FLOW THEORY AND ENGAGEMENT:

OBSERVING ENGAGEMENT THROUGH THE LENS OF FLOW IN A MIDDLE SCHOOL INTEGRATED MAKER SPACE

by

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The purpose of this study was to explore engagement as it occurred in the sample of middle school aged students situated in a learning environment of a Western Pennsylvania public school with an integrated Maker Space. This study was embedded within a larger two-year NSF study *Making Success: Researching a School District's Integration of the Maker Movement into its Middle and High School* conducted by the University of Pittsburgh's Collaborative for Evaluation and Assessment Capacity (CEAC). Flow theory, also called optimal experience theory first introduced in 1975 by Mikhail Csikszentmihalyi, played a critical role in this study. The importance of this study can be framed in the context of increasing the understanding of how students are engaged in learning within a Maker Space that is situated within a traditionally structured educational setting. This research explored student engagement from the student perspective as observed through the lens of flow theory. Flow Theory also informed the development of the research questions Evidence included data gathered to observe for presence of the nine components of flow (balance of challenges and skills, merging of action and awareness, clear goals, clear feedback, intense focus, paradox of control, loss of self-consciousness, autotelic experience, and loss of time).

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION TO THE STUDY

Dewey (1913) lamented that somewhere over the last century learning went from being an enjoyable, playful part of life to becoming drudgery. The industrialization of education mimicked the industrialization of the world during the late nineteenth and early twentieth century. At minimum, industrialization created parallels to the emerging education system in America and contributed to its social structure. Learning became work. Considering that learning has not always been synonymous with ‘work,’ it is worth investigating the essential components that contribute to learning.

This study looked at three aspects of the phenomenon of engagement as it supports learning: engagement as a function of play, as a function of flow, and engagement in the context of flow as described by middle school students in a Maker Space in a Southwestern Pennsylvania public school. The literature review that follows demonstrates that play, flow, and engagement share many common characteristics. Understanding how each of these concepts can contribute to learning in a way that enhances the overall experience of a student in the classroom could help educators and learners to understand what it means to experience joyful, meaningful learning through purposefully designed engagement.

1.1 DEFINITION OF TERMS

DREAM Factory- The Dream Factory is a maker lab located at Elizabeth Forward Middle School that encourages students to dream, create and make by providing the materials, tools and teachers to make dreams into reality. At the Dream Factory, students can learn robotics, engineering, design and programming with state of the art tools that they would not otherwise have access to, including laser cutters, 3D printers, microcontrollers and a functioning TV studio with green screen (Remake Learning, 2017).

Engagement- (or school engagement) is defined in three ways: behavioral engagement (consistency of effort), emotional engagement (students' affect and emotions in schools, such as interest, boredom, anxiety), and cognitive engagement (involving investment in learning, depth of processing, and/or the use of self-regulated metacognitive strategies) (Shernoff, et.al., 2016).

Flow- Csikszentmihalyi and LeFevre (1989) refer to flow as the "optimal experience"(Csikszentmihalyi & Lefevre, 1989). Moneta and Csikszentmihalyi (1996) define flow as a "psychological state in which the person feels simultaneously cognitively efficient, motivated, and happy." (p. 277)

Making- a class of activities focused on designing, building, modifying, and/or repurposing material objects for playful or useful ends, oriented toward making a "product" of some sort that can be used, interacted with, or demonstrated (Martin, 2015).

Maker Space-A space created for people to engage in complex, personally meaningful projects. Some examples of maker spaces include fablabs (fabrication labs) which house professional-grade hardware (Martinez and Stager, 2014).

Meaningful Engagement- "The engagement that appears to engender both dimensions of academic intensity (i.e. work-like engagement) and a positive emotional response (i.e., play like engagement)." (Shernoff, 2013, p.92)

Play- Play can be defined as a distinct sphere, an action, or a spirit or attitude. Play exists as unpredictable processes that occur within a relatively predictable form. Play is associated with freedom of creative expression and a respite from normal affairs of life (Henricks, 2008).

