	3.65	0.39	23	-1.97, -1.59	-0.05	-10.38	< .001
Efficient	1.95	0.43	3.61	0.36	23	-1.89, -1.43	-0.14	-8.38	< .001
Supportive	1.87	0.26	3.65	0.39	23	-1.97, -1.59	-0.05	-10.38	< .001
Respectful	2.13	0.94	3.83	0.21	23	-2.09, -1.31	0.21	-8.33	< .001

As observed in Table 5.4, there is a significant difference in all four learning actions between observed enactments of BI and FI. This significant difference between BI and FI can be interpreted as the differences in metacognitive awareness, knowledge and understanding as well as progressive development in becoming metacognitively competent toward governing SIL by means of MCM practices.

In order to further examine whether there are any meaningful differences between BI and DI; and similarities between DI and FI, using the most complete data from each intervention, I calculated the cumulated mean scores for all four learning actions and developed a comparative 3-D column graphs as shown in Figure 5.3.

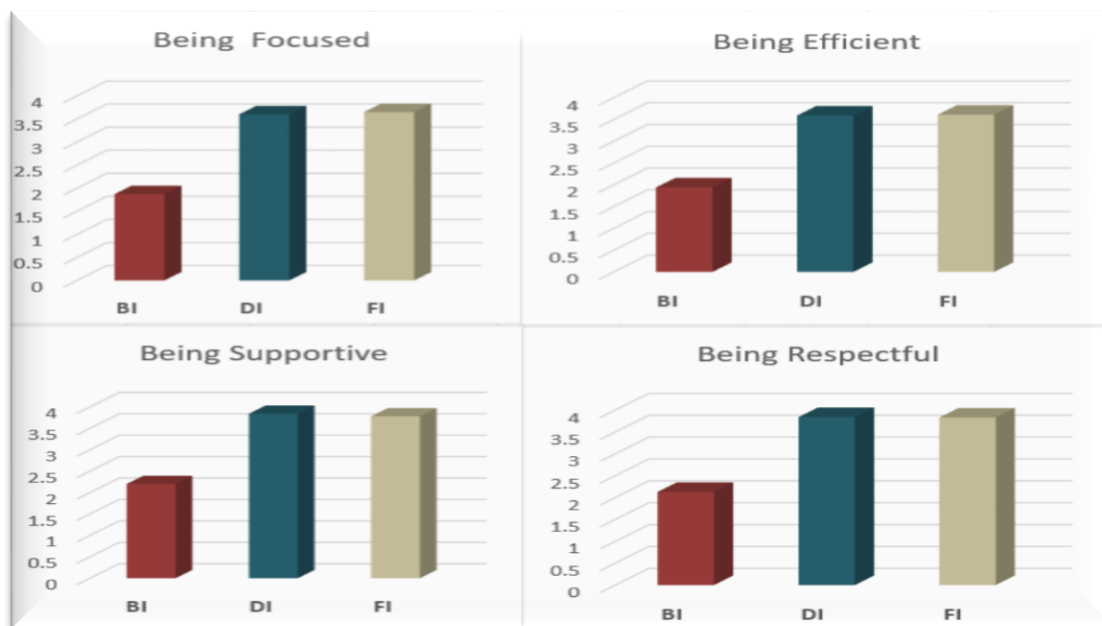


Figure 5.3. The mean of scores for each teams' learning actions for BI, DI and FI.

As observed in Figure 5.3, while there is a significant difference between the all four learning actions of BI and DI; the similarities in the mean scores of four learning actions in DI and FI is considerable.

Thus, it can be concluded that the MCM significantly supports students' progressive development of their metacognitive competence on governing their SIL through regulating their overall learning actions. It can be also inferred that while students demonstrated high level of practices DI and FI, mean scores were in the range of 3.60 and 3.84 out of 4.0, that indicate, based on the unidimensional Likert scale (see Table 4.6), *learning actions occur more on a regular basis; moderately predictable, but not yet habitual.*

## **RQ4-Does Practices of MCM Support Self- & Co-Empowerment Development?**

### **Hypothesis and Data Sources for RQ4**

RQ4 examines whether there is (1) student learning, and (2) any observable patterns of self- and/or collaborative empowerment pertaining to the engagement of the MCM take place while practicing MCM protocols toward developing metacognitive competence over their SIL. In more details, RQ4 seeks for understanding while practicing MCM protocols toward developing metacognitive competence over their SIL, is there any observable pattern on students' responses to the mood adjustment, goal framing, and academic achievement test scores that shows engagement in and attainment of self-empowerment and thus collaborative-empowerment?

Many factors may play role in the students' academic achievement. Being able to witness throughout my on-going field observations and simultaneous teaching process, I noticed and hypothesized a possible correlation between the process of students' self- and co-empowering, and their academic achievements in both directions. Thus, I found that it is worth for checking whether there is a significant correlation.

Next, for the measurement and analyses, as explained in Chapter 4, I used pre- and post-academic achievement test scores to examine possible correlation between students' academic gains and their engagement in and attainment of self-empowerment and collaborative-empowerment.

In sum, after finding out that there is a statistically significant academic achievement between the pre- and post- test results, I received for the entire group of six,

I clustered students' pre- post- achievement and gain scores under their teams. Next, I sought any patterns that shows positive or negative clustering, and /or stand out within their teams and compared to the whole team.

As a result, I captured, three cases. Next, to seek for and examine any relevant correlations between the students' academic achievement and gain scores, I used students' work artifacts as needed and written submissions of the MCM planning and reflection forms belong to phase V-practicing phase (week 6 and 7) and VI-performing phase (week 8 and 9) (see Table 4.3 for details). There was also data belong to VII-presenting phase (Week 10). I sometimes referred it only when available as it was an optional week and students were not required to fill out their planning or reflection forms. Yet many students preferred to fill out these forms. Using those data, I developed three case studies (see details in Chapter 4) comparatively analyzing any patterns and progress in developing self- and co-empowerment within the teams that shows similar correlation to their academic score patterns in both individual and collective levels. Next, I will share this process in detail.

#### **Findings for RQ4**

Student learning was assessed based on the 21<sup>st</sup> Century Online Assessment tool, was solely designed by the company of P21 Partnership for 21<sup>st</sup> Century for Learning based on the OST program curriculums (Assessment). Students from the two classes (being three teams from each class, six teams in total) were administered the tests individually at both the beginning and end of the quarter. A paired-samples t-test was

conducted to compare the amount of correct answers responded by students before the teaching begins (pre-test) and in the end of the Fall Quarter, after the teaching ends (post-test) (see Table 5.5). Students performed statistically significantly better on their post-test (M=12.74, SD=3.05) than pre-test (M=6.65, SD=2.69), indicating the growth of their learning.

Looking at the post-test scores, 61%, 14 students out of 23 gained the highest score between 12 and 17 out of 17; 35%, 8 students out of 23, had mid-score which is ranging from 6 to 11 out of 17, in contrast to one student out of 23 who had the lowest score as 5 out of 17. That means for the 96% of the students, the MCM lessons were helpful for students to learn the subject matters.

Table 5.5

*Paired t-test Results for Pre- and Post-Achievement Test Scores*

Outcome	Pre-test		Post-test		n	95% CI for Mean Difference	r	t	P(T<=t) two-tail
	M	SD	M	SD					
Scores	6.65	2.69	12.74	3.05	23	-7.59, -4.58	0.27	08.40	< .001

**Connecting student learning to students' self- and co-empowerment during the MCM practices.** As explained in Chapter 4, in order to entirely examine the effect of the MCM applications, I first analyzed each team's progress throughout the quarter qualitatively, while paying attention to the emerged patterns of their academic gain scores. As a result, the three case studies I sampled upon further categorizing students' academic gain scores investigates: for case one, an individual student's self-

empowerment progress, for case two, a team's transformation from power conflict into positive team learning dynamics, and for case three, a team's late progress in developing the needed team dynamics and its overall effects.

### **Analysis of the Emerged Patterns of Possible Self- & Co-empowerment Signs**

In the case study analyses, I focused on describing each team's learning process dynamics based on my field observations, including each student's general approach toward practicing the model, their actions and attitudes during learning processes and the possible connection with their learning outcomes.

The comprehensive reasons I chose three cases are because I noted three cases that stood out among the general categorization of the emerged patterns are as follow:

*Case one is the analysis of P2 (Purple2) in terms of her self-empowerment progress.* P2 began the quarter with the lowest academic score compared to her team members. In contrast to that, she ended up with the highest score among her peers in her team. I also observed her during the intervention while highly engaged with the principles of the MCM practices. Thus, I found it worth analyzing her case to see whether the practices of the MCM has any influence in her noteworthy academic achievement.

*Case two is the analysis of Team Green in terms of their co-empowerment progress.* Looking at the post-test and gain scores, I noticed the harmonious improvement in terms of academic achievement. Even though I saw the same harmony in *Team Blue's* gain scores, the fact that the Team Green's participants began the quarter relatively with lower scores and ended it with higher scores (compared to Team Blue) helped me decide

on Team Green to further analyze them. With this analysis I look for whether there is any correlation of their academic gain scores with their co-empowered team dynamics out of making use of the MCM.

*Case three is the analysis of Team Red as this team has opposite-conflicted post-and academic gain scores. Detailed analysis of this team shed light into possible causes for the Team Red members' learning outcome, and it also helped me to see how the MCM could be functioned or malfunctioned in a team, and what needs to be done to take precaution for future applications.*

Please note that while covering a brief general outlook of teams as well as their members' approach toward using the MCM planning and reflection tools, I try to see if there is any parallel structure between the categorized responses of mood regulation as well as goal framing that can indicate a sort of self and co-empowerment progression, and possible correlation to the academic gain scores.

After these analyses, I was further intrigued to see the extent to which students took any progress in becoming self and/or co-empowering agents. Thus, in the following paragraphs, I share these analyses that I make connections with the students' individual work and interactions with their team participants as well as the dynamics developed out of their interactions within the groups during the project.

### **Case Study 1: Purple2's Becoming Self-Empowered Leader**

In the following paragraphs, after describing Team Purple and examine the general dynamics within this group, I share a short profile of Purple2 (P2) in the process

of BI and then examine the possible influence occurred DI that caused her being able to empower herself, and her be co-empowered by her team members, and their correlation to her academic gain score.

**Description of Team Purple.** In this team, both P1 and P4 were my students previously. I had P1 in my class for a year. I worked with P4 for two years prior to this project. Throughout the years, I observed their growth in both academic and social learnings. These students are familiar with my system in general, because I developed the MCM as an extension of my years of work. Yet, they had never gone through such systematic practices I developed for this project, which is the MCM *that blends merged protocols metacognitively as a spiral process*. Both P2 and P3 were new in my class and my system was truly new to them as well. Since P3 was attending OST program classes prior to this year, the STEM learning at OST Program was familiar to her, but it was not familiar with P2 at all.

During the quarter, although P1&P2 and P3&P4 sub-teamed, because P1 missed four critical MCM lessons due to sick days, P2 more often teamed-up with the other team members. As a result, I saw that the big team took the place of their sub-teams by the time being. Instead, a friendly climate evolved within their team. They were working altogether in solving any problem in their project. They even chose completing their worksheets together with a discussion while this was not a requirement but welcomed. The fact that P2 has the highest academic gain within her team, I wonder if there is any

influence of working with academically stronger peers for the high academic achievement the P2 got in contrast to P1 whose gain was relatively smaller.

Within Team Purple members, while the highest academic achievement score is belonged to P4 with post-test score: 15 out of 17, I captured an emergent pattern out of further examining both how much each member gained throughout the quarter and comparing their pre-post test scores to see the bigger picture. Team Purple members' pre-post-test resulted with scores of P1; 5-10 (+5 gain score), P2; 4-12 (+7 gain score), P3; 9-11 (+2 gain score), and P4; 12-15 (+3 gain score) out of 17.

Looking at P2 closer, who began the quarter with pre-test score 4 out of 17, which is the lowest out of her team, and ended with 12 out of 17 with 7+ gain score showed her noticeable effort to top her academic capacity.

Next, I look at the type of team dynamics evolved in Team Purple in terms of the MCM practices to see if there is any meaningful correlation that may possibly influence P2 to self-empower herself in her academic and social learning that can also impact such academic gain.

Throughout the report of each Team Purple member's plan of mood and goal-framing regulations, and reflections (see Appendix F), it is possible to track on how their planned regulations played role in their academic and social learning.

In the first week of the intervention, Team Purple members planned to act as hardworking-energetic-happy-responsible students and dedicated themselves to help their

teams “to be hardworking and focused learners.” Some examples of their responses in the Week6:

P1: *“I am adjusting my mood FROM happy and hardworking TO happy + energetic + hardworking + productive = ALL. My own task is: FOCUSING ON my work. My team’s task is: BEING QUIET, FOCUSING ON our work.”*

**P2: *“I adjust my mood TO FOCUS ON working. Because it might help you learn and get better grades. I will make them (my team) work hard as they can in a good worker (work).”***

P3: *“I adjust my mood from normal & not energetic TO excited and hardworking. I (‘ve) never been so excited (excited). ... because I didn’t always work that hard. My task is work hard and do my best. My team’s task is to help each other.”*

P4: *“I am happy ☺ because right now I am really looking forward to learning. Adjusting my mood TO A RESPONSIBLE LEARNER. Because you are working and happy. My mood will make them (my team) work more and feel happy. My task is scratch-light animation. My team’s task is how do we solve the EMS (electromagnetic spectrum).*

After these plans, their reflections demonstrated that they were able to fulfill their planned responsibilities both for themselves and their teams as follows:

P1: *“I feel happy & hardworking because I worked hard. My team also worked hard.”*

**P2: *“I feel happy, because I was fast. We were working together and asked for help. I felt happy at the end of the class. Because I had a great time. We worked together and talked to each other about what we need and helped each other.”***

In the following week (Week7) their plans were still concentrated on being “hardworking and focusing on their learning tasks both individually and as a team.” For example:

P1: *“I feel happy & hardworking. I feel like this because I am FOCUSING ON my work and just feeling happy. MY task is (working on my) written report. Our team’s task*

*is figuring out what we should be (doing for the team-project)."*

**P2: "I feel happy because I get some help from the teachers here. I am FOCUS(ED), and ON TASK and LISTENING TO OTHERS. I will make them (my team) BE ON TASK and QUIET DOWN. MY task for today is to finish all my work, save it to my account. (as a team) We are doing good, because we help (each other) to get faster and get better."**

P3: "I am adjusting my mood FROM normal TO happy. My task is TO DO MY BEST. Our team's task is TO WORK TOGETHER."

In the end of the activity in Week7, P1, P2 and P3 did not report any reflection (due to completing their daily assignments). P4 on the other had come late due to her prior activity, but she did write a reflection, and shared what had happened in this week:

P4: "I was able to adjust my mood because I worked a lot. This felt normal at the end of the class. I want to learn more. We shared what we did (on the) PPT and scratch and written work."

As observed in the Week7, team members were progressively planning to regulate their learning actions, and, in their reflections, they report that their planning has been working so far. In Week7, they are more tuned into their individual and team-projects learning. In Week 6, only one student (P4) mentioned her responsibilities on learning subject-matters. Yet, in Week7 P1, P2 and P4 included their task responsibilities more specifically in their reports.

Team Purple continued persistently reporting about how focused and hardworking they were as they progressed. They were proud of themselves for being able to do so as well.

In Week8:

P1 was tired from hard school work, yet still determined to commit apply herself through the MCM protocols as she stated: *“I am going to FOCUS ON my work and NO TALK to others. We can HELP EACH OTHER QUIETLY and NOT TALK A LOT.”*

P2 was happy and excited about what they will learn today. She was also determined to continue her good work along with her team members as she noted: ***“I help others to GET ON TASK. My task is FINISH THE SCRATCH. My team’s task is DO our BEST.”***

P3 on the other hand, challenging herself to not influence her old habit of “not working hard” affecting her team’s success. Her awareness and empathy toward her team-mates were striking, she apparently was setting her mind through her planning as: *“I am adjusting my mood FROM happy TO hardworking, because I don’t usually work hard some of the time. NO, (I don’t allow my mood to influence my team’s success), because I don’t want to get my team down. My task is to FOCUS ON my work, work hard and try my best. Our team’s task-help each other out when we need help.*

P4 in Week8 was feeling energetic and very much excited to learn as she reported. She adjusted her mood to “BE RESPECTFUL”. Then she wrote: *“I am very respectful. I can allow my mood to affect my team-because we can get all our work done. My daily task is PPT with P3. Our team’s is mixing colors, P1-written work, P2-scratch, P3-PPT.”*

As observed throughout Week 1-3 reports so far, Team Purple members were progressively and consistently re-programming their minds to act in any way they found necessary to co-build / to reshape, redesign / to maintain their learning community.

It can be inferred from their reports that each team member was putting constant and determined effort to co-build and maintain their small learning community. They appeared, they knew what was needed to do, and they made any necessary re-adjustment continuously, relating to their previous week practices of governing their SIL in general.

One can argue that students can always see, and able to pinpoint any lacking or working aspects of such learning communities as outsiders or witnesses if they were to ask. Having a chance to focus on straightening and strengthening any situation or issues on the other hand through examining both their and others' responsibilities in such objective and supportive way was a new for them. Addressing the needed regulations on the pre-determined principles just-in-time and consistently throughout the process, is evidently proving to function as one strong way to reprogram their minds to further develop metacognitive competence in governing their SIL.

At this point in Week8, through the practices of MCM, they had an opportunity to straighten and strengthen any issues in their learning performances to better influence their and others' learning within their team. In the end of their class in Week8, it appeared that they were content of their progress, as their reflections show the following lines:

P1: *"I felt happy and hardworking, because I worked hard, and I feel proud. I like we*

*we're working hard."*

P3: *"I was able to adjust my mood that felt happy. I had someone to talk & sort of playing with. We helped each other when we needed help."*

P4: *"I was successful adjusting my mood. I still want to work. I was interested when all my team members were FOCUS(ED)."*

These reflections tell us that Team Purple members were truly able to develop a synergy within their team that helped each other focused on their learning tasks both individually and collaboratively. This is a type of *synergy* that occurs in a successful learning community in the way Ann Brown describes (1988).

Team Purple's consistent dedication applying themselves practicing the MCM protocols persisted in Week 9. Similarly, to Week8, their self-esteem gradually increased.

In Week4: P1 planned as; *"My task is FOCUSING ON my work. Our team's task is TO TALK ABOUT THE SUBJECT, HELP EACH OTHER, FOCUSING ON our work."*

She reflected as; *"I was able to adjust my mood. I worked hard a lot and I feel proud. I like we were working hard."*

P2 reported in her planning that: ***"I am HAPPY because it is a GOOD DAY...I am AWESOME. Because it will help others to be FOCUS(ED). My own task is scratch. Our team's task is BE AWESOME. "Knowing what the scores was (were).***

Then she wrote in her reflection that:

P2: ***"I was able to adjust my mood, because in class it is fun. I feel normal at the end, because I am AWESOME. Knowing that the scores were: They are FOCUS(ED). (She means the scores pointed that they were focused)."***

P4: *"...I still want to work. I was interested when all of my team members were FOCUS(ED)."*

In the last week of the intervention (Week10) students were given an option to fill out their MCM forms or not as they were preparing for the “open house portfolio sharing”, and the workload this week was more than before. While P4 was excused out of sick-day, two of them chose to fill out their forms. Once more, they shared how focusing on their tasks, and working hard together functioned for them. They were proud of themselves and their team this time. They wrote:

P2: ***“I am PROUD OF MYSELF AND OTHERS. I felt happy at the end of the class. Because my teacher is proud of me. We all worked together and helped on the test complete done.”***

P3: *“I did a lot of work and my mom is gonna be happy. We helped each other, and we worked together.”*

As observed in the weekly responses, while P1 and P2 were very much engaged with the MCM practices, P1’s absences due to her sick days may have impeded her for gaining more both academically and socially.

Taking a closer look at P3 on the other hand shows me that she took this practice seriously, but as she expressed in her responses, she never had put in such hard effort into her learning tasks before. She apparently put an effort to become a more supportive team member at a time by trying to work harder than she normally does. Her responses show her thoughtful attitude toward her team. Her reaction in her responses on not letting her mood to affect her team success in the first two weeks, showed that she felt that her original mood was not supportive of her team success. In my field observations, I had a similar impression about her. I had picked up her pessimistic approach toward learning

from the beginning. She appeared as if she did not take things seriously, but as I better understood her, I saw that the hindering factor behind that which was the lack of her self-belief/confidence. This, however, changed over the time even slowly. Toward the end of the intervention for example she reported that she would allow her mood to affect her team success (see Appendix F). It can be observed of her plans and reflection process that the MCM practices self-empowered her through turning her spotlight to herself as she reported in the end: *“I did a lot of work and my mom is gonna be happy. We helped each other (with my team) and we worked together.”* Evolved co-empowerment within the team, through which her peers’ respectful support may have also helped her gain this needed leverage in her confidence to improve her outlook toward learning as a valuable team member. Looking at her gain score, one can interpret that she was not truly trying to improve herself maybe due to this lack of believe in herself. Yet in the end, she gained what was lacking in her. What she gained in this limited time due to strong teamwork through MCM practices, is a personal achievement. I strongly believe that with this new outlook, she has a stronger potential to gain much more in her future learning endeavor both academically and socially.

P4 on the other hand was a well-aware and a mature student. Knowing her in the prior years, observing her growing out of an extremely shy student to become more and more conscious, self-aware and confident student at a time was strongly promising. Her academic score which was 15 out of 17 was an excellent demonstrator of her good progress. She was one of the exemplary students in my groups. I strongly believe if she

did not have to miss some classes due to sick days or her sport-commitment that she had to come late or leave earlier within some weeks during the intervention, she could have contributed even more to her team.

***Promising Team Dynamic Developed Within Team Purple.*** Based on the comparative analyses out of students' test scores and their written reports toward governing their SIL overall, it can be concluded that they were not only able to transfer their understanding to each other about the learning topics, but also was successfully engaged themselves in their learning though being deliberately applying a closer focus to becoming a hardworking team at a time as they aimed for, which is one of the most important principles of the MCM.

Week 8 and Week 9 planning and reflection responses show that Team Purple members persistently continued practicing the same themes in more detailed regulation at a time. For example, Purple4 added "to become more respectful" in her adjusted mood (see Appendix F, P4, W8) and reflected in Week 9 as "*I was always supportive, respectful to my team because I care a lot.*"

Among all, P2 paid very close attention to details continuously on becoming more focused and hardworking at a time. She was dedicatedly detailing her goals every week to be '*on task, to quiet down, to get faster, and to get better*' in her journey to become a more focused hardworking learner (See Appendix F, P2).

Their plans and reflections show that the Team Purple members were very much into the self-and co-empowering process. Each member was showing genuine importance

to the MCM practices, while their absences may have affected this progress to some extent. Some of them were in need to develop and strengthen their self-belief, trust, and efficacy toward themselves to further improve academically. Some on the other hand, like P2, who were highly determined and dedicated were able to reflect their improvement in their academic scores. In the next section, I will share the case study of P2 to possibly tracking her remarkable self-empowerment journey.

**Initially Purple2 (P2) was not aware of her Social Attitudes in the Class.**

Based on the following brief comparison of P2's first day diary notes and some anecdotes gathered from a video transcript of the first week reveals that she believed that she is socially very supportive and respectful, while the observation result was not conclusive of her self-image of herself.

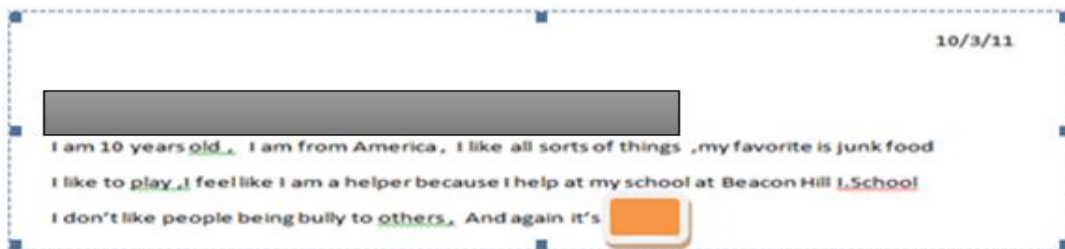


Figure 5.4. Purple2's first diary notes.

Reading her profile shows that she feels like she is a helper. It is inferred that she likes being *supportive*. She also stated she dislikes bullies that means based on Merriam-Webster dictionary, one who is habitually cruel, insulting, or threatening others who are weaker, smaller, or in some way vulnerable. One can interpret a bully as being strongly

*disrespectful* of others by means of pushing their boundaries. So, it can be inferred that she dislikes disrespectful actions.

The responses she gave on the pre-survey below, also indicates her belief/perception about herself being focused, efficient, helpful/supportive, and respectful

Table 5.6

*Purple2's Pre-Survey Responses on her Academic and Social Learning Actions*

<b>Pre-Survey Sub-Categories</b>	<b>Purple2 Pre-Survey Responses</b> on learning actions based on student responses
Individual Learning Actions: Being focused and efficient	I focus and pay attention, I learn by looking and listening to the teacher, I am focused, efficient, organized (organized), I follow instructions carefully. I am (have) a good sportsmanship.
Social Learning Actions: Being respectful and supportive	I innerack (interact) talk about things we are learning about. I listen to others comment and give sigjustions (suggestions). I would describe myself maybe something helpful, respectful.

As observed in the table above, P2 believes that she is a focused and efficient individual learner as well as a supportive, and respectful team participant.

**Before the Intervention, the Observation Data Reveals Different Aspects in P2's**

**Learning Actions.** Looking at the agenda in the Figure 5.5., item 5 indicates that students are to talk about animations (within small groups) and complete the first part of the worksheet that is the part of *the Definition of Animation Activity*<sup>8</sup>. For this activity students were distributed *an animation graphic worksheet*. Before watching the video about introduction of animations, students were supposed to brainstorm, discuss and share their background knowledge about it within their small team. The students were

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<sup>8</sup> Please note that *the Animation Activity* is the very first activity of the Unit. I analyzed the overall data from this activity, naming this activity as *Activity1*.

asked to write whatever they know collectively about animation on the *before the video* section of the animation graphic. They were then going to watch a video about the definition of animation. After that they were required to complete the *after the video* section of the worksheet to share what they learned out of this visually defined animation. Students were both visually and audibly reminded of this assignment multiple times.

Being this was the very first activity relevant to develop declarative knowledge about animation before beginning to make animation using papers, and software programming, it was important to capture their natural actions and interactions during such simple learning process.

	COPPERS FALL 2011 — WEEK 1-	oct 3rd	oct 5th	✓		NICKELS FALL 2011 — WEEK 1-	oct 3rd	oct 5th
1	to take attendance	✓		;	1	to take attendance	✓	
2	to learn about each other	✓		→	2	to learn about each other	✓	
3	to review the last year, last summer	✓			3	to review the last year, last summer	✓	
4	to create a personal diary	✓			4	to create a personal diary		
5	to talk about animations- starting the first worksheet: animation graphics	;			5	to talk about animations- starting the first worksheet: animation graphics		
6	to watch a brain-pop video about animation	;			6	to watch a brain-pop video about animation		
7	to complete the second part of the animation worksheet	;			7	to complete the second part of the animation worksheet		
8	to read an article about animation	;			8	to read an article about animation		
9	class discussion about animation				9	class discussion about animation		

Figure 5.5. “Daily to do Chart” I used for my OST program classes.

In the beginning during the activity, as observed in the below chart both the teacher and the volunteer assistant’s first impressions were positive and parallel to P2’s self-perceptions about herself.


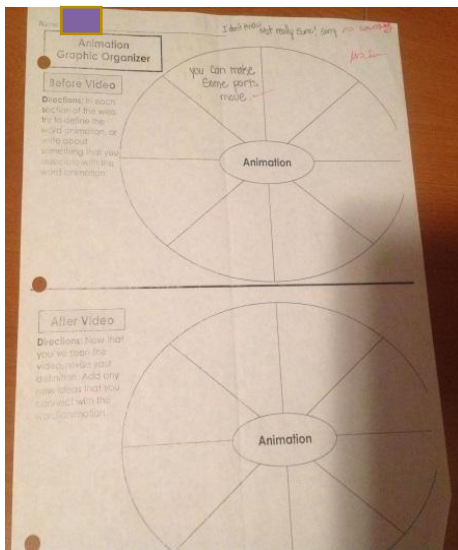
<b>Teacher's field observation notes:</b>	This is the first day. P2 doesn't know anybody, yet she is quick in making friends.		
<b>Volunteer Assistant's field observation notes:</b>		<ul style="list-style-type: none"> <li>• Knows what she's doing.</li> <li>• Waiting Patiently.</li> <li>• Silently thinking about "Animation".</li> </ul>	Not sure what animation is.

Figure 5.6. Field observation notes for Purple2 BI.

As observed in Figure 5.4., P2's work artifact that is the very first activity BI, about the definition of animation they we expected to write their theory, she wrote; "you can make some part move." She also added a note that says" I don't know. Not really sure! Sorry."

After watching the movie, students were supposed to take some notes and complete the "After Video" section of the worksheet. She did not write anything on this part.



Even though I was puzzled about this incomplete worksheet, considering it was the very first activity, I continued my observation on P2's learning progress. Meanwhile, I explained what the animation is in many other contexts through hands on flip book activities as well as online animation making program, called scratch, short article reading, etc. to prepare my students for the subject.

Figure 5.7. Purple2's first worksheet "Animation Graphics".

**Turned out Purple2 was neither acting respectfully, or supportive, nor working efficiently by focusing on her task at hand.** After the very first “animation” discussion activity, the following activity, Activity 2, was about creating paper-animations by making a flipbook. A short discussion session engaged students to brainstorm about how to make a paper animation. Upon this discussion, students were showed some examples. Finally, they watched a short clip on how to make fun flipbooks that work.

With the start of this hands-on performance activity, Purple2 started to act very independently in an unexpected way. As the following transcripts of the video about this session demonstrates, she was not paying attention to the instructions carefully, instead speaking at the same time with the teacher, teasing the volunteer assistant and demonstrating disruptive attitudes toward her team-mates. She was teasing them and creating irrelevant conversations with her peers as illustrated in the following transcript. Please note that T refers to “teacher.”

*T- I want you to think quietly and decide what animation you want to create. (And) As soon as you are ready, I want you to come here, and choose one of these post-it papers... GO! You can use extra sheets if you want to. And in the end, I am going to let you use the staplers.*

To her team-mates at the same time with the teacher:

*P2-Stop using that big large eraser.*

The volunteer assistant is asking her name, she is making fun of him giving him a wrong name:

*P2-So it is for the Jayne, no ....*

*R1-Noo, ...*

*B3-Her name is . . Detective agent Mr. D.*

Her teammates joined her in goofing around with the volunteer assistant.

*P2-these two guys are too weird (pointing at two students B3 and Y4).*

*T- I give you 20 minutes to finish your flipbook, if I see you are still working, I can give you more time, but initially I want you to have 20 minutes to create your animation.*

P2 is singing.

*P2- (speaking with her teammates in a very disrespectful manner) I disgusted you (joking pointing at two teammates-B3&Y4)*

*T-We only have three erasers, you wanna share them.*

*R1-I will create a good one (flipbook).*

R1 was speaking with P2, but P2 did not seem to care about it. She kept singing.

*P2-happy, singing with a smiling face) ...I am a barbie girl...*

Later, toward the end of the activity P2 gained momentum and started to talk about being focused and getting the work done, but she was late to complete her work when the time was over. She was drawing, and speaking at the same time and having an irrelevant conversation with her peers:

*P2-huuu, teacher teacher teacher, singing...*

*P2-Oh my gosh so you work on a computer for 48 times a day?*

All of a sudden, she said something that surprised us:

*P2-you guys 3 more minutes, pay attention, focus on your work . . .*

She is continuing irrelevant conversation, yet her hand has been working harder and faster. She is continuously making disrespectful comments to her peer.

*P2-why you say wait, nobody is waiting for you*

*P2-nobody is waiting for you*

*P2-actually shut up*

P2 finalized her drawing and got the scissors.

*R1-I forgive you for saying that*

*P2-You are a puppy cat?*

*P2-Give me the eraser. Where is the eraser? Thank you.*

P2 is discussing with R1 about R1's flipbook. Then the assistant is checking her work, but P2 is not responsive. She is pointing scissors to others and laugh, speaks, and so forth. Meanwhile, the activity time is over. P2 is still in the beginning of her cutting process and speaking to the T:

*P2- I am almost finished.*

*T-No I don't think so sweetheart.*

P2 lost her attention immediately and began talking about Chris Brown (an American singer).

During this activity P2 spent a lot of time socially engaging with her team-mates, rather than paying attention to her responsibilities to complete her task on time.

The volunteer assistant's note about her overall performance during this activity was that "She was distracted, not focused, not listening to the instructions closely, but still trying to complete her work even at the last moment."

Teacher observation notes indicated that "P2 is into music, conversation, distracted, and distracts her team members. *She is a sweet person, and in one of the occasions earlier, described herself, I am like a social butterfly. Yet she was most of the times rude toward the boys particularly and demonstrated disrespectful attitudes toward*

*her peers in general-she is neither supportive of her peers nor respectful, yet she is unaware of all.”*

Looking at the video transcriptions, field observation notes and her work artifacts, we no longer had the same impression about the P2 as we had in the beginning. We realized that she was indeed willing to keep up with the work until the end, but since she was scattered and lacked focus. Therefore, this was not allowing her to be as efficient and a focused learner as she perceived herself when she shared in the pre-questionnaire and in her daily-diary notes.

As we continued our observation before the intervention, we saw she demonstrated similar attitudes in her learning actions both academically and socially. Yet we could tell that she was not aware of neither the intensity nor the quality of her actions. She did not really realize or pay attention to how her actions were affecting her own and others' learning. Moreover, as she had no clue on how her attitudes made others feel, she was getting upset at her peers' reactions without realizing that these reactions were only the response to her actions.

**P2's Journey on Becoming Metacognitive about her Learning Actions.** In the beginning of the intervention, during the *Training Process*, she not only became aware, but also more knowledgeable about the importance/need to become aware, knowledgeable and capable of governing her self-influence that affects her own learning as well as others (SIL).

She understood that becoming aware of own learning actions is a beginning to make changes in the way she progresses in her learning in a positive way, and this also influence the success of her team. Thus, she committed to pay close attention to her own learning actions by dedicating herself to periodically practicing the MCM protocols via metacognitively planning, monitoring and reflecting her own learning actions throughout *the Practice Process* of the MCM.

Hence, DI she practiced developing skills in regulating her SIL (self-Influence on Learning). For this, she not only made thoughtful plans with the help of the MCM protocols about (1) regulating her current mood into “study mood”, (2) goal framing her own responsibilities both for her’ and her team’s successful work for the day, (3) re-stating particular academic and social learning actions that she believes she needs to work on during the activity. In the following charts in Table 5.7 you will observe a realization and change in the process P2 has gone through, from her weekly planning and reflection forms:

***P2’s Journey on Developing a Habit of Mind to FOCUS on her Learning.*** As observed in Table 5.9, starting the Week6, P2 expressed her intention of BECOMING A FOCUSED hardworking LEARNER in her plans in various ways. Her reflection form showed consistency in her work. This aligned with our field observation and video recording data. She shared her emotions and thoughts comfortably like she did in her daily-dairies in the beginning. In Week1 she wrote:

P2: *“Now I adjust my mood to being FOCUSED on working. Because it might help you learn and get better grades.”*

She puts her intention to place a close focus on working at her learning task as she believed this can help you learn and improve academically as well. Then, as an indication of recognizing her self-influence on her team she wrote in the same week:

P2: *“I can allow my (adjusted) mood to affect my team success. Because I will make them (my team) WORK HARD as they can in a good worker (in a good teamwork?).”*

She believes adjusting her mood into BECOMING FOCUSED will help herself. She also seemed determined to SUPPORT her team to do so, as she planned on helping her team work as hard as possible.

In her personal and team goal planning, while stating her responsibility she indicates her intention to be more efficient along with her team-mates. She wrote in the Week1:

P2: *“(My job is) To finish all the work like scratch Light Source. (We will) Finish what we have to do and get better.”*

She makes up her mind to act as a focused and an efficient learner as well as being respectful and supportive of her team-mates as demonstrated in her *learning action planning* in Week1 (and throughout the entire intervention):

P2: *“I choose to be focus on my learning and work efficiently by paying attention to time and my work organization. Because I care a lot.” I choose to be respectful and supportive of my team-mates by creating space for them. Because I care a lot.”*

As seen in Table 5.9, at the end of the activity in Week6, in her reflection form P2 states that she was happy after being able to focus on her learning and tried to be efficient

by paying attention to time and getting her work done on time. She was also stating that when she worked together with her team-mates, she was respectful and supportive, and they asked for help. She wrote that “(We will) Have a good score of 1’s in 4” (that means; when students act right on those four points, they receive a credit from their peers, which was another game-like protocol of MCM that I developed but did not include in measurement for this project. It is mostly because, Students were submitting their reflections in writing, and game was mostly about mathematical calculation of the overall team success. While this *peer-scoring of the company game* was a strongly effective tool on the individual and teamwork, and Team Purple highly regarded this game DI, I chose to focus on analyzing students’ written reports due to time constraints.

Table 5.7

*Purple2’s Self-Empowering Plans and Reflections*

	<b>W6</b>	<b>W7</b>	<b>W8</b>	<b>W9</b>	<b>W10</b>
<b>Current mood</b>	<b>Happy.</b> Because it has more writing. I love writing.	HAPPY. Because I get some help from the teachers here.	HAPPY. Because I am happy about the picture taking.	HAPPY. Because it is a good day.	Normal. Because I am excited.
<b>regulated mood (fake it till you make it)</b>	I am <b>being FOCUSED</b> on working. Because it might help you learn and get better grades.	I am FOCUSED and ON TASK and LISTENING TO OTHERS.	Today I (am) EXCITED ABOUT WHAT WE WILL LEARN.	<b>I am</b> also some ( <b>AWESOME</b> ).	I am PROUD OF MYSELF.
<b>Why I can allow my mood to affect my team, because</b>	I will make them <b>work hard as they can</b> in a good worker (in a good teamwork)	I will make them (my team-mates) BE ON TASK and QUIET DOWN.	Yes, (I will) help others get on task.	it will help others to be FOCUS(ED).	Yes, I can allow my mood to affect my team success.
<b>My goal for myself</b>	To finish all the work like scratch Light Source.	To finish all my work and save it to my account	To finish scratch	(I will work on) Scratch	(I will) Finish everything

<b><i>My goal for my team success:</i></b>  <i>We will...</i>	finish what we must do, and get better	We are doing good because we help (each other) to get faster and get better	do our best	be awesome	have a good score of 1's in 4
<b><i>My academic learning action plan: I choose to be</i></b>	<b><i>FOCUSED WORK EFFICIENTLY</i></b> by paying attention to time and my work organization	<b><i>FOCUSED WORK EFFICIENTLY</i></b> by paying attention to time and my work organization	<b><i>FOCUSED WORK EFFICIENTLY</i></b> by paying attention to time and my work organization	<b><i>FOCUSED WORK EFFICIENTLY</i></b> by paying attention to time and my work organization	<b><i>FO FOCUSED WORK EFFICIENTLY</i></b> by paying attention to time and my work organization

As observed in the above table, while P2 maintained her intentions throughout the process, she consistently worked on her learning actions. Also, looking at the details she provided with her planning forms throughout the intervention weeks, she demonstrates an improved realization, broader and deeper interest in becoming a focused learner at a time. In Week7 for example, she planned to focus on her learning by *“being on task and listening to others.”* She also planned to help her team-mates *“be on task and quiet down.”* She detailed her responsibility in her goal framing. About her team-goal framing she reflected how confident she felt by saying that they are doing good as they help each other to learn better and be more efficient.

According to the data gathered so far throughout these weeks, it can be observed that she has been showing a gradual increase in her interest and intention of her approach toward becoming a focused and hardworking learner. As she was developing deeper understanding, she was adding more goals on her plan of actions at a time. Thus, she expressed her goals and her progress as follows:

Week6; “to be *FOCUSED*”, Week7; “*TO BE FOCUSED, ON TASK and LISTENING TO OTHERS*”, Week8; “*I AM EXCITED ABOUT WHAT WE WILL LEARN*”, Week9; “*I AM AWESOME*”, Week10; “*I AM PROUD OF MYSELF*”.

Noticing that Week9 and Week10 is mostly about how she is proud of such gradual increase in becoming more focused and hardworking and witnessing the gains for herself, made her be proud of her attainment of the goals she set for herself dedicatedly.

***P2 Automatically Began Acting Supportive and Respectful.*** After realizing that she not only was a scattered learner, but she wasn’t able to place a close focus on her learning earlier, P2’s primary intention become “being a focused hardworking learner” DI. Once she made a connection between her personal goals and her team’s goals, she automatically began planning and executing more supportive and respectful enactments toward her teammates in the same direction. She also reported this in her reflection as observed in Table 5.7. This not only helped her become more focused and efficient but also ignited her team’s interest in placing more focus on the learning activities in a more efficient way.

### **Case Study 2: Team Green Members’ Becoming Co-Empowering Agents**

In the following paragraphs, after describing Team Green, I will comparatively examine their team dynamics BI and DI to highlight the drastic changes in their team dynamics that I observed. Then I will analyze their reflection responses to find out the effects of the MCM in their self-empowerment and co-empowerment processes that may have a possible correlation with their academic scores.