1.2 STATEMENT OF THE PROBLEM

A perpetual issue in schools is that some students in middle and high schools are disengaged and are dropping out. Archambault (2009) found in a recent study that one third of adolescents experienced disengagement during high school. She further emphasized this point in relating that "independently of behavioral disengagement, the risk that students withdraw before completing high school increases when they report disconnectedness on multiple facets of their school experience" (p.413). Shernoff (2016) spoke to the implications of dropout. "Dropping out of school diminishes their quality of life over a lifetime including but not limited to participation in drugs, alcohol, sex, crime, and delinquency (Steinberg et al., 1996; Shernoff, 2016)." Shernoff (2016) stated that "we constantly tell children to 'do their best' but for at least half of them their best is not clearly good enough…Thus, unhappiness and disengagement are *actively* created by the system" (p. 10). He further asserts that "youth appear to be more concerned with the actual *experience of classrooms* as lacking in (a) meaningful challenges, (b) leading to competence building, (c) in relevant areas of life, (d) and in the context of supportive relationships (p. 10)." Therefore, engagement in learning becomes a challenge to the educator to counter student disengagement and dropout. Educators need to understand the nature of engagement in learning to better understand how to motivate students to learn. Furthermore, the perspective that an individual takes on what it means to learn and to be engaged plays an important role in how engagement is interpreted. Each individual is unique and brings to the learning environment a unique set of skills and individual responses to challenges in the environment. This study allowed for a means to explore a non-traditional learning environment and attempts to understand from the perspective of the learner what it is that inspires them to engage in learning. Connecting the components of flow theory to first person experiences in engagement could provide a new perspective for how educators perceive the learning growth that occurs in each student.

1.3 PURPOSE

This study served three purposes. First, this study was designed to understand how students describe their engagement in learning within a Maker Space that is situated within a traditionally structured educational setting. Next, this study explored how students describe how they are engaged in similar experiences outside of a Maker Space learning environment including other classes in school and experiences outside of school. Finally, this study explored student engagement in the above contexts from the student perspective as observed through the lens of flow theory.

Shernoff (2016) equated student engagement to flow in that to achieve an ideal state of engagement it needs to be intrinsically meaningful and would include both characteristics associated with work and with play. This aspect of engagement serves to prevent disengagement and its negative consequences on learning. Three components of concentration, interest, and enjoyment had greater influence in his most recent study. Flow researchers identified nine components of flow. This research included as evidence the presence of these nine components of flow (balance of challenges and skills, merging of action and awareness, clear goals, clear feedback, intense focus, paradox of control, loss of self-consciousness, autotelic experience, and loss of time) with an emphasis on balance of challenges and skills, clear goals, concentration on task, a sense of loss of time, interest, and enjoyment as principle indicators of the potential for flow to occur.

1.4 RESEARCH QUESTIONS

The research questions for the study were:

1. How do middle school students describe their experiences in the DREAM Factory?

    a. How do the students describe this experience as being similar to or different than their experience in other classes?

    b. How do students describe experience in the DREAM Factory compared to their experience in other similar activities in which s/he participates during her/his time away from school?

2. Do students' self-reported experiences in the DREAM Factory, in other classes, or during an outside-of-school activity evidence engagement that aligns with elements of flow theory?

1.5 METHODOLOGY

The following exploratory study was an inquiry about how students describe engagement in a variety of activities using observations, a semi-structured teacher interview, and small focus group interviews. This study was embedded within a larger research initiative conducted by the University of Pittsburgh's Collaborative for Evaluation and Assessment Capacity (CEAC). CEAC, in conjunction with the National Science Foundation (2017). The larger initiative is conducting an evaluative case study titled *Making Success: Researching a School District's Integration of the Maker Movement into its Middle and High School*.

The site chosen for this exploratory study is significant. The ability to observe flow components in traditional classrooms is a challenge. Previous studies using various methods such as Experience Method Sampling (ESM), post-flow surveys, and interviews did not yield strong evidence of flow occurring for many students in a traditional classroom setting (Shernoff, 2013). Therefore, either all of the employed methodologies are flawed or the traditional school setting is one that does not often produce flow in the participants. Assuming the latter, it is worth investigating a non-traditional learning environment for behaviors that relate to flow components that may lead to a flow experience in the participants. As such, choosing a non-traditional learning environment that is exceptional in performance and well established could potentially yield more opportunities to observe behaviors that support the components of flow. The ability to find evidence of behaviors that support flow in an environment that approaches the ideal will provide insight into how to approach the future observation of similar behaviors in less than ideal learning environments.