**Analysis of Team Green.** Team Green is composed of four dynamic students. Three of them were 4<sup>th</sup> and one of them was 3<sup>rd</sup> grade students. They had an interesting journey as they began the quarter with quite a power struggle within their team members. I will briefly take you to their journey, through which we will observe their amazing transformation of becoming a co-empowering agent for each other regardless of their rough beginning.

***“Who is Gonna Type in?”***

As it sets an example of students’ natural learning enactments BI, I will refer to *Activity1* in my comparative analyses (see p.176 for detail explanation).

I video recorded the team’s performances while they were carrying on this small group discussion about animation during the *Activity1*. They were supposed to fill out the form, and a volunteer from each team was going to represent their team and share what they wrote on the form about their prior knowledge of animation.

While each team was having their knowledge sharing process, I joined each team briefly, quietly listening to their conversations. Surprisingly, Team Green members were not speaking in English. Following is the transcript of the brief conversation between me and the Team Green members:

They have just noticed I was following their team.

T: *“What are you guys about to do now?”*

Everybody attempting to answer the question.

G1: *“We are about to do...”*

When G1 was about to say what I wanted to hear, G3 jumped and said:

G3: *"We are just arguing."*

G3: *"Me and her (G1) are arguing in our language who is gonna go first in typing on that, but we are gonna start talking about the animation."*

Even though they knew there is not much time dedicated for this part of the activity, they could not help but let the power struggle wins over them by still arguing about who is going to type or write their thoughts about animation in the end of their discussion while they still did not begin any discussion yet.

G3 repeated: *"We are talking about who is gonna type in on that, but we are gonna start talking about animations."*

T: *"Ok. Then go ahead and talk then, thank you very much."*

Since this took place BI, I purposefully let them continue their argument on an irrelevant power struggle. They continued arguing and missed the learning opportunity as also indicated by my volunteer assistant in Table 5.8.

I took my notes to remind Team Green members, DI in their training process, about their power struggles and how this power struggle influenced their learning performance that they ended up not even being able to put any idea about animation on their worksheet. I collected this data to use as an evidence to raise their awareness on that missed learning opportunities.

Table 5.8

*Field Note for Team Green's Performance on the First Activity BI*

	team	Before the Intervention (BI)			
		ALA (Academic Learning Actions)		SLA (Social Learning Actions)	
		Follows the Instructions (FI)	Efficient (E)	Respectful (R)	Supportive (S)
ACTIVITY 1: Animation Graphics	green	NO Not focusing on the main task but wasting time on arguing about who is gonna type in the end.	NO Wasting time by arguing with each other	NO Interrupting each other's' words	NO Arguing for an irrelevant minor detail over the task (typing), not focusing on the main task at all.

This process must have helped Team Green a great deal. Even though in the beginning of the Intervention (DI) they were too excited to get to use the recorders at their desks. Moreover, while playing with those gadgets, some captured conversations were indicating that they continued threatening each other to not distract each other's' learning this time. Yet, this did not persist. As they get to continuously plan- role-play- practice and reflect with a shifted understanding and a genuine practice that help them put effort at a time, they went through a tremendous transformation in their collaborative learning approach.

As observed in Table 5.9, Week7, Week8 and Week9 shows this team dynamics consecutively. The most striking point in their transformation was worth noting: through the MCM practices, as part of the SARP protocol (see Appendix A), students are given a chance to become an academic and social captain for their company, and these captains are only chosen based on their good rapport. So, the model was able to capture their power struggle and turned it around in a positive way, encouraging them to practice

supportive, respectful, and co-empowering leadership. Even though, there is a slight risk for them to possibly doing the work to get the carrot, the training process have helped the team members also developed genuine care toward each other’s learning. Thus, with only a change of perspective in their mind, for Team Green members slowly but surely progressed into such empowering agents for a collaborative learning within their team.

Table 5.9

*Team Green Members’ Responses on the Reflection Forms DI*

TEAM GREEN	Share some details of your team work DURING THE INTERVENTION SELF REFLECTION		
	INTERVENTION WEEK7	INTERVENTION WEEK8	INTERVENTION WEEK9
G1	Perfect!!! Supportive. Everything went GREAT today. Everybody could coach each other PERFECTLY. Myself was FOCUSED, Green3 was TIME EFFICIENT, Green2 was ORGANIZED, Green 4 COMPLETED HER TASK.	working together Organized.	We told each other why and what to do. I loved how we cared about our work.
G2	worked together, supportive, listening, following directions	Everything went good today. We coached each other. Green4 was FOCUSED, Green1 COMPLETED HER TASK, Green3 was ORGANIZED, I was TIME EFFICIENT	1. we work(ed) together. 2. we support(ed) each other 3. We help(ed) each other
G3	We were neat, kind to each other, and we were doing good at our work for today.	We were all focused and clean. Today everything was really good. Everyone was following directions. Yes, everyone coached each other, We all helped each other. I think everyone did very good. Myself-I think I was focused, and time efficient Green1-I think she was very time efficient and focused. Green4- was listening, really focused. Follow(ed) directions.	We told each other why and what to do.
G4	We did a good job doing our work and we were focused, clean, tidy, and helpful to each other.	Today everybody did good with their work.	My teamwork is fun, exciting and a lot of fun.

Through being a supportive captain role that they embraced wholeheartedly, the Team Green was the only team whose members wrote their responsibilities and reported

everyone's progress with a great amount of details. For example, in Week7 in response to the instruction of "share some details of your teamwork each team member's' responses were quite different than I observed BI:

G1: *"Perfect!!! Supportive. Everything went GREAT today. Everybody could coach each other PERFECT*

*LY. Myself was FOCUSED, Green3 was TIME EFFICIENT, Green2 was ORGANIZED, Green 4 COMPLETED HER TASK."*

G2: *"(We) worked together, supportive, listening, following directions."*

G3: *"We were neat, kind to each other, and we were doing good at our work for today."*

G4: *"We did a good job doing our work and we were focused, clean, tidy, and helpful to each other."*

I also observed that they improved their attitude toward each other a great deal in the following weeks. They became more able to provide space to one another when needed. They were working together. They stopped teasing or threatening each other, and instead they were using encouraging words. More importantly they were being supportive for a reason.

Each person in this group was having a big problem using time effectively in the beginning. Then they started to pay a close attention to work with focus and with good pace. Some of those positive acts that I got to witness was meaningful. One of them I witnessed took place when G2 was able to finalize her project on time. G1 made a comment on G2's work, when she submitted her scratch project to me. I told her:

T: *"G2, perfect, excellent job, and I am going to put this in your website as your personal job, and for your company's (web-page as well) of course."*

G1: *"G2 look you are representing us in every single way."*

T: *"Exactly, that is fantastic."*

G3: *“Me and G4 are doing it (the scratch project) together.”*

T: *“That’s fantastic as well.”*

To highlight the huge difference, I will also share what I experienced in BI. This was during the activity three, one of the scratch animations making practices. It was an individual activity. When I approached Team Green, they looked very engaged. Then I asked some questions:

T (to G2): *“You are doing it correctly (pointing the sprites she is adding to the scratch animation program). Can I see the questions?”*

She could not show me any question. She was supposed to add some questions about the light we studied in the previous class. She was still working on the details instead since the previous class.

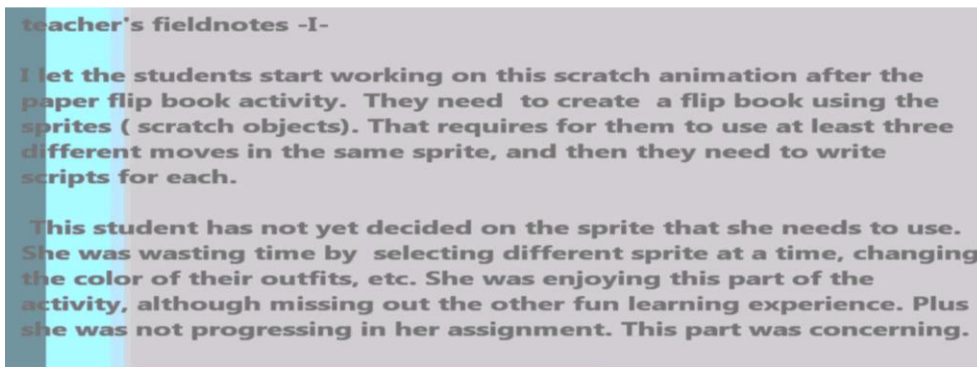
T: (very surprised) *“You haven’t made a progress so far !?!”*

G2: *Oo, you think soo?*

G2 was surprised as well, as she was keeping really busy for deciding the right scripts on the program and thinking that this was adequate progress while she was behind the overall schedule.

T: *“You worked too slow. You cannot think about this process for two hours and a half. You wanna just be more proactive.”*

The conversation went in a smiling mode, yet later I wrote in my reflections the following notes:



*Figure 5.8.* Teacher's field notes about the G2's lack of willingness to work more efficiently.

The students had enough background knowledge to carry on the assignment. When you are teaching technology, you want your students to practice as much as possible. Considering they are still 4<sup>th</sup> grades, it is quite alright to let your students enjoy with the details.

In ideal conditions I would have let her explore as much as possible. However, being on a timely schedule and carrying on a STEM curriculum is really something you must pay a close attention as a teacher. You need to make sure your students are moving forward along with you to the next level. Otherwise, it is really not easy to bring everybody on the same level especially when meeting only twice a week for an after-school program for 90 minutes per class.

Maybe what was lacking in my students' understanding was that while it is quite alright to spend much time in longer times to explore things in technology learning, they needed to realize that STEM team learning requires paying attention to following

instructions sharply and as timely as possible. They also needed to realize that there is a thin line between learning in your own pace, which must happen (which must be arranged via home projects, HW or side working sometimes) and missing out the learning opportunity while spending too much time and energy in the details, even though evidently those details may be quite fun.

As a teacher I wanted my students grow to become more alert, keen, and cognizant learner, while learning to be able to prioritize their tasks and focus on one at a time. Thus, I was more determined to help them to take actions in their own learning responsibilities and develop needed capacities for their life-long learning.

After such an experience with G2 BI, G2's being able to submit her complete animation to me on time DI, was such an accomplishment on her side. On my sides as teacher, it was a reward.

In the end of the intervention process, Week9 reflections of the Team Green members was demonstrating this remarkable transformation:

G1: *"We told each other why and what to do. I loved how we cared about our work."*

G2: *"1. We work(ed) together. 2. We support(ed) each other 3. We help(ed) each other."*

G3: *"We told each other why and what to do."*

G4: *"My teamwork is fun, exciting and a lot of fun."*

It can be inferred from these reports that the team members were not only having meaningful learning conversations, but also sharing the reasoning of their decisions about the projects they worked at this time. From a pedagogical point of view, this can be named as a harmonious collaboration. The overall data about the Team Green indicates

that their team work changed progressively over time. Cognitive learning theory explains this positive change in team members' behaviors through their changed thought process (Levine, 1975). Social learning theory explains such progress of harmonious collaboration as a result of the specific conditions and social standing in which the students are situated (Bandura, 1962). The MCM provides students with such a context. Bandura's social cognitive theory of self-regulation (1991) is highlighted through Team Green's meaningful co-empowerment through self-empowerment. The purposefully situated social learning environment helps engaged students to practice regulating their self-influences, and students supported each other, thereby influencing their learning environment in return.

G4 is the only 3rd grade in this team. Her enthusiasm about the practices of the MCM was commented by her parent in the end of the quarter at the open house portfolio sharing party, whose son I also taught in the previous years. He commented in the following way:

I am very impressed with what Mrs. Sunkel taught weekly. Her teaching style is very impressive. Social Coaching is very effective with her individual work weekly. Each person works with a team. My daughter is eager to attend to class and discusses on the ride home her class work and whom she worked with. Mrs. Sunkel is very thorough with her teaching. All the students are eager to learn, have learned and obtain the work. They keep all their learning.

**L. M. Henry, Open House Guest, Parent, OST Program, Open House, Fall 2011**

*Figure 5.9.* G4's parent's feedback about Mrs. Sunkel's approach

Throughout the quarter, the entire Team Green learned to work more harmoniously by using the MCM's metacognitive planning, execution, and reflection

tools that were blended with protocols to help them deepening their understanding of governing their SIL. This, in turn, helped them place a better focus on their learning activities. As a result, I observed their achievement not only in their Science unit on Light and of Electromagnetic Spectrum, but also in becoming more proficient at using the technology, particularly Microsoft office tools such as Word and PowerPoint, as well as using Moodle and making Scratch animations online.

In the beginning of the quarter Team Green members' pre-test scores were: G1: 8; G2:8; G3:7; G4:8. At the end of the quarter, each member's post-test scores were quite harmonious: G1:16; G2:15; G3:15; G4:15. The post-test scores as well as their academic gain scores were the outcome of their genuine effort they put consistently in becoming collaboratively focused and hardworking empowering agents.

Harmonious collaboration was one of the outcomes that was aimed through the MCM practices. It is purposefully designed to function as a systematically structured game-like channel for this outcome to take place. It is possible to track such harmonious collaboration in students' individual and teamwork progresses.

### **Case Study 3: Team Red's Late Involvement with the MCM**

In the following paragraphs, after describing Team Red, I will examine each student and their team dynamics to find out how the MCM possibly functioned or malfunctioned for the Team Red members to have such conflicted academic scores and gains. I will be examining their responses in their plans and reflections, as well as their consistency using the MCM practices.

**Analysis of Team Red.** Based on my overall observation; BI, Team Red members needed to strengthen both their academic and social learning actions in order to develop a co-empowering learning dynamic. DI, while each member embraced the MCM practices in different times and levels, I observed that MCM application was helpful in terms of raising Team Red members' awareness about their own academic learning actions to different extents and eventually uniting them as a team. Based on my field observation I noticed that, for this team, dynamics were very different from my other teams, so were each individual's approaches toward utilizing the MCM practices. While all of them appeared to be taking the MCM practices seriously, some mostly chose to focus on improving their individual empowerment; one of them didn't feel any need to practice the MCM in the beginning as she believed she already possessed such attitudes. Some, on the other hand, wanted to, wholeheartedly, embrace it, yet did not have enough focus to dedicatedly practice the principles, nor were these students accepted by their other team members to receive enough peer-coaching in order to develop the needed team dynamics for them to better carry on the MCM practices. Thus, it took a lot of observation and teacher-peer, teacher-peers' interventions to bring each member of the Team Red on the same page. It was only toward the end of the quarter, they were able to act as a team fully and put forward intentional plan of actions to develop a co-empowered team dynamic in their learning.

Team Red had similar result to those observed in Team Green, but the students took longer to reach the same point. Results show that this late yet successful engagement

with MCM practices is association with their improvement in their understanding of team building, both collectively and individually. Yet, I believe, they did not have the opportunity to practice this dynamic long enough to reflect on their academic post-test scores. Thus, Team Red was the only team among others that had four conflicted academic scores. Out of 17, the pre-, post-scores and gain scores of R1 is: 4, 16, 12, R2 is: 5, 5, 0, R3 is: 4, 10, 6, R4 is: 7, 8, 1. Looking at their scores it is possible to see their sub-teams they naturally formed. R1 and R3 teamed up quickly, while R2 and R4 neither teamed up with each other, nor with the other members as R4 was too fascinated by the technology, while R2 was very hyperactive and social and had difficult time focusing on one topic at a time.

In the next paragraphs, I will share each student's profile in more detail examining their connections with the MCM practices DI.

### **Team Red Members' Involvement with the MCM Practices**

*Red1 (R1).* *BI, she* began the quarter academically weak, with her pre-test score being 4 out of 17. She was shy in participating in learning conversations, yet talkative and friendly with her peers. She also was observed while putting genuine effort in carrying on her responsibilities. She was very keen during the training process of the MCM as well. When practicing the MCM, R1's written planning and reflections from the day one till the last week demonstrated how much she embraced those practices particularly on an individual level.

While R1 began classes usually tired, she always came to OST program ready to learn. R1's planning responses shows her effort to turn around her lack of energy and shift her focus on her learning tasks. Throughout the weeks she was planning as: "*I am adjusting my mood into*":

W6: "*FROM happy TO be excited*",

W8: "*FROM normal & not energetic (but) productive & hardworking TO focused & simply simple*",

W9: "*FROM normal, not energetic, productive, hardworking TO normal & tired but hardworking*",

W10: "*FROM happy, energetic, productive, hardworking TO good*".

It was surprising to see that she always aimed to perfectly empower herself throughout the process by making her mind to focus on her learning not matter what. Looking at her reflections about her mood-regulation during the activity, it is possible to see her dedication to the plans she made at a time, for example, she made similar statements both in Week 9 and Week10 saying that: "*I was sleepy at first, excited now. I felt happy, energetic, productive, hardworking because after -OST- (the student wrote the name of the program), I always feel this way.*"

She always demonstrated putting effort in applying her best to focus on her learning. In terms of co-empowering her team members, on the other hand, while supporting her peers seemed to be in her mind, R1's spotlight was mostly toward her own improvement. To the question of "*Can you allow your mood influence your team's success*", R1's responses were pointing out her own actions. Based on the field note, while she seemed to *be highly shy but at the same time caring and sweet toward her*

*peers*, it can be inferred that she may have realized that her mood truly influences her team so that she may be purposefully focusing on her own actions, or she did not feel comfortable enough to support others, before strengthening her own capacity.

R1's responses she gave in consecutive weeks to the statement of: "*I can allow my (adjusted) mood to affect team, because:*

W6: "*(when) I am happy they (my team) might be (as well)*",

W8: "*I will be hardworking*",

W9: "*I am feeling hardworking*",

W10: "*I feel good and I will speed (up).*"

As observed, "accept the first week", her statements about her influence of her team-mates with her mood was highlighting her decisions about her own acts. She did not mention about her team in her responses. Only in the end of the intervention, I saw her progressive improvement on the effort of co-empowering her team in her written responses.

In Week 6, Week 7, and Week 8 she only mentioned about hers and her teams' academic responsibilities such as "*to get good at scratch, finish, fix, improve the scratch -ppt- projects*". Then in the very last week, in Week10 she wrote:

*"For my team, I will help them finish their tasks."*

This last report of R1 indicates that she felt responsibility to support her team members that day. She did not reflect this responsibility in this way earlier.

She had taken her science and technology learning very seriously throughout the quarter. Toward the end, she not only became more proficient at using the scratch but

gained confidence in this area. It also seems that her interest in teaming up due to persisting MCM practices that asks them to state their responsibilities for their teams' learning began to arise as she gets stronger academically. About their team work throughout the intervention, she also reported in:

W6: *"Everybody was working OK. R3 was awesome. R2 wasn't focused. Same with R4."*

W9: *"We did awesome, on task mostly."*

W10: *"Me and R3 finished the quiz and color wavelength. We finished the work."*

The above responses indicate that she was not into teaming up with her whole team instead with R3. While R1 shared her observation about R2 and R4 as *not being focused*, she did not reflect in her further written report any willingness to support them to be more focused. Instead, she chose to continue sub teaming with R3. She and R3 together observed maintaining their rather a judgmental observation toward the other team mates for a while.

*Red 3 (R3)*. She was a responsible student who has her own will. She missed some critical MCM training classes. When I attempted to explain the model in more detailed, she said to me that *"I am already a hardworking student and I don't need this practice."* It came across as very direct, so I preferred to watch her progress.

It took time for her to appreciate the MCM practices truly. When she was present, she filled out the planning forms as there was a dedicated time for everyone, but most of the times, she did not make time to fill out her reflection forms, except toward the end of the practices.

In her plans of action particularly in the sixth week she demonstrated her hardworking-deterministic side. It was only at the last two weeks of the intervention she began demonstrating of her care toward her teammates for her mood regulation. This took some work to bring her to this level:

In W6: *“I feel normal, because there is nothing really to be excited about. Now I am adjusting my mood INTO getting your (my) work done, because you (I) can be good or bad.”*

In W7: *“I am happy, productive, hardworking. Now I am adjusting my mood INTO work done. Because you are (I am) in a good mood.”*

It was Week8 when she first mentioned about how her mood can influence her team and how she would feel about it. She wrote:

In W8: *“I feel sad, because my side hurts. I cannot allow my mood affect team’s success, because it effects everyone if I don’t get work done. My own daily task is stay focused. Our team task is to stay on task.”*

In W10: *“I am feeling normal, not energetic, not hardworking, because I am tired. Now I am adjusting my mood INTO positive, because you are feeling happy. No, I cannot allow my mood to affect my team success, because if I mess up, I will let the team down.” “My own daily task is to stay awake. Our team’s is to stay on task.”*

In her reflection R3’s responses were the following:

In W10: *“Yes, I could adjust my mood during the activity. I felt happy ☺, not energetic (but) productive, hardworking, because I worked hard.” Some details about my team work: “People didn’t finish but we (our team) did good.”*

From R3’s written reflection, her pride about their good team work can be observed. While this came very late, it is noteworthy and promising to see they finally

were able to embrace each other as a team and worked together welcoming each other and participating in full capacity.

When she could attend to my classes, R3 put genuine effort to understand the science topics and technology, and she worked closely with R1. They two worked in harmony together and always appeared self-driven and determined to learn about the topics and animation making. Looking back at their natural collaboration, I can also see why there was a resistance teaming up with the other sub-team members. I will try to show this in the further lines.

***The collaboration between R1 and R3.*** Throughout the quarter, R1 and R3 teamed up well, and they both demonstrated a focused and an efficient / hardworking approach toward their learning tasks. Both R1 and R3 showed varying willingness to team up with R2 and R4 when needed, as they seemed they were concerned about their own learning progress. Both R1 and R3 were 5<sup>th</sup> grade female students, and R2 and R4 were 4<sup>th</sup> grade male students. In this team, there was an interpersonal gender conflicts from the girls' side. It may be mostly because the R1 and R3 were more determined and focused to gain the best out of the program. Yet, they were coming to class tired most of the time. On top of that R2 and R4 were not able to approach their learning task with a focused, determined manner as R1 and R3 did. They were rather way more distracted, and with this aspect, they were disrupting R1 and R3's attention. Thus, it is likely that R1 and R3's reactive attitudes toward R2 and R4 were mostly to protect themselves and get their own work done timely which they cared about greatly. Thus, R1 and R3 chose to

name the other sub-team as “the boys” and they were telling me, “*The boys are not paying attention.*”

While my field notes suggest differently, throughout the quarter, the boys have not appeared truly meshing themselves in their work in the girls’ perspectives. There were times R1 and R3 demonstrated highly pessimistic and judgmental approach toward the other sub-team members. That was generating some tension within the team, particularly on R2’s side according to my observation. From my perspective as their teacher, if R1 and R3 did not show such resistance, and chose to team up with R2 and R4, they could have seen the perfect intention both R2 and R4 put in to better understanding the topics and completing the common projects together. Perhaps R2 and R4’s positive outlook and optimism could have influenced them to develop a positive team dynamic earlier for them to act as a team and learn collaboratively. The emotional turbulence developed through such social stressors (Boekaerts, 2002) created a barrier to team learning, and removing this barrier took time for this team.

Closely witnessing R2 and R4’s personal efforts, I observed what was going on. I tried to turn things around as much as and as quickly as possible. Along with many one-on-one, and team interventions, I switched the sub-teams many times despite the “girls’ resistance.” This turned out to be the right thing to do in terms of helping them get to know one another better at a personal level. Then I required them to work altogether without sub-teaming. Sometimes I had to involve in their team to coach them how to work together. Sometimes, I found listening to each team member was helpful in terms of

helping them understand their own perspective (Larkin, 2006, 2010). That helped me better coaching them. Eventually, they began embracing each other more like how team members should be. At that point, they were able to focus on the cognitive goals of the tasks (Hogan, 1999b).

*Red2 (R2): He was such a genuine, yet a hyperactive student who was highly scattered. He only was not unaware of this BI. During the training process, he truly absorbed into what I was explaining to the entire group and he was always showing that he was grasping the concept and showing true understanding about what needs to be done. While understanding emerged in him, practicing of his understanding took time.*

R2 is the only student who does not have any academic gain score within the six teams. While he was highly interactive even with other teams' members, he was having a serious lack of focus on a topic he learns at a time. DI, however, he became aware of this lack of being focused in his learning and he was making points in his reflections on the MCM forms about his plan of being focus on his learning. His responses he indicated this genuine intention as:

W7: *"My own daily task is to concentrate",*

W8: *"My job is to concentrate. I focus. Because I need to, study fast, I should work clean, tidy, organized, because I should stay focused."*

In W9 however, he did not write his daily goal, instead he stated the followings in his written report:

*"I feel sad, not productive. Now I am adjusting my mood into HARDWORKING. Because I want to learn. I may be (allow my mood to affect my team success). Because I am angry."*

I have been also observing that he was upset about some ongoing struggles he had to face within his team, and this seemed to highly influence him. After addressing his struggle and anger during the class, at the end of the day in the same class, he noted in his reflection report that:

*“In the end of the class I was NORMAL and I (worked) PRODUCTIVE. I like teams.”*

In the Week10 he wrote:

*“My daily task is to complete work; our team’s daily task is to help each other. In the end of the day I felt normal and productive. I want to help others.”*

Conclusive with my own and my volunteer assistants’ field observations, which were triangulated throughout the entire process, he was such a genuine student who wants to become aware and improve of his learning actions. He showed willingness to develop a stronger focus on his learning, but he was unable to turn his spotlight to himself most of the time, instead he was very much willing to help others. What kept him unable to progress in my view is his lack of awareness and understanding that he first needed to work on developing such a capacity on himself within the time period before attempting to help others. I tried to show him throughout the quarter as a teacher that he needs to first fix what is not working in his attitudes, then he will truly be such a support for everyone as he was so caring. Perhaps he and I needed a longer time period, in which this could have been better addressed through further raising his awareness on the need of self-empowering himself first to truly be able to co-empower others.

*Red4 (R4):* R4 was one of the shyest, yet truly sincere and one of the highly enthusiastic students in my groups. The STEM learning environment was new to him, and he had a lot to learn at once. He was very much into technology. He worked hard to improve his computer skills while he was learning about the Scratch animation programming tool, and he was learning about science through a team project. This multi-learning aspect of STEM learning may have come across too much on him due to his unfamiliarity of this type of learning environment.

Despite his interest and desire to be able to concentrate on the overall learning topics and to catch up with his team, he was not appeared efficient enough to do so. R4 was so much into detailed technology learning (Scratch software programing tool) and this was causing him to lose focus on the overall STEM learning topics. Many times, I found him being magnetized by some small details about using Scratch. While this improved his understanding on the Scratch programming, yet that kept him busy while we all were working on another learning topic. He was truly interested and wanted to make perfect animations. His being new to this program, and learning everything from scratch was also keeping him slow in his progress naturally.

Because of his keen interest in technology, he sometimes demonstrated difficult time listening and following the instructions of what needs to be done at a time. Working through a project task consistently was something new to him as well. Despite all of these, he never had given up on his learning technology. He was always respectful, and a caring person toward his team success.

R4 had positive view about his team and he felt he was part of it while he was not involved as much. As his attention was somewhere else, R1 and R3's reactions toward him and R2 did not seem to be influencing him while it highly influenced R2. During any conflicts, as his attention was truly on the Scratch animation programming tool, he kept himself busy with it and stayed out of it. Regardless, bringing R4's attention to other learning topics to better learn about them and teaming up with his peers was a constant trial throughout the quarter that we as a team became successful to some extent.

R4 was progressing in his technology learning at a time. It was toward the end of the quarter, R4's parents and I became successful in helping him to raise his awareness on his lack of focus and efficiency in learning STEM. We helped him catch himself while he believed he did really well in the previous activity, while actually he did not. It was W8, at the end of the activity, I sat down with him and his parent, and showed him pointing out his worksheet, what and how he was supposed to work on his worksheet along with his Scratch animation making tool simultaneously. I tried to show him what he missed in his work by placing too much attention to one aspect of his learning. Thus, he saw the reason he lost time and stayed behind of his work. That was an unexpected and a powerful realization moment for him suddenly. He understood that he needed to learn the science topic well in order to develop his Scratch animation assignments more meaningfully. So, he made a decision of paying more attention to science learning together with his team to better complete his part of the task.

He realized that his distraction was coming not from him being truly unfocused- but from him being focused selectively. He also acknowledged that he needed to be on the same page with his teacher and his team members. This was a social awareness as far as feeling the necessity to show respect and support of his teacher and his team in their learning process.

His parents were very much involved and engaged in helping him grow as a better learner. Thus, working together with his teacher and parents inspired R4, and ignited a better willingness in him to want to follow instructions with a different sense of focus and supportive respect toward his whole team. Toward the end of the quarter, he truly demonstrated that (please see Figure 5.2). This awareness was only the beginning for R4. He didn't have enough time to reflect this in his academic score at that point. However, I strongly believe that he gained the needed self-awareness in his approach toward his individual and team-learning, that can help him improve his learning in the long run. His parents' feedback in the end of the open house meeting was confirming of his gains as shown in Figure 5.10.

Overall, as an action researcher, I tried to work with the Team Red members by following a similar approach to that used in Larkin's work with younger children in developing metacognitive knowledge and collaborative learning skills. She did this through asking them to explain themselves and their learning process. I similarly tried to help my Team Red members self-evaluate while self-explaining (Larkin, 2006). I focused on improving their social-emotional development while trying to help them establish a

collaborative science learning environment within their team (Larkin, 2010). During this process, I used the MCM principles in conjunction with creating Vygotsky's zone of proximal development (Cole & Vygotsky, 1978). My eventual goal was to help them embrace and value their differences and focus on thinking critically and scientifically in a supportive learning environment (Hogan, 1999b, 2001).

Outstanding! My son gained Great tech skills. Great team work is good life skills to learn, great class work, super community working together. Great on all levels and social togetherness is wonderful. I think this is great for all KIDS to participate in if they can. THANK YOU!!!  
**A highly involved Parent, OST- School Program, Open House, Fall, 2011**

*Figure 5.10.* R4's parents' feedback about their observation of the MCM practices at work

## **RQ5-Do Students' Learning Conversations Reflect Patterns of MCM?**

### **Hypothesis and Data Sources of RQ5**

**Research Question 5.** Do students continue regulating their academic and social actions (learning actions) four months after the conclusion of the MCM intervention? If so, is there any observable pattern in their learning communications that indicates improvement that may be correlated to the MCM intervention?

**Hypothesis 5.** If the needed-shift occurred in students' understanding about their self-influence on learning (SIL), and as a result if they are able to progressively becoming more metacognitively competent of governing their SIL throughout their learning practices, then it is expected that students reflect on this improvement in their learning communications over their learning interactions, conversations and reporting.

In the following lines, I will share transcriptions and comparative analyses for BI (before the intervention) and FI (four months after the intervention) in terms of seeking for any change in students' overall learning communications in the form of interactions, conversations and reporting.

I used the video transcriptions of the very first animation discussion BI, which is called *Activity1* (please see p. 177 for detailed about it). It is the same activity I used to make comparative analysis to answer the RQ1. This was an animation discussion activity. The teams were supposed to carry on a small group discussion to share their prior knowledge about the animation. They were hold responsible for completing the first section of the animation graphic together before they watch a short documentary about the introduction of animation.

Then for the FI, I used students' verbal progress report transcriptions that I recorded while they were taking the inventory of the Lego Mind Robotic Kit. In order to seek for any observable pattern in students' learning interactions, and communications, I analyzed those short interview transcriptions that I conducted with my students while they were taking those inventories in the beginning of the spring quarter. This kit has 104 types of small Lego pieces that are used to make robots. Each pair of students were given a nine-page inventory form along with a Lego Kit. Students were asked to categorize and count each set of pieces. They were held responsible for not only find out if there are any missing or extra pieces in their kits, but also to purchase the missing or return the extra pieces later. For this, they also were supposed to calculate the grand-total cost of the

Lego pieces in their entire kit. This was part of the game we were playing on the background of this learning project.

In this game-like complex mathematics activity of taking inventories, each team was expected to make lots of decimal-points multiplication, addition and subtraction accurately. While the scenario was strongly encouraging, this was a challenging activity for such a mixed group of 3<sup>rd</sup>, 4<sup>th</sup> and 5<sup>th</sup> grades. Thus, my students' success in this process was highly depend upon how they teamed-up and functioned throughout the process. This was a critical data gathering tool to elicit information about how much transformation is in progress as far as MCM learning principles being in the students' performances, and how much of it will be reflected over their verbal reporting.

### **Findings for RQ5**

#### **The Comparative Analyses Between BI and FI**

Next, I will share the comparative analyses for Team Green, Purple2 and Purple3 Sub-Team, Team Yellow and Team Orange. I will share in total seven sub team's verbal report analyses. These are the only teams I had complete data of both BI and FI for the activities I chose to make analysis.

**BI Team Green Members' Power Conflict was Apparent.** The case study for the Team Green, through video transcription data and analysis (on p. 188) that was used for RQ4 shows that Team Green members were having a power conflict between each other. It was reflected in their learning communications via their interactions, and the reporting of their progress during this time. For example, the team members were

apparently arguing about something during the animation discussion time, but as they were speaking in their own language (Ethiopia) I couldn't understand what it was about. Then I approached to them and asked what they were talking about. Green3 responded as; *"me and Green1 are arguing in our language who is gonna go first in typing on that, but we are gonna start talking about the animation."* While they were spending time discussing for who should lead their team, they ended up being unable to complete the first part of the activity. It was obvious that the team members were captured in such a power struggle, they were neither performing supportive, nor respectful toward each other. Lack of focus on acting on the instruction toward completing the task timely was missing. Thus, they were not able to perform efficiently toward their learning task during this time.

#### **Team Green's Transition Process in the Beginning of the Intervention (DI).**

When the time MCM was introduced to the students initially, students went through many "meaningful realization" moments. Yet the development of comprehensive understandings about *the importance of taking responsibilities, how to better co-develop collaborative learning community, and what attitudes can distract such development, or how to best fulfil their responsibilities to better co-participate building such a community at a time* was not entirely taken place yet. During this time, while teams were naturally persisting their previous learning communications to some extent, as they progressed into their MCM practices, they became a lot more able to make the needed shifts in their learning interactions, and thus they were more often able to reflect those understandings.

Team Green for example, continued their power conflict for a little more while. This time however, they were also paying more attention to their personal and team learning progresses. After some certain practices, this caring mindset about their learning progresses began dominating their learning conversations. In the following transcriptions between Team Green members can demonstrate this outlook:

Please note that, each sub team had one flip camera, and one audio recorder was available for table captains to record the teams' progress. Using these tech tools, Team Green members had gone through an interesting conversation.

G4: *What do you expect (? guessed-this word was difficult to understand from the recording) from yourself G3?*

G3: *Nothing actually, because we are not supposed to be doing this, you are knowing this, are you?* (referring to the audio recording G4 was holding. G4 was acting as if she was interviewing G3).

G1: *You guys are weird.* (G4 was upset and looking at G1.)

G1: *Both you guys. You know this is recording you guys. So, you do anything weird, or not productive, it will video tape it.*

G4: *Yeah, right, right.* (G3 and G4 are whispering something to each other's ears meanwhile. Then made a decision, nodded their heads. This time, G4 hold the microphone to G1 asking:

G3: *Hold on G1, what did you say? Can you say that again?*

G1. *I am good.*

G3: *Okay, cause we still have this as well.* (showing the recording camera in their side)

G1: *Noo, it wasn't anything baaaad, and it wasn't anything hu-mi-li-a-tingg Joseee* (she nick-named her while G4's name is not Jose).

G3 is turning around, following G2 while recording her moves and reporting. She says:

G3: *doing their work, running around, not paying attention, looking at the wall.*

G4: (repeated her question to G1) *So, what do you have to say for yourself again G1?*

G2: Showing G1 that G4 is recording G1's speech, G2 says; *That's why you are not Saying.*

G1: *Actually, I have to say, you are being a very big distraction on my learning.*

Meanwhile G3 is working on her scratch making program. Started to clap her hands.

G4: (excitedly moved her attention to the computer screen); *Ooh, that we are doing that scratch.*

G4: (moved back to G1 and persisted continuing that conversation saying that) *"And G1, are you doing something humiliating?"*

G1: *No, I am doing my work.*

G4: *No, you aren't.*

G2: *Yes, she isss.*

G4: (looking at the camera, counting its timing); *"11 minutes-6 seconds. now 12 minutes".*

G2 is asking to G1 about a spelling of a word they are working on at the moment.

G2: *Is this how to say ultra-violet?*

G1. (Looking at G2's notebook) *Ultra-violet... Ultra. You don't need that extra r right there, and the a.*

G1 looked at G2's work again, confirming: *"this is good."*

G2: *Ultra-violet.* (Meanwhile, teacher is asking questions to G3 and G4).

T: *How are you doing? Are you working on your work? Asking to G4, "how about your work?"*

G4: *That's my scratch showing the project G3 is working on.*

T: *to G3, "how about yours?"*

G3: *We are working on it together.*

T: *You are doing it together as a team. Okay, I said that I remember. Yes, that's true.*

*As long as you report it that's perfect.* (Then the teacher corrected the cameras).

G3 showing the scratch work to G3, saying: *"All we have to do is record now."*

G4: *We did it! (G4 is excited!)*

G3: *No, we didn't, not all of it.*

G1: Working on her own project independently letting the others see her next step, says; *now, I am going back to here,* (and listening to online video information about electromagnetic spectrum.)

G3 *announces to G1 and G2;* "I got one of our scratch done."

The entire team got excited. G1 exclaimed.

G1: *Awesome!* (G3 was very content and excited.)

G3: *We have four scripts, so everybody can take one part.*

Students were supposed to report their team work in the end of the activity as a team, G3 was now offering to share their scripts they created together with G4, with G1 and G2. To G3's suggestions, G1 and G2 were smiling. Then they shared about their sub-team's progress with G3 and G4:

G1: *We were too busy. You tuned to (your scratch work). Because we had no time at all, we're on a roll here.*

G2: *I had to finish this (writing task) I am only on my third page.*

G1: *I know I am only on my 6<sup>th</sup> script so I got work to do.*

This transcript overall tells a lot about the back and forth group dynamics. It is obvious that they still naturally bring their power conflict, but at the same time, they pay an apparent effort to complete their team project. While the overall picture shows evidence of a back and forth dynamic, G3's demonstrated effort – for example in trying to empower her entire team, sharing her accomplishment, and invite them to contribute

their part in the work – is strong evidence for such a positive transformation. Each member was reporting to each other about their progress. They were able to tune into their learning task and was able to leave their emotional battle behind.

BI, there was an apparent power struggle not only between the two sub teams, but within their sub teams as well. The striking part is, as shown in the analysis of 2<sup>nd</sup> case study DI, and in the above example, this shift points to the possible success of the MCM in transforming students' actions. While the captured moments were only the beginning of such transformation. Once the Green Team members established a true understanding of their role and the consequences of what could happen if they don't fulfill their responsibilities, they truly owned their part and put apparent effort to turn their small team into a developing nurturing and caring learning community by meshing their efforts to empower their team through self-empowering themselves with their good work.

### **FI Co-Empowered Sub-Teams Were Able to Demonstrate their Good Teamwork Through Their Progress Report**

The next two analyses are to demonstrate Team Green's progress they kept it up even after the four months of the MCM practices.

The following transcription is to demonstrate the good progress of Team Green in becoming better team at a time especially after a long process to come from a point of a strong power conflicts as well as verbal battle over gaining power to demonstrating respectful support through providing space for one another and sharing responsibilities in reporting their learning processes in collaboration.

***Green1 (G1) and Green2 (G2) Chose to Report Collaboratively.*** This short reporting was recorded while they were taking their robotic inventories. They were asked to explain what, how and why they do:

*G1: ... and we are taking our inventory.*

*T: Why you are taking an inventory?*

*G1: To build a robot.*

*T: Ok, then how did you start this process?*

*G1: We first got our kit. And then (G1 was looking at G2 for her to carry on the rest).*

*T: Do you wanna. (let G2 speak?)*

*G1: Yeah.*

G2 was ready to carry on the reporting- she was looking at G1, waiting for her sign to let G2 speak. Then, G2 naturally carried on their report.

*G2: and then we got our - how much does a kit cost paper-, so we have to see the number on there (pointing the inventory form) and we have to see how many are in there (showing the robotic kit box) and then we write how many in our kit.*

*T: A-haa,*

*G2: And then how much they cost each and then you have to add all these numbers up. This one (is) \$18.95 cents, we have three, you do 18.95 times plus 3 equals \$56. 85 cents*

*T: Plus, or times?*

*G2: times*

*T: What do you mean by times that means that three times you have to pay this amount (showing the unit amount of coast for that piece), right?*

*G2: (Showing the related box correctly) Yes.*

**How Much Does My Kit Cost?**

How much do you think your kit costs? \_\_\_\_\_










Color	Description	Picture	Qty	Kit Qty	Cost Each	Total Cost
LtGrey	Mindstorms NXT		1	1	\$144.95	\$144.95
LtGrey	Motor		3	3	\$18.95	\$56.85
<b>Subtotal Section 1</b>						
Black	Balloon Tire 56 x 26		4	4	\$3.50	\$14.00
MdGrey	Wheel 43.2 x 22		4	4	\$3.50	\$14.00
Blue	Ball 52 mm		1	1	\$14.00	\$14.00
Red	Ball 52 mm		1	1	\$2.25	\$2.25
MdGrey	7.4V Rechargeable Battery		1	1		
LtGrey	Light Sensor		1	1		
LtGrey	Sound Sensor		1	1		

Figure 5.11. G2's explicit explanation of the breakdown of their calculations.