Elizabeth-Forward school district with the help of the Grable Foundation and many other foundations developed a Maker Space program beginning in 2013. The program at Elizabeth-

Forward expanded to include both middle and high school levels. The DREAM Factory, at the middle school level, provides curriculum and maker environments for students to learn robotics, engineering, design, and programming with state of the art tools. All middle school students are enrolled in DREAM Factory. The only exceptions to enrollment are students who have schedule challenges due to some music courses. The success of the program at Elizabeth-Forward made it a regional hub for consultation to schools from surrounding counties (Remake Learning, 2017). This program receives national and international visits from educators who want to learn more about Remake Learning and how a functioning and established Maker Space works. If student behaviors that parallel flow components leading to meaningful engagement can be observed in a learning environment, then Elizabeth-Forward's DREAM Factory may serve as the most viable exemplar available and accessible at this time. Furthermore, if disengaging behaviors present themselves, then these behaviors could be more easily identifiable as a contrast in this environment.

This exploratory study included four data source recommendations (Yin, 2009): interviews (focus groups), direct observations, documentation, and physical artifacts. Several observations of approximately one class period in length were conducted of a middle school classroom of approximately fourteen students in the DREAM Factory, an integrated maker space in the Elizabeth Forward Middle School. Two focus groups of six to eight students each, approximately thirty minutes in duration, were convened. Each focus group interview included questions to elicit responses that reflected the students' experiences in the DREAM Factory and in other active engagement environments experienced by the participants. The researcher conducted teacher interviews with the teacher and student teacher who instructed the student participants in DREAM

Factory. The interview protocol intended to elicit responses that focus on student engagement and disengagement in terms of the nine flow components as observed and reported by the teacher.

The researcher coded data from observations and focus groups using a general inductive approach. “The purposes for using an inductive approach are to (1) condense extensive and varied raw text data into a brief summary format; (2) to establish clear links between the research objectives and the summary insights derived from the raw data and (3) to develop a model or theory about the underlying structure of experiences or processes which are evident in the raw data (Thomas, 2003).” The classroom observer coded data for nine flow components as outlined by Csikszentmihalyi (1990) including the balance of challenge to skill, merging of action and awareness, focus, control, feedback, goals, loss of self-consciousness, loss of time, and autotelic experience. Through coding, analysis identifies emerging themes. Classroom observations yielded evidence of student engagement and disengagement as recorded in the context of flow components for future use while conducting the focus groups.

This research chose to use focus groups instead of individual interviews of middle school students due to a distinct advantage focus group interviews provide. According to Breen (2007), focus groups are “far more appropriate for the generation of new ideas formed within a social context” (p. 466). Questioning techniques utilized during each focus group as outlined in Krueger’s categories as they appear in Breen (p. 471) helped to guide the process of gathering data of observed flow components during each focus group interview. Krueger (2002) also influenced the guidelines used for focus group design.

The focus group interviews allowed for further gathering of evidence of engagement and disengagement. These focus group interviews provided evidence as to how the student experience within the DREAM Factory environment compared to the student experience in other classrooms and outside of school. The interview with the teacher (and student teacher) provided further insight to the engagement and disengagement behaviors of the students. The evidence gathered helped to better develop an understanding of patterns of behavior within the context of the DREAM Factory environment. Triangulation of coded data from the observations, the focus groups, and the teacher interview contributed to the development of insight as to the function of flow, engagement, and disengagement in the DREAM Factory. The researcher revised and refined the original category system by way of a general inductive approach to reduce overlap and redundancy towards the end of creating a new model (Thomas, 2003). Triangulation of the emerging data provided insight as to how students' experiences within the DREAM Factory learning environment compare with their experiences in other classrooms and outside of the school setting.

1.6 SIGNIFICANCE OF THE STUDY

Dewey (1910) expanded on the understanding of engagement of children in the context of play. He stated that when children play they are creating "a world of meanings, a story of concepts (so fundamental to all intellectual achievement), is defined and built up" (p. 161). Play indicates the domination of activity by meanings or ideas. According to Dewey, playfulness is to be considered even greater than play as play is an attitude of mind, but playfulness is the outward manifestation of this attitude. Therefore, exploring engagement in learning as a function of play as outlined by Dewey merited investigation. One way to accomplish this goal was through the investigation of flow.

“Engagement is an important outcome of schooling in its own right. Mounting evidence suggest that engagement is a vital protective factor and leads to a host of positive educational and social outcomes and decreases in negative emotions and behaviors (Shernoff, 2013, p.10).” Drawing conclusions from previous research conducted by Steinberg et al. (1996) Shernoff concluded that disengagement in “students who are withdrawn from school are far more likely to have psychological problems ranging from depression and aggression to participation in drugs, alcohol, sex, crime, and delinquency” (p.11). Student engagement is necessary for learning in that it is a psychological investment in, and an effort directed toward, learning. Play, flow, and engagement have distinct overlaps in components and function. Flow acts as a nexus between the concept of play and the structure of engagement as it supports learning. The literature review that follows further explored this connection. Considering the overlap in components and functions among play, flow, and engagement this research recognized that flow is an aspect of play. Csikszentmihalyi (1975) explained that “games are obvious flow activities, and play is the flow experience *par excellence”* (p.37). He further states that “by studying play one might learn how work can be made enjoyable, as in certain cases it clearly is” (p.5). Play can be understood as a foundation for understanding flow, and therefore, the lens through which the understanding of engagement in terms of flow is generated. There is value in viewing classroom interactions through the lens of play as a means to understanding the importance enjoyment plays in the learning process. Even negative and non-productive interactions can be explained as a function of ‘play going wrong’ with characteristics of non-productive engagement or disengagement (Eberle 2014). The literature review that follows explains how flow, as a function of play, can also explain interactions that lead to anxiety, boredom, or complacency and a move away from positive engagement.

Student interactions (with each other and with the learning environment) can seem like play to them. However, this type of engagement where learning is enjoyable is rarely the case in U.S. public school classrooms (Shinn and Yoshikawa, 2008). Shernoff (2013) found from a 2010 study that “on average, high school students were less engaged while in pubic classrooms than they were elsewhere” (p.83). He further suggested that “enjoyment is the key element missing form life in classrooms that makes flow and engagement so rare” (p.83). His conclusions also suggest that even where concentration and interest may be high in a given classroom, the one component that measured below average was enjoyment.

This study explored the interactions of students in a learning environment observing if these interactions reflected play, engagement that supports learning that may lead to flow experiences (an optimal experience), or somewhere in the range between these two extremes.

1.7 BACKGROUND OF THE PROBLEM

The following study illustrated that play, flow, and engagement are all individualistic in nature. This study extracted from the most recent research on the concepts of play, flow theory, and engagement to develop an understanding where the interplay of these three concepts create a cohesive insight into the world of learning and engagement. Nonetheless, all three share commonalities that are universal in experience. Even with recognizing the components, characteristics, and processes associated with play, flow, and engagement, recognition itself does not complete the understanding of the nature of either play or flow, nor how each relates to engagement. Identifying what play and flow are not is equally important to understanding both concepts in order to find connections to engagement that supports learning. The next chapter also sets parameters to illustrate what constitutes play and flow and what does not.

Research on flow indicates that there are many specific challenges to recognizing the degree to which flow manifests itself in an individual. Learning aspects such as the balance between skills and challenges (Shernoff, Csikszentmihalyi, & Schneider, 2003), the perception of difficulty (Baumann & Scheffer, 2010), mood, level of interest (Schiefele, 1991), increased engagement, motivation (Schaik, Martin, & Vallance, 2012), locus of control (Keller & Blomann, 2008), the correlation between motivation and achievement (Nystrand & Gamoran,1992), and if the person is 'action-oriented' or not determine the viability of a flow experience (Keller & Bless, 2007). Research also suggests that while the psychological features of optimal experience (flow) and the other extreme, apathy, appear to be universal across cultures, emotional experiences such as what is regarded as 'happy', fluctuates in intensity among cultures (Delle Fave & Massimini, 2005).

It is also important to understand the perspective on engagement as it relates to learning in the context of the approach to education in schools for this research. This research countered the industrial approach to education where learning environments and subsequent engagement within these learning environments are founded in the concept of producing student output as a result of variations of contributors of input of information. Traditional schools measure learning growth through testing content knowledge using a variety of assessments such as in-class teacher or textbook created pencil and paper assessments or standardized assessments from which multiple year results statistically calculate learning growth. Dewey (1937;1946) explained that the means to which traditional schools address skill acquisition and knowledge presents a danger of depriving students of purpose, meaning, and vibrancy when learning does not occur within a useful context.

The following study explored engagement in a learning environment where learning is constructed. Natural curiosity leads someone to want to grow, and subsequently to engage. Engagement in the context of flow theory occurs when the participant is challenged at a level that is relatively balanced with the skills s/he perceives to possesses at that time (Moneta & Csikszentmihalyi, 1996). As a result, growth may occur in the context of the skill on which the learner is challenged. Many other factors are involved in providing an environment that is conducive for growth to occur. The aspect of observing engagement in a non-traditional learning environment takes on greater importance with the increase in learning environments such as maker spaces in public middle and high schools. There exists a lack of clear understanding how engagement is measurable in these learning environments and if this engagement is meaningful engagement. The next chapter illuminates the connections between play and flow as well as how flow as an aspect of play can function as a means to observe engagement that leads to learning in a maker space learning environment.