T: OK. So, then you've already told me that you are working on the sub-total GI?

G1: Yes

T: Does it mean that you are almost done?

G1: Yyyeahh!

T: OK then, I think that you are working on. let me check where are you guys.

G2: G1 said she wants to do the subtotals,

T: Okay, but

G1: I can't do the sub-total that much. That's kind of hard for me because I mixed up.

T: That's Okay, I am sure you can do it perfect. Why don't you do the separate one then. You are almost done. This is your last page. Okay G1? Thank You very much.

I will come back in 2 minutes I am hoping that you will finish it.

G1: Maybe five?

T: Okay, five (minutes) but finish it in five then.

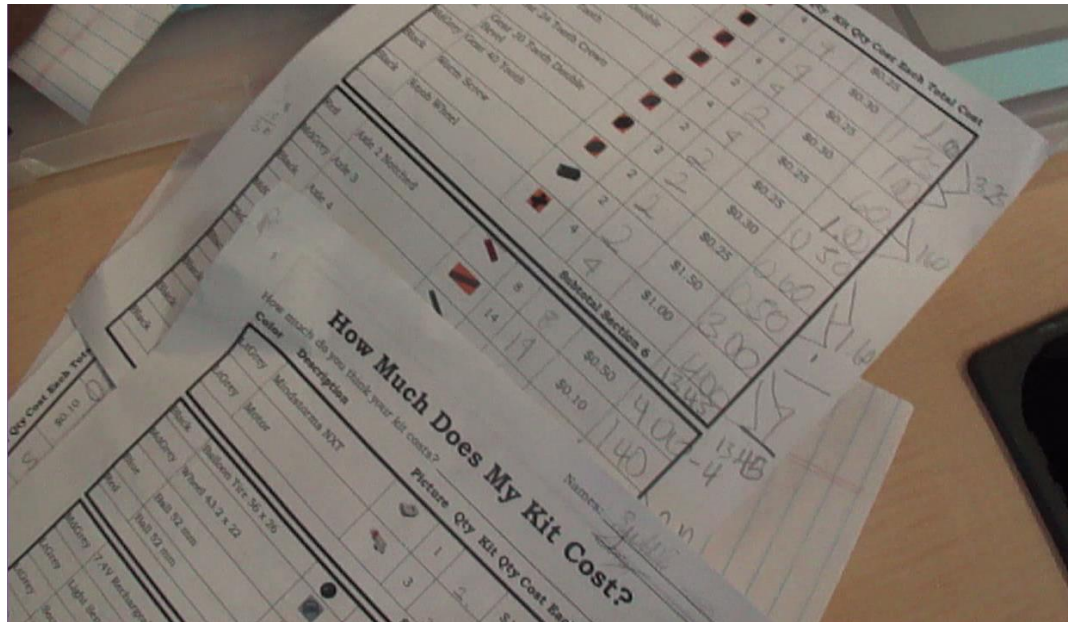


Figure 5.12. The detailed calculations of the Inventory Kit for costs of Lego pieces

This short interview initially shows that G1 and G2 were on the right track in terms of completing their calculations with a correct understanding. It was also informative that they took the initiative for sharing the responsibilities based on their strengths. They demonstrated collaboration in their reporting. They were paying attention to be focused and efficient as when G2 was reporting their progress to me, on the background G1 continued making the calculations knowing that they had a limited time.

**Green3 (G3) and Green4 (G4) Demonstrated their Hard Work through Collaborative Communications.** In this sub-team while G3 was 4<sup>th</sup> grade, G4 was 3<sup>rd</sup> grade. G3 worked in such a harmony with G4 that helped G4 feels comfortable in her learning progress. Following they shared their progress on taking the inventory:

G3: *We are adding the numbers and seeing what is the total one.*

T: *What numbers are they?*

T: *So, what are you? You are a company, who is supposed to buy some items for your robotic kits, right? And then, how are you calculating them?*

G3: *ahmm, we are, so like for example, we are taking 1.44 times one, if we will get one, and you would get \$1.44.*

T: *Exactly. Can you give me example of a motor? If you wanna buy three motors, and one of them is \$18, 95.*

G3: *You would time it by three, and you would get \$56. 85.*

G4 was following the conversation, and joined in this part, and repeat the final number at the same time with G3 looking at their report.

G4: *\$56.85.*

T: *How are you writing this down?*

G4: *It says how much does my kit cost. And we wanna see how much it cost and we are adding it up and seeing the total.*

Together G3 and G4: *We are adding up \$144.95 plus \$56.85 and the total is \$201.80*

T: *Is it the total, or is it the subtotal?*

G3 and G4: *Subtotal*

T: *Okay. How did you share the responsibility?*

G3: *Ohmm, we switched, ahhm, Sometimes I did the writing, sometimes she did the math. Sometimes I did the math, sometimes she did the writing. Sometimes we just did it together. She did the half, and I did the half.*

T: *Okay, as long as you were happy and you both were taking this responsibility, it is okay., and because you are working very efficient, I am happy with you as a team, thank you very much.*

Both G3 and G4 were able to go through the complex decimal multiplications, along with sub- and grand total additions of nine pages of form without any frustration. They also reported their progress in an enthusiastic synergy.

Looking at the overall Team Green's FI data, it can be observed that they demonstrated a synchronized teamwork showing their ongoing connection as a

collaboratively learning team. They showed a sense of shared responsibility and a willingness to engage in teamwork.

When the FI data is compared to the data of BI, it can be inferred that the positive transformation took place in terms of each team member's efficiency, and focused work, through their respectfully supportive learning communications via interactions, conversations, attitudes, and reporting.

Each member directly or indirectly influenced their own learning environment throughout the process. Using the principles and protocols of the MCM, students strengthen their learning communities both social-emotionally and academically (Baykent, 2010; Boekaerts, 2002; Brown, 1992; Dewey, 1959; Dweck, 2007a). In this way, the MCM positively manifested Bandura's social learning theory; guided by the model's scaffolded path, students improved their own understanding and thereby influenced their learning communities.

**BI Purple2 (P2) Demonstrated Unfocused-Scattered Communication Pattern that Distracted her Peers**

The analysis of the transcript for P2's learning interactions for the Case Study 1 (please see p.164) shows that during the flipbook making activity BI, she wasn't demonstrating focused or efficient work. Neither was she communicating with her peers in a respectful or supportive way for their learning.

*FI Purple2 (P2) and Purple3 (P3) were Tuned into Their Work. This* By the time I conducted this short interview with this team, it was an earlier time in the process

of taking inventory. They seemed to be busy with counting and calculating the pieces of their Lego Kit when I arrived at their desk. Here are the recording results:

P2: *Yellow one, we should be Okay.*

P3: *Right.*

T: *P2, P3 how is it going?*

P2: *Trying to turn P3's neck, says turn your neck as P3 was in her process of counting the pieces of the Lego kits.*

T: *That's Okay. Where are you in the process?*

P2: *I think we are on the third page, I think. To P3, so we have 8 right. (as P3 already had given the total amount of a new set of lego-P2 was writing this number down while responding to me).*

P3: *yes,*

P2: *Okay and wrote the number.*

T: *Very good.* (Teacher respecting their willingness to tune into their calculation, left the conversation).

For any outsider, who doesn't know P2 and P3's progressive improvement on how much they grew to prioritize their work over, giving up on their work and goofing around, they may conclude them being rude. To me on the other hand, I was truly an exciting moment to see that they were still respectful, but truly tuned into their work. They were given a timely task. They demonstrated that they were cognizant of their timing and the sensitivity of their tasks. They had to and report it in a 9 page-form to submit in no more than two class times of 90 minutes.

BI, this alert attitude was missing. Even in the first activity of the FI, they demonstrated such a professional outlook in figuring out how they should act, to be working as efficient and focused as possible.

They were evidently putting genuine effort to prioritize their work to fulfil their responsibilities toward finalizing their task successfully. This team demonstrated that they were able to integrate the principles of the MCM in their learning performances. In the end, they finalized their work successfully and submitted it in the complete and correct form.

### ***BI Orange and Yellow Team Members Demonstrated Conflicted Learning Communications***

For the animation discussion activity, Activity1 (explained on p. 176) the teams were supposed to carry on a small group discussion to share their prior knowledge about the animation. They were held responsible for completing the first section of the animation graphic together before watching the movie about animation. The following short transcript shows what the team members chose to discuss about regardless of the instruction.

T: *What are you guys about to do now?*

All of them started to speak at the same time and responding to each other's responses:

Y1: *The woman we are gonna draw on a wheelchair*

O3: *We're...*

O2: *We are gonna draw a guy doing a backflip...*

Y1: *No, we all care about the woman, the old woman on the wheelchair.*

O3: *We are gonna draw a guy doing a triphone/chasing ...(?), actually can't do that*

*because... (his voice was not recognizable between cross-talking).*

*T: So, are you talking about the definition of animation though?*

*Students: Oooooo*

*Y1: I told them that was what we were gonna aim to dooo .*

*T: Yes, that's what you need to do.*

As observed, the members of this team disregarded the original task, and instead, chose to discuss about the next activity on making flipbook animation ideas. While one of the members had told them the aim of the current activity was different, they still chose to follow their own lead.

By doing so, they were so into that conversation, innocently made themselves believe that this is the right topic to discuss. They seemed that they were not realizing that they were not paying attention to the fact that they were not following the instructions, neither controlling themselves, not prioritizing, or focusing on the given task.

While some can argue to take this as a sign to note where the kids' interests are, it is indeed a significant indication that there is a need to help each individual initially to develop capacity and will power to be able to prioritize the learning task and respectfully control their own will in action. Changing the topic for the future and omitting the foundational animation definition activity would be only damaging students' further science and technology learning while using animations through omitting the part they otherwise can build the needed declarative knowledge. This first activity was also meant to help students develop the needed realization of what they know or what they still don't understand.

BI, there was lack of prioritizing of the learning task, as well as nurturing of respect and support toward developing a focused and efficient learning community in a limited time frame was obtained in this team's short video transcript.

***BI Yellow Team Members Demonstrated Shy Approach toward Learning Communications.*** The next transcript shows the team members were hesitant of communicating about their discussions.

*T: What are you guys talking about right now?*

*O1: Ta daaa*

*Y3: we are talking about animation*

*O1: hhmhhh*

*Y2: nodes her head confirming-smiling (shyly)*

*T: Okay, go ahead then.*

Initially, in case of the members' showing this reaction in front of the camera, I turned it off, and waited for a while for them to begin communicating between each other. They were too aware of my presence. They too paused, keeping their silence looking at me shyly. I concluded that they either had not much to share, or they were too shy to share even their ideas as they may be too concerned of making mistakes in front of me.

Later, through further observations in the BI phase, I found out that even after the entire Yellow team was completely formed, Y2 and Y3 continued demonstrating this shy attitude. O1(Orange 1) on the other hand, was relatively showed detached and disinterested in the Orange team BI and kept himself personally involved with his work while mostly choosing to communicate with Y2 and Y3 when needed. These three

students were cousins, and for a while they gravitated to only communicating with each other unless I warned them to communicate with everyone.

Also, Y2, Y3, and O1 were academically strong students. This was reflected on their work artifacts as well, even BI. Yet their unwillingness to team up with others were not allowing them to become good team players for the others. While this made an impact on the development of the Yellow team and Orange team dynamics in the beginning, their shy approach in communicating with others continued until the MCM was introduced.

***During the Intervention (DI), Y2, Y3 and O1 Demonstrated Genuine Willingness to Provide Support to Others.***

DI phase, these students demonstrates some striking changes in their learning actions that were conclusive of the data I collected out of their writing plan of their actions as well as reflection of their executions.

Y2, Y3 and O1's transitions from acting absolutely shy and quiet to demonstrate supportive attitudes toward their team members while making themselves points by writing in their planning forms "be focused", "be efficient", or "I enjoy supporting others" types of notes over and over was one of the prominent examples. More importantly they were able to demonstrate much more focused yet supportive attitudes toward their team learning.

***FI, Y3 and Y4 Provided with a Stellar Progress Report.*** When I approached their team, it was close to the end of the class time. I was in a hurry with a concern of covering

every team, Yet, they were very calm and confident of their work. This sub team responded to my rushing questions with such an improved clarity.

T: *Ok, you have two minutes to explain your case. What did you do?*

Y3: *So, to share the work equally we opened two-page frame (She was pointing the page to me). He did that part and I would do this one.*

T: *What did you do?*

Y4: (Showing the cells in the form) *So, aa, there is number here, and right here. So you multiply it and then you add them to get the subtotal.*

T: *Okay, but my question is why there are these numbers over here, and what are these about?*

Y4: *So, these are tools to make a robot. (pointing each number in the cells), this number is how many (Lego pieces) you are supposed to have, this number (is) how many you do have. And if you do have the right numbers, then you are Okay. Sometimes you are missing, one or two, or you have too many.*

Y3 is helping Y4 by showing the details on the paper while Y4 was explaining.

Y4: *...and so, if you are missing you put minus one (-1) right next to it, and then you write down the number of how much (many) you have, but if you have too much (many) you just put plus one (+1 for example). And, we have more missing ones, and so the number here you multiply by this then.*

T: *What is this?*

Y4: *That's how much it costs.*

T: *Which, how many of them cost?*

Y4: *himm, it was, one,*

Y3: *I think two (at the same time with Y4)*

T: *Two of them cost that much?*

Y4: *One,*

T: *This is the unit price, right?*

Y4: *Yeah, that's why you multiply it (with it)*

T: *Exactly. Alright. Have you finished all these calculations? Are you done with sub-*

*total calculations?*

T: (Looking at the entire form) *in this case, (you are done) over here as well, very efficient work.*

T: *Did you also follow this instruction, (turning the camera to the decimal calculation instruction written on the board).*

Team: *Yes,*

T: *Ok, very organized work. Then you are about to calculate the grand total. And then you are gonna answer these questions in the last page, thank you very much.*

As observed in this transcript, in two minutes, Y3 and Y4 demonstrated a stellar collaboration in explaining their understanding and progress to me while completing each other's understanding.

***FI, O1 and O2 were Informative and Concise in their Communications.*** When O1 sub-teamed with O2, he showed his determination of being supportive of others, and demonstrated this striking transformation of helping others. This truly helped O2's academic progress as O2 also reported in his reflections as "*O1 helped me adding my third power point*", "*Today O1 helped me in my scratch project*" etc. They continued their good work together. The following short conversation only reflects their good work in terms of developing common understanding of their learning topic and being able to reflect their understanding in a clear and concise way:

O1: *Today we are doing an inventory. We are calculating the subtotal sections until the final price of a whole kit. After that we are making robots with all these parts.*

T: *Beautiful, so in the beginning how did you start the process?*

O2: *ahm, like we did the inventory. We counted each piece, then we do the subtotal. Then we do the total, total, and total – then final total.*

T: *Okay, sounds very good. Why we are doing that? Why we are going through this*

*process?*

O2: *So, then we know how much it cost of those stuff (the Lego pieces).*

T: *And then do we also wanna know -do we have an extra one or do have any lack (missing pieces)?*

O2: *Yeah, and then we get to know the pieces, what they are called.*

T: *That sounds very good, thank you very much.*

This team worked so much in harmony throughout the quarter, after some point, they not only were able to act as my student assistants to help others in taking better progress while programming their robots, but also in the Trophy Contest that took place within the entire (17) OST program classes in the end of the school year. In this contest, O1 and O2 together won one of the 1st place awards out of the robotic competition they built and programmed together.

Analysis of RQ5 results show students successfully demonstrated improvement in their academic learning capacity through interactions with each other (Vygotsky in Karpov & Haywood, 1998). However, interactions are influenced by where students are situated both socially and academically. Students must also learn to adequately govern their learning actions in ways that produce quality learning interactions (Baykent, 2002; Baykent & Esme, 2007). Evidence from this research analysis shows significant transformations in the way students act and interact within their learning activities.

## **Chapter 6: Discussion, Conclusions, and Recommendations**

### **Overview**

With this dissertation project, I investigated an instructional approach aimed at developing co-empowered learning communities through self-empowered individual leaders. The goal of this instructional approach is to train students to not only become metacognitively competent in governing their Self-Influence on Learning (SIL), but also simultaneously be educated in the importance of co-empowered learning. Ultimately, students are to develop a shifted perspective through which they can genuinely understand why it is essential and more humanistic to develop understanding for “co-empowering learning communities through self-empowered individuals,” and why it is crucial for individuals to invest in themselves while concurrently gaining such a *background understanding*. In my view, and according to previous research, this can be one of the basic foundations for effective practices in STEM disciplines as well as in other education fields.

### **Knowledge and Research Gaps That Gave Rise to This Project**

For almost two decades, a number of instructional models provided guidelines for researchers and educators for effective approaches that improve learning in STEM fields for K-8 students through increasing students’ awareness and regulation capacity (Cleary & Zimmerman, 2004; Darling-Hammond, 2007; Engle & Conant, 2002; Hacker et al., 1998; Herrenkohl et al., 1999a; Kistner et al., 2010; White & Frederiksen 1998, in Minstrell & Van Zee, 2000; Peters & Kitsantas, 2010; Brown & Campione 1996, in

Schauble & Glaser, 1996). Results of numerous studies conducted on a broader age range of students and in other learning fields also indicate that academic achievement improves with the development of one or more of the following: metacognitive awareness, knowledge development, or skill building through metacognitive assessment and regulation practices (Abdellah, 2015; Cubukcu, 2009; Everson & Tobias, 2001; Gourgey, 2001; Leader, 2008; Sandi-Urena, 2008; Swanson, 1990; Tobias & Everson, 2002; Van der Stel, Veenman, Deelen, & Haenen, 2010; Wilson & Clarke, 2002; Yavuz & Memis, 2010). Several other studies specifically demonstrated that developing awareness of one's own thoughts and actions resulted in the emergence of high-level cognitive competencies (Shea et al., 2014; Weil et al., 2013). Still other researchers reported that by means of continuous metacognitive instructions, there was an increase in metacognitive capacities, learning performance, and intellectual ability as well as academic achievement in students and teaching performance in teachers (Abdellah, 2015; Van der Stel et al., 2010).

However, as Ellis et al. (2014, p.4015) note, “there is a dearth of evidence showing how specific practices are implemented to affect student achievement.” This dissertation project provides methodologies to help educators improve student achievement.

Previous studies have focused on finding ways to develop students' various metacognitive strengths in educational settings, particularly ways to help students use metacognitive techniques to improve academic achievement. Some attempted to

strengthen social emotional development. Some organizations like CASEL and SEAL (please see in Chapter 2, p. 46 for detailed information) The work of these organizations have such optimistic results as far as establishing emotional intelligence (Goleman, 1995b; Salovey & Mayer, 1990) along with social emotional learning components. Research in these field suggests that well-designed programs that simultaneously foster students' social, emotional and academic growth be highly beneficial to be widely implemented in schools.

Thus, the purpose of this dissertation is to help close these gaps in two ways. First, the project focuses on developing metacognitive competence to govern SIL for establishing co-empowered learning communities through self-empowered individual leaders. The second purpose is to share the specific practices investigated in this study; the results of these practices indicate that they are helpful to students' social-emotional and academic achievement.

In addition, this project provides an in-depth perspective on specific practices implemented to enable students to develop a successful learning community by means of first, sharing answers about what, why, and how to raise students' metacognitive awareness toward their self-influences in their learning; second, through opportunities created for "meaningful realization" moments while building the necessary comprehensive knowledge and understanding about the importance of discerning why taking sole responsibility for one's own learning process is crucial. What would happen if one didn't choose to fulfil that responsibility?

The project also examines students' approaches to the practices facilitated by MCM, and their academic and social outcomes, both of which illustrate how the shifted understanding and practices develop another layer of awareness and cognizance and leverage self-responsibility in students on an individual level. These practices heighten students' dedication to self-empowering themselves and to co-empowering their learning communities through their improved academic and social-emotional strengths.

So far, in the above overview, I have provided the unique aspects of the project. Next, I will describe the Metacognitive Coaching Model (MCM), by elaborating the instructional foundations, highlighting the key elements of this pedagogical approach. I will then share the research findings and discuss the limitations. I will conclude the chapter by providing the teaching and learning techniques educators need to incorporate into their everyday classroom to develop capacities in governing SIL in their students.

### **MCM as a Pedagogical Approach**

The purpose of the MCM is to prepare students to gain the necessary skills and capacities to successfully take charge of their own learning while co-building a supportive, respectful, efficient learning community by becoming metacognitively competent of governing their SIL. This learning process takes place through the MCM training and practicing processes aimed at empowering individuals through developing Self-Action-Regulation for Collaborative Learning (SaR-CoL) skills.

Empowerment of individuals comes through helping them first develop cognizant self-awareness and genuine understanding of influences that affect them, including the

effects of their environments. Individuals must realize that their actions are formed as reactions of the influence of numerous external and internal emotional stimuli. Next, empowerment comes through helping students recognize that regardless of those stimuli, it is possible to be shielded from these influences as much as possible through skill development. Once this takes place, shaping self-actions get easier at a time in a balanced way; prudently, responsibly, and wisely for theirs' and others' learning.

### **Building Classroom Culture of the MCM**

The MCM approach requires a supportive and respectful classroom culture so that students can make the necessary shift in their perspectives to perform the needed transformations in their understanding. To develop such an environment, I first implemented classroom culture building methodologies as a strong background, such as developing class norms and expectations. Applying these traditional methodologies helped me as a teacher setting strong and supportive expectations of my students. Next, I spent further time developing a foundational methodology of the MCM to transform this environment into a community of learning. The essential points of this methodology are explained in the following from the pedagogical point of view:

First, I aimed to help students realize that they need to turn their spotlights to themselves to focus on their self-empowerment during our limited learning time in the classroom, which is related to the 0th layer of the MCM that will be explained in the further sections. Second, I made the point that it is vital they focus on sensitively supporting each other, and that they need to know why providing self- and peer support is

so crucial. To accomplish this, we discussed how acts of kindness and respect toward themselves and others can help everyone to focus on their self-empowerment through learning. We also discussed what actions can translate to being supportive and respectful. Finally, we brainstormed on what it means to be focused and efficient, both of which are needed for them to self-invest by refining their learning process through strong discipline and work ethics.

Then, I explained to them that everyone has strengths and weaknesses. I urged my students to keep this fact in mind as they work together. I explained that their goal is to solve any mistakes or negative actions they or others may engage in without blaming anyone, and to concentrate instead on being part of a solution in whatever way is the most peaceful and supportive.

In summary, I asked them to put on a supportive hat for themselves and others to strengthen those weaker parts, while cultivating the strong parts. I suggested an approach in which they tenderly and objectively coach themselves and each other to realize the harm undesired acts maybe causing in their learning environment. In short, I invited them to co-contribute to establishing the most supportive environment possible in order to more easily replace undesired acts with desired ones to cultivate a more efficient and peaceful learning environment in which everyone can strive together.

For this initial understanding to translate into their actions in practice, they needed to first identify their own strong qualities and while holding onto them, also monitor and objectively pinpoint their own undesired thoughts, beliefs, and habits, so they can shift

the latter into positive ones to help their overall learning processes. The main idea of the MCM approach is individuals taking responsibility to govern their own thoughts and acts while coaching each other to achieve their ultimate personal and social success. This aspect of the methodology encouraged a shift in my students' understanding. To help them comprehend the components necessary to achieve this shifted understanding, I introduced a "gem" metaphor that has three important aspects: Merging the uniqueness, diversity, and equity within; highlighting and cultivating the leader within; and facing and curing the weaknesses within.

*The First Aspect: Merging the Uniqueness, Diversity, and Equity Within.* The first aspect of the metaphor focuses on *the uniqueness and unity of a gem*, and suggests every gem has shiny parts and raw parts in different yet unique ways. Just as with the gem, everybody has active shining qualities that are unique to themselves with which they can do wonders in different capacities, and at the same time we all have "raw" qualities that are our weaker parts to be activated through our own work with ourselves by means of gentle interventions. Equity comes through knowing that the essential part is the gem is the strong leader within, and the raw part is that which is covered by dust clouding one's potential. This raw part is uncultivated potential that needs our help to be activated. Thus, if we view this raw part as uncultivated potential, blaming ourselves and others for these aspects is no longer necessary. Instead, it makes sense to provide genuine and gentle support toward ourselves and others to cultivate those potential, raw gem aspects so they can shine through, completing the diverse and unique gems in each of us.

We all have the potential to complete missing pieces of the puzzle (Baykent, 2006) in our own unique ways. Each puzzle is being a shining gem, radiating their composition of colors.

***The Second Aspect: Highlighting and Cultivating the Leader Within.*** The second aspect focuses on *the shiny part of the gem within the self*, and suggests acknowledging the positive, helpful, supportive thoughts that arise effortlessly. These are the qualities that provide understanding of the world around oneself and facilitate one's success. For example, some people easily make friends, while others are excellent at time management. To truly appreciate these qualities requires diligent work and further cultivation and polishing, resulting in these aspects manifesting in actions and productions that can translate as academic and social achievement, both individually and collaboratively.

***The Third Aspect: Facing and Curing the Weaknesses Within.*** The third aspect focuses on *the raw part of the gem within the self that may be opaque, not shiny, or darker, or may have dust or even small stones around it*. This part of the metaphor represents acknowledging any negative thoughts or misunderstandings we have about ourselves due to our having a difficult time in such things as building meanings about academic concepts, feelings of incapability in the classroom, having barriers to using some talents and qualities, or not being able to interpret our world on some areas as easily as some others. We may develop a misperception or self-doubt about our classroom capabilities due to these stressful emotions that arise from such fear and concerns. For

example, we may believe we are incapable in some disciplines due to struggling to perform in the classroom on these topics. Such perceived beliefs and the resultant feelings of incapability may cause us to make negative statements about ourselves that further block our potential. These statements that we knowingly or unknowingly make about ourselves are the metaphorical dust around us that needs clearing away. This dynamic is something that every individual may face in different ways.

This is the aspect that attracts emotional stress and may cause us to become reactive in our actions. These often-inadvertent actions tend to negatively influence our mood and environment. However, if we simply keep these discomforts within and don't resolve them, we may accumulate uncomfortable feelings and risk those emotions eventually bursting forth, resulting in an even stronger negative influence.

The unresolved negative beliefs and emotional reactions burst out as undesired actions that directly result from our own perceptions rather than those of the outside world. When we begin to resolve such unresolved negative beliefs and feelings, we can expect our actions to come across more balanced and unreactive. Hence, our interactions with others are smoother and friendlier and more productive (see details in Chapter3).

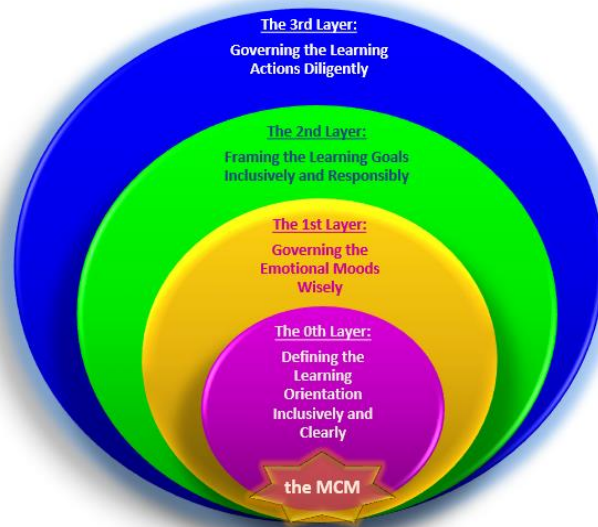
After we understand this basic mechanism, we need to achieve this shifted deeper understanding by building the appropriate skills, which in this case involves training our minds to become aware of and knowledgeable about any negative feelings, and then work through them to develop more balance within (see details in Chapter 3). In other words, we need to truly re-structure the way we function in our thinking mechanism, focusing on

how we perceive ourselves and govern our thoughts and emotions. When an action arises as a product of genuine understanding, it is a balanced act instead of a reaction based in emotional conflict.

The proposed MCM approach offers one way to do this through developing *metacognitive thinking capacity*, which will be explained in the following sections of this chapter.

### **Foundational Layers and the Key Points of the MCM**

Upon developing that necessary shift in my students' perceptions and helping them gain the needed core understanding through the "gem metaphor," I used the following layer-like structure of the MCM to help them further build the necessary foundational understandings.



*Figure 6.1.* The foundation of the Metacognitive Coaching Model for Governing Self-Influence on Learning (SIL) to develop self-empowerment for co-empowerment.

***The 0th Layer: Defining the Learning Orientation Inclusively and Clearly.*** This initial layer is for guiding students to develop awareness and understanding about their own learning orientations. I classified learning orientations under two categories: *self-oriented learning* and *others-oriented learning*. In *self-oriented learning*, one focuses on bettering ones' capacities for the purpose of achieving overall well-being and self-empowerment in the long run. In contrast, in *others-oriented learning*, one focuses on learning as a means to feel content in the short run by "winning" via grades, credits or rewards, or beating others for the top spots.

In our classes, we educators use many teaching methodologies as well as manipulations and motivators that may foster others-oriented learning, for example, games, challenges, and competitions. Our aim is to effectively help a group of usually 25 to 30 students at once. Most educators want students to focus on their learning in an enjoyable and peaceful way and to gain the most out of the teaching setting. However, our approaches may lead to students engage in others-oriented learning, especially if students lack awareness, knowledge, or a clear definition of their learning orientation. At least in part due to teaching methods that foster competitiveness, students may unintentionally gravitate toward practicing the others-oriented learning approach over and over, even though an educator's objective is to use such teaching methodologies to genuinely support the students' learning.

While these methods are undoubtedly needed in a learning environment to develop engaging variety in teaching settings, unless taking some precautions in advance

in students' minds, they may carry the risk of generating several student misperceptions regarding learning. Hence, I found that it is crucial to initially spend time clearing up these misperceptions in students' minds, via class and small-group discussions. To help students developing an inclusive and clear definition of these learning orientations, they need to make sense of some key points:

1. Learning should be about improving one's own capacities.
2. While friendly competitive learning activities are still important to take seriously as they are also beneficial, the overall aim should be topping oneself through steady progress in self-empowerment via learning about our world and gaining the needed skills, not outdoing other students. So, keep up the good work if you win, and take it as a sign to work harder if you lose while congratulating the winner wholeheartedly. Nothing is personal.
3. Students must realize that they can strengthen their thinking capacity a great deal if they apply themselves into their learning processes to develop accurate understanding about their world around themselves. They also need to realize that showing reluctance for developing the needed capacities to become *a wiser learner*<sup>9</sup> at a time may harm their reasoning capacities.

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<sup>9</sup> A wise learner is described as having the power of discerning and judging properly as to what is true or right; possessing discernment, judgment, or discretion. 2. characterized by or showing such power; judicious or prudent: a wise decision. 3. possessed of or characterized by scholarly knowledge or learning; learned; erudite: wise in the law. (dictionary. com)

4. Each learning project is a unique opportunity to develop the needed skills for lifelong learning such as gaining robust study discipline and a strong work ethic to self-empower oneself and to become a better collaborative lifelong learner.
5. Once students develop the necessary habits of mind by practicing skills such as prioritizing, concentration, consistency, self-motivation, dedication, perseverance, and similar types of helpful approaches, students will become strong contributors through their robust skills that enable them to truly co-empower their own learning and that of their social communities while improving their own well-being.

In sum, the students need to clearly see that school years can be their best chance and the best time to gain such capacities. They need to realize that it is possible for them to assume primary responsibility for developing the capacity of such self-leadership through which they can govern their own learning actions and thus contribute to their society with their most refined, finest, and optimum influence.

**The 1st Layer: Governing One's Emotional Moods Protectively and Wisely.**

Lack of awareness of the need for defining a clear and healthy learning orientation, may negatively influence the way students approach their learning tasks. Particularly, students who inadvertently follow the *others-oriented learning approach* may suffer various consequences, such as becoming overly ambitious at times in order to win over others, or to give up on winning if their previous trials didn't work out. They may also try to win power or get attention through undesired actions, which may disturb the learning

environment. Regardless of the result, with the others-oriented learning approach, the focus is rarely on nurturing the self through learning individually or/and collaboratively. Instead, the focus is mostly on jockeying for position to take the best spots, most rewards, most appreciation, and so forth. Indeed, we need to encourage students to become their best. However, we first need to establish a clear and inclusive definition in students' mind of what it means "to become their best."

Another common challenge is that unless students have already established a self-oriented learning approach, an others-oriented approach may trigger ongoing conflicts between each other, which can make students emotionally vulnerable. These emotional imbalances can directly and easily impact students negatively. For example, some may take an aggressive stance by jockeying for positions, dominating others, not being respectful or supportive of others learning space through entering their boundaries, and so forth. Some, who are in the other side of the equation, the students who are not being respected or being provided space for them to be and to learn comfortably, they may react, unknowingly, toward such harsh emotional stimuli sometimes by taking a passive stance (e.g., by becoming shy, quiet, or unwilling to participate), or fighting back in their learning environment. All these approaches can generate social stressors among learning groups, and influence every single student differently, As well as their learning environments.

These social stressors, as explained by Boekaerts (2002), are social-emotional tensions that distracts students' attention due to conflicts about what actions benefit an

individual versus the whole team. In other words, these distractive reactions burst out due to emotional imbalances within, and act as a threat to the balance and peace of the environment. These stressors, perceived as apparent or silent threats, distract students and disrupt team dynamics and the individual in the learning setting. Thus, students are not able to truly focus on developing deep understanding on a subject matter, nor can they produce quality learning products by using their potential effectively; instead, they waste their invaluable yet limited learning opportunities through disruptions caused by social-emotional tensions.

Due to these dynamics, training students how to govern their emotional mood is an important step in their developing SIL. This is addressed within the MCM application through everyday practices that help students develop a capacity to govern their emotional moods (see Chapter 3 for details).

**The 2nd Layer: Framing the Learning Goals Inclusively and Responsibly.**

Goal framing has been studied in terms of describing how to use “I” and “we” language (Boekaerts, 2002; DiDonato, 2013; Dweck, 1992; please see Chapter 2 for details). My approach was slightly different in application from previous research. I focus on the idea of both fulfilling “*my responsibilities*” for my tasks and, fulfilling “*my responsibilities*” to contribute to my team’s success. As the goal was to help students realize that they have responsibilities to fulfill, both for themselves and for their teams, if they are to truly contribute in developing a learning community. So, I addressed this in the MCM applications by having students first make themselves a plan in which they recognize

their responsibilities in each learning activity. In this plan, the first step is for students to self-empower themselves, then to co-empower their teams, and finally to report on how they were able to execute their intentional plans. The purpose of this process was to help students develop the desired habits of mind by providing them with persistent practices of acknowledging, planning, carrying out, and self-assessing their responsibilities for themselves and others.

**The 3rd Layer: Governing the Learning Actions Diligently.** After mood adjustment and goal framing, I asked my students to plan their future learning actions. The objective behind this task was helping students state their intentions in a structured plan to focus themselves and to refer to it when needed. I developed two categories and included them in a semi-structured scale within their entry and exit tickets along with the other tools. The learning principles were classified as; academic learning actions (including actions that translate to being focused and efficient), and social learning actions (include actions that translate to being supportive and respectful). Prior to engaging in each activity, students used entry tickets to rate (using a pre-arranged uni-dimensional Likert scale) how determined they were to enact their plans to be more focused and efficient. Students used the Likert scale, which to report the level at which they thought they would be able to practice these acts, how much effort they intended to put forth, and the levels of these they stated in their plans in the beginning of the activity.

Following this planning, students were expected to act upon these planned actions while performing in their learning tasks, thereby fulfilling their responsibilities to

themselves and others. An example of fulfilling their responsibilities to themselves, they practiced being focused and efficient by paying close attention to their learning task and prioritizing it over chatting with friends. Other examples include putting in effort to being more organized and tidier, paying attention to details, listening to the teacher, reading, searching for information using their laptop, thinking, questioning, and working to make effective use of their learning time to ensure they attain the essential learning goals of the activity.

To fulfill their responsibilities to their team members they might, for example, put effort in being respectful and supportive by practicing actions such as listening to each other by looking into the eyes of the person speaking, communicating with each other respectfully, brainstorm about their project at hand, providing space to one another, raising their hands, controlling their voices, working with their peers in a supportive and kind way, and answering their questions.

So far, I briefly laid out most of the basic layers of *the Training and the Practice Processes of the MCM*. Next, I will briefly review the overall project application, which includes data collection, measurement, analysis, and synthesis of the research questions. I will provide discussions at the end of each research question to share my understandings and interpretations based on the analysis and synthesis of the qualitative and quantitative measurements.

## **The Summary of the Findings and Discussion**

The purpose of this dissertation is evaluating the results of implementing the MCM while teaching STEM subjects to students in Grades 3-5 in an after-school on-site-training (OST) program. As argued earlier, implementing the MCM enables students to develop metacognitive competence in governing their SIL by self-empowering team members to co-empower their entire teams via improved academic and social achievements. More specifically, because of the capacity of the SIL that is being developed, it is expected that students will better engage in social learning processes together with peers, which should help them make further progress in their own understanding of complex STEM projects as well as develop shared understanding of complicated problems and projects.

To this end, I examined five research questions. In the following, after sharing these questions, I will briefly lay out the findings and share my discussions for each research question.

### **The Research Questions**

**RQ1.** Before the intervention (BI), that is, before undertaking the training and practices of the MCM intervention, how aware were students of their social and academic actions during individual, and collaborative/team learning?

In other words, before the MCM intervention, what is the level of students' initial metacognitive competence regarding their learning actions in general? More specifically,

are they able to accurately monitor and reflect upon their learning actions before the training and the application of the MCM intervention?

**RQ2.** During the intervention process (DI), are students developing metacognitive regulatory control over learning actions as they practice and perform the MCM protocols using the planning, execution, and reflection assessment cycle, and if so, do students demonstrate any consistency in (a) executing their plan of actions or (b) reflecting on their executed plan of actions accurately?

**RQ3.** What is the association between the MCM application and students' metacognitive competence for regulating their learning actions /governing their SIL overall after four months of the intervention (FI-follow-up Intervention, where there is no formal MCM application) when compared to before the intervention (BI) that took place in the Fall quarter?

**RQ4.** While practicing MCM protocols toward developing metacognitive competence over their SIL, is there any observable pattern on students' responses to the mood adjustment, goal framing, and academic achievement test scores that shows engagement in and attainment of self-empowerment and thus collaborative-empowerment?

**RQ5.** Do students continue regulating their academic and social actions (learning actions) four months after the conclusion of the MCM intervention? If so, is there any observable pattern in their learning communications that indicates improvement that may be correlated to the MCM intervention?

## Findings and Discussion of Research Question 1

**Before undertaking the training and practices of the MCM, (i.e., before intervention; BI), how aware were students of their social and academic actions during individual, and collaborative/team learning?** RQ1 investigates whether students are initially aware of their own learning actions. To answer this question, I made a chart-graph measurement and conducted the SPSS paired t-test analyses to compare the students' responses on the pre-survey questions based on their perceived views about how they act academically and socially in their learning environments versus their real enacted *learning actions*<sup>10</sup> based on the cumulative observation results that are composed of field observation notes and video recordings BI. The findings revealed that students' self-reports of positive learning actions in the pre-survey were significantly higher than the observation results conducted across the four aspects: being focused, being efficient, being supportive, and being respectful. In other words, students were unable to correctly pinpoint their overall actions, nor they were able to recall their self-actions precisely.

This is called the *overconfidence effect* in psychology, and it is consistent with findings in the literature that children are unable to predict their own performance, even though they are capable of making accurate predictions about other children's performances (Finn & Metcalfe, 2014; Lichtenstein, Fischhoff, & Phillips, 1977; Salles, Ais, Semelman, Sigman, & Calero, 2016; Stipek, 1984). Researchers propose multiple

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<sup>10</sup> "Learning actions" are examined in terms of *Academic Learning Actions (ALA; staying focused, being efficient)*, and *Social Learning Actions (SLA; being supportive, being respectful)*.

reasons for this effect, including that young children are not able to differentiate between their wishes and expectations (Piaget, 1930 in Inhelder & Piaget, 2013); report how well they wish they performed (Bjorklund, 1997); may remain overly optimistic about their performance even after negative feedback in order to protect their motivation (Bjorklund, 1997; Lipko, Dunlosky, Lipowski, & Merriman, 2012; Lipko, Dunlosky, & Merriman, 2009; Salles et al., 2016; Shin, Bjorklund, & Beck, 2007); or might be still developing skills for regulating their behavior from the output of this process (metacognitive control) (Salles et al., 2016; Schneider, Visé, Lockl, & Nelson, 2000).

In sum, before the intervention process, students were unable to accurately evaluate their own learning actions of being focused, efficient, supportive, and respectful. Specifically, the results suggest that at the BI phase, students were not aware of how they actually performed individually and socially in a collaborative learning setting.

Consequently, students were not metacognitively aware of their self-influences on learning that comes through their learning actions as they were not metacognitively competent at accurately monitoring or reflecting on their self-learning actions.