Flow is a complex and multi-faceted phenomenon. It appears to be a facet of play that unlike play is able to be quantified enough to evaluate its presence or absence and degree of intensity. A flow experience can occur in many environments and contexts, but is subject to the individual experiencing flow. Flow occurs in learning environments and is closely associated with engagement and subsequently has strong potential to enhance learning. Observing the presence of flow in a traditional classroom is challenging in that findings from previous studies suggest that enjoyment is the key element absent in this type of environment that makes finding flow and engagement a rare occurrence (Shernoff, 2013). Nevertheless, if flow can be observed in a learning setting, there is greater likelihood that it would be found in a learning environment that provides the conditions for flow such as Elizabeth-Forward's DREAM Factory.

1.8 SUMMARY

Engagement in a learning environment is complex and is comprised of many factors. Deconstructing engagement in a learning environment in terms of contributing components and processes can vary depending on the underlying perspective adopted by the observer. Education in the United States over the last several decades manifested itself as a mirror to industry in purpose and design. Learning in schools became work diverging from a previous conception of learning that included a sense of play or enjoyment. A resurgence of constructivism in learning and education during the last decade inspired the development of unconventional learning spaces such as maker spaces through the maker movement.

Flow theory proposes that when nine components are in place when a participant is actively engaged where there exists a balance between the participant's perceived skills and the challenges being presented, the participant can potentially experience flow, or an optimal experience—"optimal experience" implies that the participant is functioning at the highest point of performance capable for him/her at that skill (Moneta, 2012). Growth occurs as a result of the prior skill set meeting and successfully completing the challenge.

Flow is an aspect of play. Play theory, like flow theory, is composed of essential components, processes, and characteristics. Play fractal theory contends that patterns of play repeat over time and increase in complexity. Flow experiences parallel this pattern of behavior where higher states of flow increase the likelihood of future flow experiences. In this sense, both play and flow share commonalities with engagement.

In conclusion, researchers study flow, play, and engagement to better understand the nature of each concept. Flow is an aspect of play reinforces the idea of the existence of commonalities between the two concepts. Engagement that leads to learning has traditionally been studied through the lens of a traditional, industry-influenced educational system. Engagement that leads to learning as observed in a non-traditional learning environment requires a new approach. Flow provides the observer with the ability to perceive growth through engagement where skills are in balance with challenges. Other factors such as a sense of control over the process (autonomy), a loss of sense of time, immediate feedback from the environment, interest, and enjoyment serve to further support growth. Ideally, a learning environment where the learner constructs learning would provide opportunities to observe for the presence of flow as engagement that leads to learning. Therefore, observing for flow components in a learning environment such as a maker space becomes the first step to developing an understanding of what potential instruments can be used to better understand engagement as it supports learning in most learning environments.

2.0 PLAY: A FOUNDATION FOR FLOW AND ENGAGEMENT

Flow, as described by Mihaly Csikszentmihalyi (1990), is “optimal experience”. Csikszentmihalyi provides many broad examples as to when flow can occur that are related to play experiences such as playing chess, rock climbing, and sculpting. He also provides many examples of flow that are not traditionally considered play experiences such as experiences that would occur in a work situation or while learning a new skill. Flow is universal, and yet, is individual. Anyone can experience flow in innumerable experiences and contexts but each individual’s flow experience is unique in its composition. Flow becomes an aspect of all constructs of social life and serves as a model for successful culture. If flow occurs in nearly every social context, further explanation is required to ascertain how flow is considered to be an aspect play.

Csikszentmihalyi (1990) said it best when he stated, “When culture succeeds in evolving a set of goals and rules so compelling and so well matched to the skills of the population that its members are able to experience flow with unusual frequency and intensity, the analogy between games and cultures is even closer. In such a case we can say that the culture as a whole becomes a ‘great game’” (p. 81).

Schrank (2010), a game designer and theorist, explained the concept of flow as play by connecting Csikszentmihalyi’s concept of life as a ‘great game’. This belief can be imagined where reality is essentially a simulation. The universe, in this sense, becomes a giant computer with multiple networks designed to play the great game of life. All of our interactions in this great game become a means to train us to playfully function in reality. In essence, we are all part of a simulation game and everything we do becomes play. This study proposes the idea that consideration be given to view all interactions as a form of play. Assuming this point of view provides a unique perspective on engagement as observed through flow theory.