Results indicate that students' inability to accurately evaluate themselves" comes from one or both of the following: their lack of competence in tracking or monitoring their thoughts backward, and their inability to recall and reflect on their learning actions metacognitively.

Due to such lack of knowledge and understanding, students may be unwilling to pay a close attention to self-learning actions. They may not be aware of the necessity to

pay attention to their actions. This can be a possible root cause of such unawareness of self-actions. The hindering reason behind this possible lack of willingness, and thus unawareness, can be resolved through helping students gain solid understanding of why they need to pay attention to their own actions, why it is necessary for ones' turning their spotlights to their own actions, what is it to do with their goals, what they need to do to achieve their goals, and how they can achieve them. In other words, students lack metacognitive awareness, knowledge, and understanding in SIL, which is considered as primary cognition (Nelson & Narens, 1990) as part of developing cognitive process that is the first step of developing metacognitive competency.

Once this gap in their understanding was fulfilled, throughout the training provided by the MCM, students demonstrated genuine willingness to pay attention to their own thoughts and enactments during the practice process of the MCM. Practice process focuses on developing the secondary cognition (Nelson & Narens, 1999) as part of developing control process of metacognitive competency. Thus, as they progressed in their practices in this dissertation, the students developed sharper capacity and a better consistency of accuracy translating that they were in progress in developing metacognitive competence.

Initially, students often don't understand that people must develop Self Action Regulation for Collaborative Learning (SaR-CoL) skills, and that most of us do not develop these skills entirely on our own. Developing SaR-CoL skills is one example of the type of lifelong learning skills that Cornford suggests educators facilitate (Cornford,

1999, 2002). That is, helping students gain lifelong skills and capacities metacognitively that teach them to *learn to learn* (Biggs, 1988; Hattie, Biggs, & Purdie, 1996; Hattie & Jaeger, 1998). The needed revolution in approaches to teaching and learning involves achieving “the ideal of effective lifelong learning through the teaching of cognitive and metacognitive skills” (Cornford, 2004, p.13). Currently, although “the vast majority of teachers at all levels of education have good intentions to promote effective learning by their students, they have never been taught how to incorporate the teaching of cognitive and metacognitive skills into their sessions” (Cornford, 2004, p. 12). Thus, teachers need adequate support if they are to help their students develop metacognitive competence of governing the SIL at an early age.

Hence, based on the results of the RQ1, I propose to provide educators with this needed support by establishing a series of systematic training programs through which students should be trained first become metacognitively aware of their self-actions through metacognitively turning their spotlights to their own thought and action processes, and second to set expectations for themselves to pay more attention in shaping their actions responsibly.

While this can make students realize their true potential, at the same time it will help them develop these skills as early age as possible. These two steps will enable them to better gauge their self-expectations and goals, thereby assisting them in making their goals a reality through a process of strongly planned, well-disciplined, responsible actions. Through the process of planning, carrying out actions, and self-evaluation,

students can witness how hard work can result in rewards once they put in genuine effort toward reaching their goals. They can also experience the self-confidence arising from attaining their high expectations in their lives and witness their true potential.

The aim of the MCM is to help students develop the capacities necessary to govern their SIL and in turn, develop more proficiency in core subjects. To evaluate whether the MCM was successful in attaining this end goal I asked RQ2, which focuses on examining whether students developed metacognitive competence after they complete the planning-execution-reflection training protocols.

### **Findings and Discussion of Research Question 2**

#### **Are Students Developing Metacognitive Regulatory Control Over Their Own Learning Actions? Were They Engaged in Such a Process because of the Training?**

The aim of practicing and performing of the MCM protocols is for students to develop an awareness of and capacity to mindfully plan their actions, to know what to do, and to be more thorough and thoughtful when reflecting on what they did and how they acted. Through this training, they are expected to develop *a consistency* between the planning and executions of their plan of action, as well as *an accuracy* in reflecting on their executed plans of action. In other words, students should be able to execute their plans of action and be able to accurately reflect on these actions. In order to find out whether such consistencies and accuracy occurred, thus indicating metacognitive

regulatory control development, I used the consistency accuracy chart analysis and the SPSS paired t-test analysis.

The findings for the *consistency* measurement revealed no significant difference between the students' planning and execution. From this result, we can infer that success in execution of plans was attained during the intervention, based on the data from the performance phase report analyses. These analyses were conducted across the following four aspects: being focused, being efficient, being supportive, and being respectful.

The findings for the *accuracy* measurement revealed a significant difference between the students' reflection on the plans of execution in terms of being focused and their actual level of focus, while there was no significant difference in terms of being efficient, being supportive, and being respectful. Thus, results indicate that students were mostly successful in executing their plans. This finding was also confirmed by the consistency accuracy chart analysis results (See Figure 5.2), which indicate that the teams demonstrated consistent accuracy in executing their plans for at least three of four consecutive activities DI. This result also shows that the planning section of the MCM functioned successfully in helping students to become more mindful of their individual and social actions while students were in the process of developing their metacognitive skills for planning and executing of their actions in general.

As mentioned above, although the students were accurate in their reflection of their enacted actions for being efficient, supportive, and respectful, they were not as successful in pinpointing the extent to which they were able to focus on their learning.

Students perceived themselves as more statistically significantly focused ( $M = 3.78$ ) than they actually were ( $M = 3.59$ ). In other words, the “*overconfidence effect*” was still at work in this domain. This result may indicate that the MCM protocol needs to be revisited in order to better address the conceptual understanding of “what it means of being focused”, “how to apply a better focus on learning at a time”, and “how to self-monitor, and pin-point being focused or not”.

### **Findings and Discussion of Research Question 3**

**What is the overall relation of the MCM in developing students’ metacognitive competence for regulating their learning actions /governing their SIL, when compared to before the intervention (BI)?**

In order to find out whether there is change occurred in students’ enacted learning actions due to practicing the MCM protocols during the intervention (DI), I analyzed the coded field observation data collected BI, DI, and FI (follow-up of the Intervention after four months of the conclusion of the MCM applications).

***What is the Association of the MCM Practices in Students’ Enacted Learning Actions, if any?*** To find out the MCM’s overall relation to enhancing students’ self-social-emotional and academic success in the long term, the coded field observation data of students’ executed enactments for BI and FI were compared using the SPSS paired t-test analyses.

The findings revealed a significant difference in students observed enacted learning actions BI versus FI across the four aspects, being focused, efficient, supportive,

and respectful. These findings (based on the BI field observation notes) contrast the RQ1 findings in which students overestimated some of their actions due to possible lack of metacognitive awareness. This noteworthy change in students' enacted actions in FI, compared to BI, can be interpreted as the MCM having significant support on students in developing metacognitive competence in governing their SIL through regulating their learning actions.

On the other hand, the RQ3 findings revealed no significant differences in students observed enacted learning actions DI versus FI across the four aspects. The fact that the DI and FI are consistent, that means the students at least demonstrated such enactments that indicate sustained improvement during FI. This insignificance between the DI and FI can be interpreted as indicating the positive association of the MCM on students' enacted actions aimed at developing metacognitive competence. In addition, during FI, when they were no longer receiving support through the applications of MCM DI (as they were in the performing phase), students continued their positive enacted actions during the FI. This can be interpreted as students having a strong understanding of metacognitive practices and translating these into their actions through their self-choice.

***Metacognitive Thinking Process has been Established in Forming Responsible Learning Actions.*** Metacognition as terms and models have been widely analyzed either under cognitive or control processes. For this study, I initially adapted Nelson and Narens' view of metacognition as primary and secondary cognitions. *Cognitive process* is

defined under primary cognition (Nelson & Narens, 1999), which is widely defined as metacognitive knowledge, or the knowledge of cognition. *Control process* is defined under secondary cognition (Nelson & Narens, 1999), which is widely defined as the process that involves monitoring and controlling, or regulation of cognition (Bransford & Schwartz, 1999; Brown et al., 1983; Donovan, Bransford, & Pellegrino, 1999; Flavell, 1979; Garner, 1990; Lorch et al., 1993; Nelson & Narens, 1990; Paris et al., 1983; Paris & Winograd, 1990; Pintrich, 2002; Pintrich, Wolters, & Baxter, 2000; Schraw, 2001; Schraw & Moshman, 1995).

The field observations also confirm the RQ3 findings. During the FI, which took place after the four months of the intervention, students' enacted learning actions resembled the enactments that were established DI, yet the FI actions were more mindful, friendly, and settled. During the FI, students' enactments significantly differed from the ones observed during BI. Upon students' receiving the MCM training, students' enactments better shaped DI. In the FI process, students seemed better able to harness their metacognitive awareness, knowledge, and insights by the time they completed the practices of metacognitively thinking and acting during the overall application of the MCM. Toward the end of the FI process, it was observed that the students were able to place a better focus on their learning processes individually and collaboratively.

During the FI, the repeating patterns observed in students were demonstration of improved attentiveness in thinking, more dedicated focus in executing, and objective cognizance in monitoring. They appeared more thoughtful, and more fluent in their

verbal reporting. These patterns demonstrate a promising progress in ability of using both primary and secondary cognitions effectively while learning a new subject matter.

What I clearly observed was, that through the process of developing such metacognitive competence of the SIL, my students' thinking processes evolved into a new pattern. While in the past, they were not even aware of the need to be paying attention to monitoring their own learning actions, upon the training and practices processes of the MCM, they became more competent at catching their own thoughts, filtering any internal or external stimuli that may trigger emotional imbalances. The positively evolved learning environment was also helpful for students to govern their SIL. In addition, results suggest that they refined their thoughts, which was translated into balanced acts that were more responsible, respectful, and supportive than those initially observed. This change that brought more balanced actions and interactions may have allowed students to focus their energy toward better progress in their learning, both individually and collaboratively.

Overall results indicate that students were able to develop metacognitive competence in SIL by learning techniques, via MCM training and practices. It appears they better learned at a time to take external and internal stimuli as data and use these data to become better equipped to transform their initial emotionally influenced thoughts into responsible acts. During the process, when they were still not able to cope with the emotional burden they faced, students grew through receiving support from teacher and their peers as *the coaching protocol* of the MCM taught them to trust each other to be on

their sides to grow stronger at a time individually and together. Hence their positively balanced actions as a product of such metacognitive thinking ignites better learning interactions, resulting synergistic environment for a successful community of learners (Brown, 1992), who were able to develop scientific learning communities (Reddy, Jacobs, McCrohon, Herrenkohl, 1998), and as a result were disciplinary more engaged with their learning processes (Engle & Conant, 2002) through systematically structured protocols and guided participations (Rogoff, 1990).

Such training and practices within any curriculum at schools and in any family atmosphere at home, with the necessary integrations may be significantly helpful in preventing youth from developing self-sabotaging acts in their learning due to lack of knowledge and trainings of SIL.

#### **Findings and Discussion of Research Question 4**

**Does Practicing the Supportive Tools of the MCM have any association on Students' Self- and Co-Empowerment Development during the Intervention (DI)? Is there any observable pattern on students' responses to the mood adjustment, goal framing, and academic achievement test scores that shows engagement in and attainment of self-empowerment and thus co-empowerment?**

To answer this question, I examined the concerted association of goal framing as well as mood and learning action regulations on developing the overall metacognitive competence in terms of developing self-empowerment for supporting co-empowerment.

These applications were part of the daily protocols of the MCM. I found three patterns and examined those in three case studies.

In *Case Study 1*, one student (code named Purple2) was analyzed throughout her journey on developing metacognitive competence in her learning actions. The detailed look at her overall data revealed that BI she shown the signs of overconfidence effect. Neither was she aware of her SIL.

Results of a detailed analysis revealed that after the MCM intervention, she demonstrated a pattern of dedication in applying the MCM tools. Ultimately, she became aware of what she needed to do to help herself become a better student and at the same time be involved in co-building a successful learning community. The MCM protocols provided her with the structure and the pathway for her to develop such discipline she needed. Specifically, the MCM protocols allowed Purple2 to govern her SIL through regulating her emotional moods in conjunction with her overall goal framing and learning actions for herself and her team. The MCM practices helped her significantly in her self-empowerment (See Chapter 5, Table 5.7). This was also conclusive with her academic test score. She significantly improved her academic achievement with the score of pre-test result is 4, and post-test result is 12 out of 17.

In *Case Study 2*, I tracked the members of one team (code named Team Green) and analyzed how well they became co-empowering agents for each-other. The findings revealed that even though there was an ongoing power battle within Team Green members initially (BI and in the beginning of DI), as they went through the training

process, they underwent a significant transformation. This transformation was indicated in the team's consecutive reflections DI, in which they included detailed descriptions of their interactions. As the MCM training progressed, each member began changing the pattern of "I and others" language to more inclusive "we" language, indicating that the member began to embrace each other more as a team. The patterns of their self-reports about their work also signaled caring, compassionate, and tender support toward their individual and team learning (see Table 5.9). This caring synergist environment developed out of nurturing interactions that helped the entire team transformed into a collaborative learning community. This positive dynamic was also conclusive of their academic test scores. All the team members attained some of the highest gains, based on the post academic test results. Results indicate that the MCM protocols were tremendously helpful for this team's individual, social, and academic achievement during the project.

With *Case Study 3*, I analyzed the team code named Team Red in terms of its members' conflicted interpretation of the MCM. This was the only team among the six that came up with such an outcome. Detailed analysis of this team shed light on possible causes for their conflicted learning outcome compared to the other teams and provides a snapshot of what can happen when members refuse to team up with each other due to conflicts. Findings revealed that members needed to develop self-empowerment in their own way and at their own pace, and these differences caused conflict. A sub-team developed and, they demonstrated teaming up long before the rest of the team members.

This difference caused an emotional stress on the others, particularly on one of the members, and helping them resolve these conflicts took time. However, as each team member became more aware of the need to become a better learner, he or she could better focus on self-empowerment and began addressing others' needs in the team learning activities. It was only toward the end of the quarter that they were able to put forward intentional plans of action that resulted in an impressive co-empowered team dynamic. Till that point, within the time frame of this project, team Red members were not truly able to develop such a learning community within their group, nor were they able to reflect on any synchronized and harmonized improvement in their academic post-test achievement scores. The harmony they finally were able to generate was too late in the process. Hence, only the lack of harmony in their team co-occurred with their conflicted academic scores.

For the MCM application to be more successful for a team like Team Red, more one-on-one and collaborative work with its members for a longer time may be required. By doing so, students can develop the essential metacognitive understanding like Hogan did in developing collective metacognitive while exploring possible interaction of individual, social, and cultural meanings in small groups' reflective thinking (2001).

Further, there is a need for generating some additional future MCM protocols to help students overcome such resistance. Initially, three new protocols can be generated: (1) gauging / checking if the set of expectations that are required for students to understand for co-building community of learning within their team initially is well

understood by each team member; (2) monitoring absenteeism or lack of participation; and (3) helping students to close any understanding and/or knowledge gap about what is needed to develop a strong collaborative learning. These new protocols should ensure necessary precautions to help students develop the required team building steps among the members for them to develop capacity for self-action-regulation for collaborative learning.

### **Findings and Discussion of Research Question 5**

**Four months after the conclusion of the MCM intervention is there any observable pattern in students' learning communications that may be correlated to MCM practices?**

This question is to find out whether there is any observable pattern in students' learning actions reflected in their learning communications (i.e., conversations, interactions, verbal reflection, and learning progress reporting) that indicate any improvement correlated with the MCM intervention. In other words, is there any association between the MCM intervention and the students' learning conversations?

In order to answer this question, I transcribed and analyzed the learning conversations data from BI and FI that show details of students' communications. Some relevant data from the DI was also transcribed and analyzed to comparatively examine students' progresses. The data indicates that the team members were either having internal conflict or teaming up within and following their own lead instead of listening to the instruction or being too shy or unwilling to communicate about their progress BI.

DI, by the time being, each team developed further familiarity and understanding with the process, they showed willingness to better communicate with each other. They paid attention as a way to be more respectful and supportive of each other. As shown in Team Green, there were transformational changes in each team's social interactions, and the expectations of the protocols had a significant role in this transformation. Four months after the intervention, while there was no formal expectation set for students, the tone and the way of learning communication was further improved. Short interview transcriptions revealed how much they embraced the principles of the MCM protocols and how much of it was included in each sub team's learning progress reports, learning interactions, and via overall communication. The patterns of observed communication within the sub team members were highly collaborative, respectful, and supportive of each other, while they had a good work and time share, even in their work-progress reporting.

The overall findings show how willingly and attentively students were still contributing to forming an efficient learning community FI. It was obvious that they have placed a better focus into their own knowledge construction after the four months of the end of the intervention. Compared to DI, they were also more engaged in their social learning processes during the FI, which helped them make further progress in their own understanding of complex STEM projects as well as develop shared understanding of complicated problems and projects.

## **Limitations**

There are two limitations that are important to note. The first set of limitations are due to the cultural expectations of the program. While this project was conducted at an after-school program, it was not a usual informal learning environment. It was an ambitious setting that aimed to provide striving STEM foundation for the participating students, who were mixed grades, composed of 3rd, 4th and 5th grader. These students were attending from different schools and they had different social, economic and cultural backgrounds. This unique combination of student population and a short amount of learning time with such a comprehensive work load was presenting a necessity for a team-work that may have been a supportive factor in the success of this project. Thus, the future researchers should be cautious that incorporating the MCM into an everyday K-12 learning environment may not work as smoothly as it is presented in this dissertation. Consequently, there will be a need for an adaptation in any new learning environment and for each grade level, given the culture and norms for the learning community that students and their teachers are situated in. Otherwise, the results may not be the same as obtained in this dissertation project.

Second, the findings need to be interpreted with cautions because of some methodological limitations. While originally, I planned a quasi-experimental design by including both control and experiment conditions, the number of classes and class size made it more realistic to use the pre- and post- design. In addition, because of the sample size, I was unable to apply the Hierarchical Linear Modeling to analyze the collected

data. Instead, I used the paired t-test to compare students' learning outcomes before and after the MCM intervention by ignoring the fact that students were nested groups and then groups nested with classes. In sum, given these methodological constraints and the sample size, the findings should be interpreted as a preliminary effort as an action research to investigate the association between the MCM and student learning.

Admittedly, given the complexity of the proposed MCM approach, future research based on a design-based research (DBR) is needed to explore how characteristics of students, curriculum, and classroom culture may interact with the MCM-based protocols and activities by continuously refining the MCM approach based on students' and teachers' learning experiences and outcomes.

### **Implications and Future Directions**

This dissertation stresses the importance of teaching students to regulate their self-actions in ways that help them focus on both their own self-improvement and becoming stronger contributors in their team's collaborative learning through selfless acts and genuine participation. The results of this study provide understanding and a perspective on how to raise students' awareness in their self-thought and action processes, so they can realize that they may be acting differently from how they view themselves. Through the MCM's applications, this research provides possible implications and new insights into how to generate students' metacognitive understanding in learning environments, training them to effectively self-regulate their

learning actions with an awareness of the possible debilitating influences of unregulated actions on their and others' learning capacities.

The MCM provides students with pathways to practice developing the needed skills to gain metacognitive competence in governing the SIL. The goal of this dissertation project was not to work toward developing students' study skills; instead, the purpose was to help students gain lifelong learning skills through application of metacognitive assessment strategies.

The most inclusive aspect of the MCM is to provide a strong instructional tool for teachers of K-12 in metacognitive facilitation. This aspect intends to close an important gap in teacher training fields by offering a way of developing metacognitive facilitation. Some research suggests that there is a need for major curriculum revision and a revolution in approaches to teaching and learning through the teaching of cognitive and metacognitive skills (Chapman & Aspin, 1997; Cornford, 1999, 2002, 2004). For example, Cornford states that "the vast majority of teachers at all levels of education have good intentions to promote effective learning by their students, but they have never been taught how to incorporate the teaching of cognitive and metacognitive skills into their sessions. In short, along with changes in curriculum, a revolution in approaches to teacher education may well be necessary" (2004, p. 13). This project, with such proposed Metacognitive Coaching Model (the MCM), attempts to address this need with cognitive and metacognitive skill development aspects.

The materials developed for the MCM practices can be integrated into school district teacher training programs for teachers to apply in their everyday teaching at different grade levels. They can be further integrated for informal home-schooling of parenting education. Metacognitive assessment workbook can be also derived for school leaders and administrators use for teacher training purposes. Thus, this work should be brought into broad practice of use at home by parents to work together with their children, by school leaders to work together with their teachers, by teachers to work together with their students to genuinely develop metacognitive competence in governing the SIL as well as establishing metacognitive thinking capacity in everyday lives.

The overall application of the model not only offers a deeper awareness of students' learning processes both individually and collaboratively, but also provides opportunities to employ effective communication and solid work ethics in teamwork. The MCM helps generate strong teams by engaging individuals in blending their strengths together, by working side by side, and consciously generating good teamwork.