The sections that follow will systematically deconstruct play and flow in order to provide a clear understanding of how play and flow are related and the role each plays in engagement. The understanding of the components, characteristics, and processes related to play and flow is essential for the development of a model that encapsulates the complexity of the roles flow and play have in engagement when applied to the context of a learning environment.

2.1 FIVE CHARACTERISTICS OF PLAY

The most recent deconstruction of play consolidates the many approaches to define the characteristics of play into five basic qualities. The intent was to more easily identify the attributes of play for the purpose of using them as criteria that can be applied as standards for play. The qualities are as follows: (1) play is purposeless (2) voluntary (3) outside of the ordinary (4) fun, and (5) focused by rules (Eberle, 2014, p. 215). A cross-comparison of the qualities of play with characteristics and elements of play proposed by various theorists yields the elimination of duplications within the other theorists' lists and provides a more succinct and global definition for some characteristics. The qualities of play also strip the definitions of identifiers that would be specific to a particular field of study. This is not to say that the qualities of play definitions supersede other definitions. Rather, clarification and context can be discerned with greater specificity through referencing other theorists' definitions of play (Eberle, 2014).

2.2 THE PLAY PROCESS

One voiced concern is that in most research on play there exists an absence of the accounting for the movement, change and process of play (Eberle, 2010). The disposition of the player and how s/he connects to the environment around him/her impacts the play experience in process. The person experiences aspects of play from the point where play is initiated (anticipation) to the conclusion of an episode of play (poise). In anticipation of play interest narrows and the mind focuses. Anticipation gives way to surprise as something incongruous or novel happens. In this way, anticipation functioning as curiosity leads to the pleasure of discovery. Pleasure acts as incentive to continue play and leads to understanding. Understanding in this sense can mean increased appreciation of others, increased knowledge, greater sensitivity, and other insights that give way to making play more enjoyable. Understanding builds strength in the player by increasing mental, physical, or social capabilities. When a player reaches this point of play he is rewarded with a sense that he is prepared for anything. He senses balance and a perception of the suspension of the passage of time. This last element is defined as poise (see Figure 1):

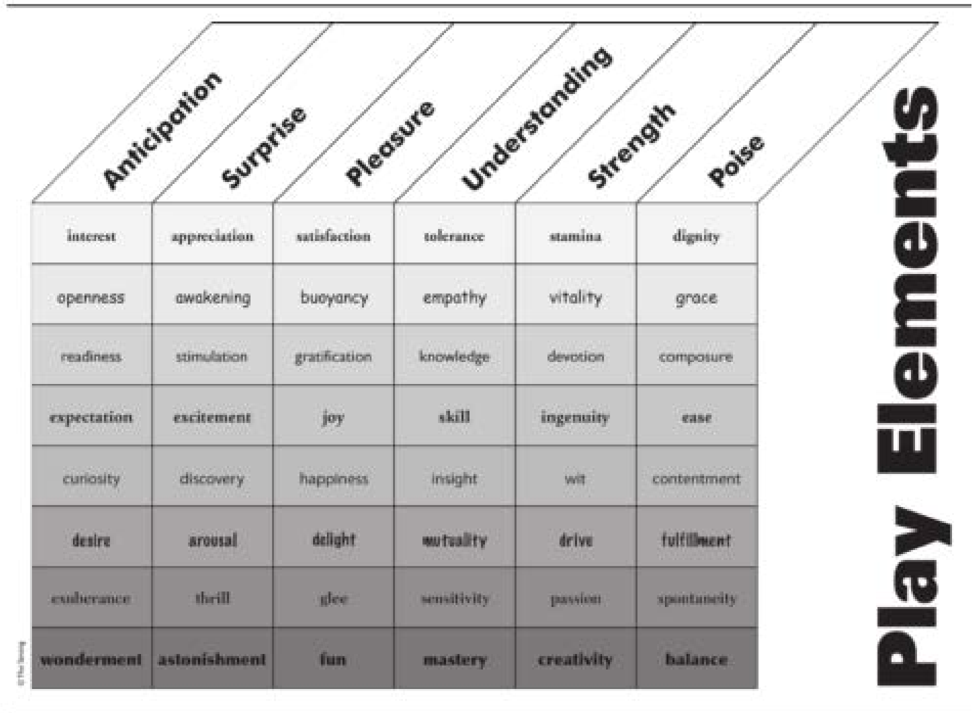

Figure 1. Play Elements. Reprinted from Eberle, S. (2014). "The Elements of Play: Toward a Philosophy and a Definition of Play," by S. Eberle, 2014, *American Journal of Play*, *6*(2), p.221. Copyright 2014 by The Strong. Reprinted with permission.