Furthermore, through providing these benefits to students, the MCM can potentially close many gaps in current understanding of metacognitive competency in STEM learning and beyond. It does so by addressing the importance of Self-Action-Regulation for Collaborative Learning (SaR-CoL) through helping students develop metacognitive competence for higher-quality learning actions and interactions and as a result of higher emotional, social and academic learning achievement.

This work also helps students by addressing how students can better think, act, and learn together, why it is important, and what each student's role is, as well as what happens if the individual responsibilities are not fulfilled appropriately. These aspects are crucial for K-20+ students to cultivate to be better learners, team participants, and citizens. Through which they will deliberately progress into becoming a part of strong workforce of the future STEM fields not only as citizens of their nation, but as global citizens of the united nations of the world.

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## Appendices

### Appendix A: The Main Protocols of the MCM

These protocols are embedded in the tools of the MCM that are used during the practice process. They are used within *the entry, process, and exit forms*. On the forms, metacognitive prompts were included to use in the students' knowledge integration and utilized as a reflective assessment tool during the process (Linn et al., 2004; Peters & Kitsantas, 2010; White & Frederiksen, 1998). These forms include *two sets of protocols: the SIRP; Self-Influence-Regulation-Protocol*, and *the SPCP; Self and Peer Coaching Protocol*. The protocols are run by means of the forms. SIRP appears in *entry and exit forms*, while SPCP appears only on *the process form*. In the following sections, I will briefly define the protocols.

#### **SIRP Protocol: Self-Influence Regulation Protocol**

**Aims** to raise and develop students' awareness to show that it is possible to regulate self-actions for collaborative learning (SaR-CoL) by governing through orienting, straightening, cultivating our moods, assuming our roles in every aspect, and setting intentions on how we act and interact to better learn individually and collaboratively.

**Proceeds** by asking students, through scripted questions, to plan how they would regulate their moods, responsibilities, as well as academic and social actions (on the entry form) and reflect in the end of the activity (on the exit form), as an individual learner and as a team participant, on how much they think they could proceed according to the plan.

**Measures** students' responses that show the level of interest, engagement, consistency and accuracy.

### **SPCP: Self and Peer Coaching Protocol**

**Aims** to raise and develop students' awareness that it is possible to execute, monitor and revise their academic and social actions as a team-participant during the activity.

**Proceeds** by encouraging students to engage in metacognitive strategies of executing, monitoring and revising (on the process form) through self-, peer- and teacher-coaching.

**Asks** students to follow certain rules to score their actions.

**Measures** the level of effort that is put into maintaining the students' individual regulation plans.

**Please note that** for this project, only the SIRP protocol measures were analyzed. The SPCP is generally shared in this document to provide information.

The "Self-Influence Regulation Protocol" is blended with metacognitive assessment strategies (planning, monitoring, executing, and reflecting). By means of both the SIRP and SPCP protocols, students are asked to regulate their self-influences for collaborative learning by (1a) re-orienting their mood/emotional states, (1b) re-adjusting their individual and collaborative goal framing for daily learning-tasks, and finally (1c) re-defining/re-stating previously defined learning principles, which are composed of individual and social actions. Alternatively, the "Self and Peer Coaching Protocol"

functions through self-reflection and interactive feedback process, where students are guided to practice (2a) self- and (2b) peer- coaching. The MCM protocols take place in three steps. They appear in different forms each time. Below chart illustrates what instruments take place for each step.

Table A1.

*The Practice Instruments of the MCM*

<b>Steps:</b>	<b>Step 1</b>	<b>Step 2</b>	<b>Step 3</b>
<b>Timing:</b>	Just before activity	during the activity	at the end of the activity
<b>Instruments:</b>			
<b>Forms</b>	Entry form	Process form	Exit form
<b>Metacognitive strategies</b>	Self-planning	Executing, monitoring revising spiral cycle	Self-reflection
<b>Protocol in use in each step</b>	SIRP in action  during the -Planning part-	SPCP in action  during the -Execution part-	SIRP in action  during the -Reflection part-
<b>Procure of each Step</b>	SIRP asks each student plan re-orienting the mood and responsibilities as well as re-defining their individual and social actions on the entry form.	SPCP asks each student to self- and peer coach to make sure they are executing their planned actions. These actions are being monitored and revised during this process (by the teacher and the volunteer assistants as well as video-recordings)	SIRP asks each student to reflect on their perceived performances of their practices of regulated individual and social actions as well as on the moods and goal framing.

## Appendix B: Pre-questionnaire

Table B1.

*Pre-questionnaire on Students Self-Perceptions/Beliefs about their LAs & Approaches*

Q1	reason:	Why do you think you are attending this after school program?
Q2	interest:	What do you want to learn?
Q3	learning style:	How do you learn best?
Q4	learning conditions:	What helps you to learn better? (How do you approach your learning task?)
Q5	learning approach/attitude:	How do you approach your learning task (are you focused, efficient, clean/tidy/organized/do you follow instructions carefully completing the assignments?)
Q6	learning behavior in a team:	How do you learn in a team?
Q7	learning communication within the team:	How do you communicate with the members of your team?
Q8	Self-perception as a team member (supportive, respectful, providing space for others):	How would you describe yourself as a team member? (are you supportive, respectful, do you provide space to others to be themselves, etc.?)
Q9	Self-perception of their own emotions/moods/ attitudes in the beginning of the instruction (what emotions they carry along with themselves in general- to find out if there is any underlying emotional barrier):	How do you usually feel at the beginning of the class? Circle one of the below feelings or write your thoughts below if you have different feelings): Happy, Normal, Sad, Energetic, not energetic, productive, not productive, hardworking, not hardworking
Q10	The reason of self-feeling entering the class (What is the underlying factor that maybe causing this feeling ):	What does it depend on? (it may depend on what you are about to learn, your class-mate, the weather, etc.)
Q11	The self-controlling capacity of overcoming emotional barrier if there is any:	How willing and successful you are in adjusting your mood to completing the task carefully?
Q12. Write the meaning of the following as you know Principles, study discipline, work ethic, attitude, approach, focus, respect		

## Appendix C: Pre- and Post- Academic Test


Post-Light and Scratch Assessment / Achievement Test  
Instructor: Derya B. Sunkel

1 

What block in Scratch should you use to make a sprite disappear?  
Choose one answer.

- a. I don't know.
- b. hide
- c. show
- d. disappears

Submit

Question 2 

How are animations made?  
Choose one answer.

- a. By displaying a rapid succession of images.
- b. I don't know.
- c. Draw one image and then the computer does the rest.
- d. Disneyworld does it with special science.

Submit

Question 3 

How do you send a message in Scratch?  
Choose one answer.

- a. By clicking the message button.
- b. By selecting "broadcast"
- c. I don't know.
- d. By selecting "When I Receive"
- e. By selecting "When clicked"

Submit

Question 4 

In Scratch how do you know whether a sprite is touching a certain color?  
Choose one answer.

- a. I don't know.
- b. By using "touching color <>?" from the Sensing section.
- c. By clicking on the sprite and entering the color.
- d. By using "touching color <>?" from the Control section.

Submit

Question 5 🚩

How do you copy a sprite in Scratch?

Choose one answer.

- a. Magic.
- b. Right-click on the sprite and select "Duplicate".
- c. Press the "Copy" button.
- d. I don't know.
- e. Left-click on the sprite and choose "Copy".

Submit

Question 6 🚩

What is light?

Choose one answer.

- a. a form of energy that travels in waves
- b. a form of work that reflects
- c. a series of vibrations
- d. what we see with our eyes

Submit

Question 7 🚩

A prism separates white light into \_\_\_\_\_.

Choose one answer.

- a. red, green, and blue
- b. red, orange, yellow, green, blue, indigo, and violet
- c. yellow, magenta, and cyan
- d. red, orange, green, violet

Submit

Question 8 🚩

Reflection happens when light strikes and then \_\_\_\_\_ a surface.

Choose one answer.

- a. refracts
- b. reflects
- c. breaks
- d. bounces off


Submit

Question 9 🚩

Give one example of a light source

Answer:

Submit


Question 10 

Light travels in a straight line called a \_\_\_\_\_.

Choose one answer.

- a. frequency
- b. highway
- c. path
- d. wavelength

Submit


Question 11 

The visible spectrum of light from longest to shorter wavelength is \_\_\_\_\_.

Choose one answer.

- a. red, orange, yellow, green, blue, indigo, violet
- b. radio wave, ultraviolet, gamma, visible light
- c. infrared, ultraviolet, gamma, x-rays, microwaves, radio waves
- d. violet, indigo, blue, green, yellow, orange, red

Submit


Question 12 

The speed of light is \_\_\_\_\_.

Choose one answer.

- a. 300,000,000 meters per second
- b. 3,000 meters per second
- c. 30,000 meters per second
- d. 300 meters per second

Submit

Question 13 

An object under white light that reflects green light and absorbs the other six colors of the spectrum will appear \_\_\_\_\_.

Choose one answer.

- a. red, green, and blue
- b. purple
- c. green
- d. blue

Submit

Question 14 🚩

The primary colors of light are \_\_\_\_\_.

Choose one answer.

- a. magenta, blue, green
- b. blue, yellow, cyan
- c. red, yellow, cyan
- d. red, green, blue

Submit

Question 15 🚩

When red and green light mix, \_\_\_\_\_ light is produced.

Choose one answer.

- a. blue
- b. cyan
- c. yellow
- d. magenta

Submit

Question 16 🚩

When red and blue light mix, \_\_\_\_\_ light is produced.

Choose one answer.

- a. yellow
- b. cyan
- c. blue
- d. magenta

Submit

Question 17 🚩

When red, blue, and green light mix \_\_\_\_\_ light is produced.

Answer:

Submit

## Appendix D: Semi-Guided Student Observation Form

Table D1.

### *Semi-Guided Student Observation Form for the Scorers/ Volunteer Assistants*

FIELD OBSERVATION NOTES

NAME OF THE OBSERVER:

NAME OF THE CLASS, COMPANY, AND ITS MEMBERS:

**HOW TO ACT & INTERACT WHILE LEARNING? / SOCIAL PROGRESS MONITORING & REFLECTION, Derya Sunke, Dissertation Project**

<p>Reminder about the Scoring:</p> <p>The scores are: -1, 1, +1: 1 means; student's actions are already appropriate for a particular task</p> <p>Their goal is to receive pure 1 (only 1 that means neither -1, nor +1)</p> <p>They need to be observed putting effort to balance their acts for each of the following actions</p>	<p>Time slots Information:</p> <p>We have six time slots to observe individuals learning actions and interactions</p> <p>At least every 15 minutes out of 90 minutes data needs to be collected</p> <p>Individual and teamwork can be scored separately, please note when proceed this way.</p>
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STUDY DISCIPLINE (SD) PRINCIPLES	Scores of Team Green Members:			
	Green1 (Se)	Green 3 (L)	Green2 (Lu)	Green4 (So)
Work ethic (WE) PRINCIPLES				
SD1. keeping FOCUS / NOT while working on a task				
SD 2. using time& resources EFFICIENTLY /NOT during the activity				
WE1. Being SUPPORTIVE to yourself, your team members and others /NOT				
WE2. Being RESPECTFUL to yourself and others				
Please explain why you scored the way you did: What did you observe? Write about your observations on Individuals' learning actions and their interactions w/ each other				

## Appendix E: Coding and Scoring Indicators for Learning Actions

Table E1.

*Descriptions of Coding and Scoring Indicators for Learning Actions*

Type of Learning Action		Descriptions of Coding Indicators with examples
Academic Learning Actions	<p><b>FOCUSED</b></p> <p>If a student is being focused; then he/she</p>	<p>pays close attention to their tasks</p> <ol style="list-style-type: none"> <li>1. by not getting scattered (or not allowing any distraction to act responsibly, or controlling to eliminate any distraction</li> <li>2. by appearing focused and making progress with an evidence (for this I look at their work artifacts)</li> <li>3. by visually getting busy with their tasks such as reading quietly, looking at the screen and continue working, writing, etc.</li> <li>4. by asking relevant question(s) or talking thoughtfully about the relevant topic</li> </ol>
	<p><b>EFFICIENT</b></p> <p>If a student is being efficient; then he/she</p>	<p>performs in the best possible manner without wasting time, or effort</p> <ol style="list-style-type: none"> <li>1. by visually not wasting time with irrelevant things</li> <li>2. by shows signs of following instructions, some sort of organization, such as following a plan, talking about what to do and how to do, etc.</li> <li>3. by visually being focused / putting effort to work on their daily tasks</li> <li>4. by completing , or (if necessary) submitting their work(s)</li> <li>5. by the quality of work artifact: complete, how much it meets the criteria, etc.</li> </ol>
Social Learning Actions	<p><b>SUPPORTIVE</b></p> <p>If a student is being supportive; then he/she</p>	<p>provides sympathy and encouragements toward team-mates</p> <ol style="list-style-type: none"> <li>1. by assisting them when needed</li> <li>2. not being argumentative</li> <li>3. by rather having a positive attitude toward any team issues &amp; team learning</li> <li>4. by acting like a contributing team-player –not acting independent during the teamwork</li> </ol>
	<p><b>RESPECTFUL</b></p> <p>If a student is being respectful; then he/she</p>	<p>shows value other people's perspective, time and space</p> <ol style="list-style-type: none"> <li>1. by not interrupting others' words, speech,</li> <li>2. by listening while someone is speaking</li> <li>3. showing kindness and courtesy</li> <li>4. not excluding others</li> </ol>

## Appendix F: Team Purple’s Weekly Planning and Reflection Report

Table F.1.

### Team Purples’ Weekly Planning and Reflection Reports

DURING THE INTERVENTION SELF REFLECTION: <u>Planning: (before the class begins) &amp; Reflection (in the end of the class)</u> /Share some details of your team work					
	WEEK6	WEEK7	WEEK8	WEEK9	WEEK10
P1	<p><u>Planning:</u> -I am adjusting my mood FROM happy &amp; hardworking TO happy+energetic+hardworking+ productive =ALL * -Because if I do all the thing(s) it mean(s) I work hard. -I can allow my mood to affect my team. IF WE work hard, WE will feel the same thing. My own task is FOCUSING ON my work Our team’s task is being quiet, FOCUSING ON our work <u>Reflection:</u> -I feel happy &amp; hardworking because I worked hard. -MY TEAM also worked hard.</p>	<p><u>Planning:</u> -I feel happy &amp; hardworking. -I feel like this because I am FOCUSING ON my work and jut feeling happy -MY task is (working on my) written report. -Our team’s task is Figuring out what we should be (doing for the project) <u>Reflection:</u> N/A</p>	<p><u>Planning:</u> -I am adjusting my mood FROM normal&amp;hardworking TO ALL*=normal -Because I worked a lot today (at her school) I am tired. -I am going to FOCUS ON my work and no talk to others. -We can help each other quietly and not talk a lot. <u>Reflection:</u> -In the end of the class I felt happy&amp; hardworking -Because I worked hard, and I feel proud. -I like we were working hard.</p>	<p><u>Planning:</u> -I am adjusting my mood FROM productive &amp; happy TO ALL* -I am going to work hard and feel happy. -If they do the same thing I do they will feel the same. -MY TASK is FOCUSING ON my work. -our team’s task is talk about the subject, help each other, FOCUSING ON our work. <u>Reflection:</u> -I was able to adjust my mood and I felt happy and hardworking. -Because I worked hard a lot and I feel proud. -I like we were working hard.</p>	*This Student was absent.

P2	<p><u>Planning:</u> -I feel happy because there is more writing, I love writing. I adjust my mood TO FOCUS ON WORKING. Because it might help you learn and get better grades. I will make them (my team) work hard as they can in a good worker (work). <u>Reflection:</u> I feel happy, because I was fast. -We were working together and asked for help.</p>	<p><u>Planning:</u> I feel happy because I get some help from the teachers here. I am FOCUS(ED), and ON TASK, and LISTENING TO OTHERS I will make them (my team) BE ON TASK and QUIET DOWN. MY task for today us to finish all my work, save it to my account. - (as a team) We are doing good, because we help (each other) to get faster and get better. <u>Reflection:</u> N/A</p>	<p><u>Planning:</u> I am happy Today I am excited (about) what we will learn Yes, I (I will allow my mood to affect my team's success) I help others to get on task My task is finishing the scratch Our team's task is DO our best. <u>Reflection:</u> N/A</p>	<p><u>Planning:</u> I am happy, because it is a good day. I am awesome. Because it will help others to be FOCUS(ED). My own task is scratch Our team's task is BE AWESOME. <u>Reflection:</u> -I was able to adjust my mood, - because in class it is fun. -I feel normal at the end of the class, because I am awesome. -Knowing what the scores was (were). They are focus(ed). She means the scores pointed that they were focused)</p>	<p><u>Planning:</u> I feel normal, because I am excited. I am proud of myself. Yes, I can allow my mood to affect my team. My task is to finish everything Our team's task is (to) have a good score of 1's in 4 (area) (1 means acting right) <u>Reflection:</u> -Yes, I was able to adjust my mood - because I am proud of myself and others. -I felt happy at the end of the class. -Because my teacher is proud of me. -We all worked together and helped on the test -complete done.</p>
P3	<p><u>Planning:</u> I adjust my mood from normal &amp; not energetic TO excited and hardworking I('ve) never been so exited(excited). I have been acting like this for years and hardworking because I didn't always work that hard. NO, (I cannot allow my mood to affect my team-she probably means the previous mood) because if I do, they might not finish the work or something. MY task is work hard and do my best Our team's task is to help each other. <u>Reflection:</u></p>	<p><u>Planning:</u> I am adjusting my mood FROM normal TO happy Because I feel like it. NO, (I can't allow my normal mood to affect my team) or I could let my team down. My task is to do my best Our team's task is to work together. <u>Reflection:</u> N/A</p>	<p><u>Planning:</u> I am adjusting my mood FROM happy TO hardworking. -because I don't usually work hard some of the time. NO, because I don't want to get my team down. My task is to FOCUS ON my work, work hard and try my best. Our team's task-help each other out when we need help. <u>Reflection:</u> -I was able to adjust my mood that felt happy at the end of the class. - I had someone to talk &amp; sorta playing with. - We helped each other out when we needed help.</p>	<p><u>Planning: (before the class begins)</u> Adjusting my mood FROM normal TO hardworking. Because I didn't really feel like I worked so hard today (during the school-prior to this class) No, So, I don't let them down. My task- work hard Our team's task- help each other <u>Reflection (in the end of the class):</u> N/A</p>	<p><u>Planning: (before the class begins)</u> Adjusting my mood FROM sad TO happy &amp; hardworking Now is not really a time to deal with this (because I was sleepy, and I had to wake up to get here). Because everyone has a job as being part of the group. My task-work hard&amp;try my best Our team-to help each other. <u>Reflection (in the end of the class):</u> -I was able to adjust my mood - that felt happy at the end of the class. -I did a lot of work -and my mom is gonna be happy. -We helped each other, and we worked together.</p>

	<p>-I was able to adjust my mood and I was excited for anything but not much stuff.</p> <p>- I felt happy at the end of the class.</p> <p>-Because I had a great time.</p> <p>-We worked together and talked to each other about what we need and helped each other.</p>				
P4	<p><u>Planning:</u> I am happy ☺</p> <p>-because right now I am really looking forward to learning</p> <p>Adjusting my mood TO A RESPONSIBLE LEARNER</p> <p>Because you are working and happy My mood will make them (My team) work more and feel happy.</p> <p>My task-scratch light animation</p> <p>Our team's-how do we solve the EMS</p> <p><u>Reflection:</u> N/A</p>	<p><u>Planning:</u> N/A_she came late</p> <p><u>Reflection:</u> -Yes, I was able to adjust my mood -- because I worked a lot.</p> <p>-This felt normal at the end of the class.</p> <p>-Because I want to learn more.</p> <p>- We shared what we did (at) PPT and scratch and written work.</p>	<p><u>Planning:</u> I feel energetic.</p> <p>I am so excited to learn today.</p> <p>Now I adjust my mood TO be RESPECTFUL</p> <p>I am very respectful.</p> <p>I can allow my mood to affect my team- because we can get all of our work done.</p> <p>My daily task is-power point with P3</p> <p>Our team's-Mixing colors, P1-written work</p> <p>P2-scratch, P3-ppt</p> <p><u>Reflection:</u> -I was successful adjusting my mood.</p> <p>-It felt normal at the end of the class.</p> <p>- Because I still want to work.</p> <p>-I was interested when all my team members were focus(ed).</p>	<p><u>Planning:</u> N/A Late</p> <p><u>Reflection:</u> I was always focus, time efficient, worked clean and tidy, I complete the task, because I care a lot.</p> <p>It felt normal in the end</p> <p>Because the class is over.</p> <p>I was always supportive, respectful to my team because I care a lot.</p> <p>-We shared what we did for the light conversation.</p>	*This Student was absent.