Play can be defined as one of four fundamental forms of human activity. The other three basic human activities are ritual, work, and communitas. The function of ritual can be understood in this sense as a means to rely on guiding forms, learning from obligations to otherness. Work is exemplified as the effective and efficient practice of goal-centered employment. Communitas is the concept of the realization of the possibilities of mutual support through connections to the world. Separating play from the other three basic human activities, and considering the previously mentioned elements of the process of play (Eberle, 2014) a pattern emerges. The process of play exposes an underlying deconstruction of meaning, a reordering, and a later reconstitution of meaning that leads to satisfaction. This underlying pattern in the context of emotions carries over to all four fundamental activities (ritual, work, communitas, and play). In this light as it relates to play, a transformation occurs where players form, de-form, and re-form circumstances through identification, confrontation, and manipulation of the elements of their world at their own choosing. In this manner, play as a self-directed enjoyment begins with anticipatory curiosity, moves to fun as the unknown deconstructs meaning. Fun progresses to exhilaration when meaning is reconstructed and order restored while in play. Finally, play culminates in the feeling of gratification on reflection of play (see Figure 2) (Henricks, 2008, p. 176; Henricks, 2015b, p. 274):

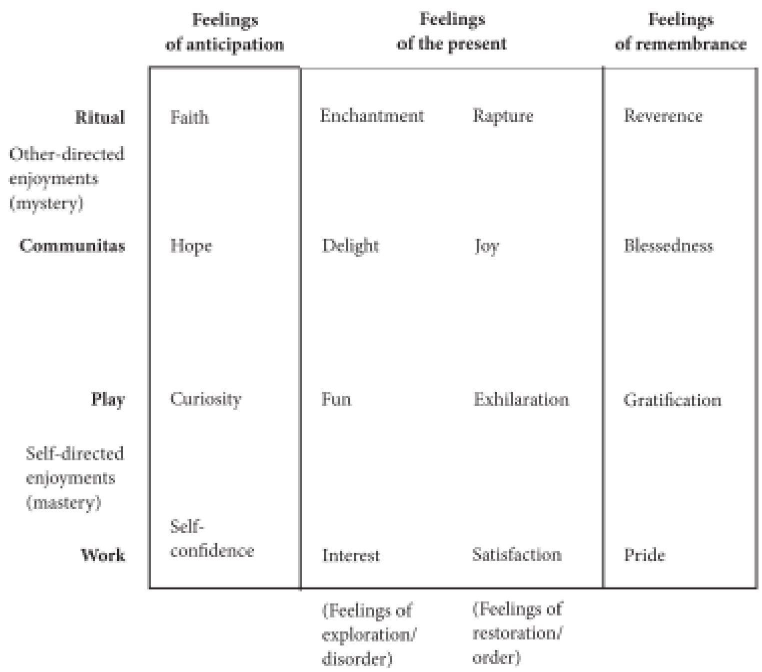

Figure 2: Four sequences of positive emotions. Reprinted from "Play as Experience," by T.S.Henricks, 2015, *American Journal Of Play*, *8*(1), p.44. Copyright 2014 by The Strong. Reprinted with permission.

2.3 PLAY AND NON-PLAY

To understand play it is important to note what play is not. Physiological indicators of what is and is not play can be discerned among players through facial expressions and gestures (Goffman, 1974). Physiological indicators are not the only means to discern play from non-play. Taking into consideration the five qualities of play (Eberle, 2014), play would need to adhere to all of the following parameters (1) play is purposeless (2) voluntary (3) outside of the ordinary (4) fun, and (5) focused by rules. Deconstructing play in another way provides insight by employing the previously outlined elements of the play process of anticipation through poise (p. 220). Play turns into something different when one of the five qualities of play is missing or one of the elements of play is taken to the extreme. Eberle summarizes succinctly with the words “too much of a good thing becomes a bad thing” (p. 227). For example, a bully may be having fun (the fourth quality of play), but it is fun taken to the extreme of cruelty and therefore is not play. Furthermore, the person who during a normal play experience would take pleasure in a pleasant surprise (the second element of the play process) would experience shock at being bullied. What a person experiences at the extreme of the range of each element as play as spins out of control and morphs into something completely foreign to play.

Eberle (2014) defines six qualities of play that occur when the fundamental elements of play are all present: anticipation, surprise, pleasure, understanding, strength, and poise. Each of these qualities exist and progress through the play process unless, as mentioned previously, something is introduced into the play process that morphs each of these qualities into the antithesis of play. A player can have anticipation of play, but can also become obsessed. A surprise if not received in good fun can become a shock or even terror if taken to an extreme. Pleasure at play can lead to excess when seeking that pleasure derived from play becomes the primary focus.

Likewise, understanding becomes indifference possibly due to desensitization from overexposure. Strength becomes heedlessness when empathy diminishes or the love of power becomes consuming. And, finally, poise becomes abstraction distorting the essence of play (see Figure 3).

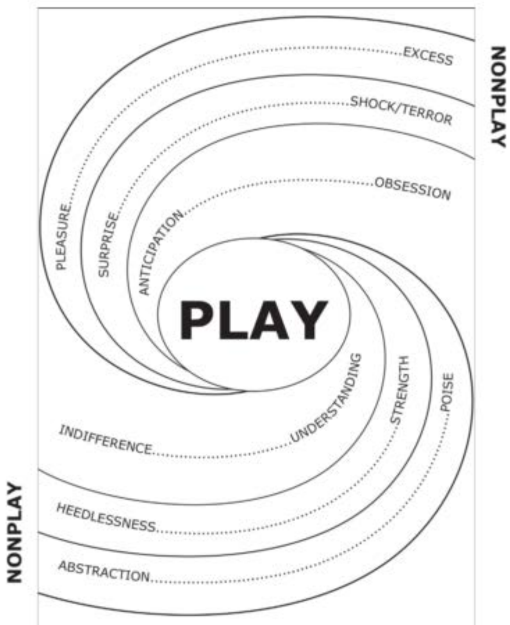

Figure 3. Play and Nonplay. Reprinted from "The Elements of Play: Toward a Philosophy and a Definition of Play," by S. Eberle, 2014, *American Journal of Play*, *6*(2), p.230. Copyright 2014 by The Strong. Reprinted with permission.

2.4 DEFINING FLOW

Mihalyi Csikszentmihalyi, the Hungarian born psychologist, is considered to be the leading researcher and primary architect of Flow Theory. He first introduces the structure of Flow Theory in his work *Beyond Anxiety and Boredom* (1975). Research conducted since that time maintains the essential meaning behind his theory with minor variations on the same theme. What is Flow?

Csikszentmihalyi and LeFevre (1989) refer to flow as the “optimal experience”(Csikszentmihalyi & Lefevre, 1989). Moneta and Csikszentmihalyi (1996) define flow as a “psychological state in which the person feels simultaneously cognitively efficient, motivated, and happy” (Moneta & Csikszentmihalyi, 1996, p. 277). Csikszentmihalyi (2014) began his research during the 1970’s by interviewing approximately 100 people who participated in activities such as dance, music, and art. He chose these people because it intrigued him as to why they would expend so much energy and time on activities that would not likely yield rewards such as money and status. He discovered through those interviews what he called the flow experience, an experience that you enjoy so much that you want to do it for its own sake (p. 132). Since his original research in the 1970’s, flow experiences have been observed in nearly every imaginable daily experience and to have been experienced by every demographic. The flow experience is nearly identical in description regardless if the person experiencing flow is an artist, scientist, athlete, affluent, destitute, male, female, young, old, or from any country or culture in the world (Csikszentmihalyi, 1996, pp. 111-112).

2.5 EXAMPLES OF FLOW IN WORK, PLAY, AND DAILY ACTIVITIES

The universal experience of flow does not intend to imply that everyone who experiences flow does so in the same way and under the same conditions. Flow is a subjective experience in that there are many underlying factors that contribute to the flow experience that vary from individual to individual. Moneta and Csikszentmihalyi (1996) point out that flow theory proposes a “space” for optimal experience to occur. Yet, the experience is constructed on the participant’s perception of his own skills and his own perception of his ability to meet the immediate challenges of the activity (p. 282). Considering that flow experiences are subjective and vary in context from sports, to the arts, to daily activities, to work, to any other activity, one might assume that the flow experience is more often associated with activities grounded in leisure. To the contrary, when average adults were studied flow experiences predominantly manifested from work conditions rather than leisure (64% and 47% of the time for managers and workers, respectively) (Csikszentmihalyi, 2014, p. 164). Csikszentmihalyi (2014) describes this essential focus of the flow experience as the opposite of psychic entropy. Psychic entropy is “a state of disorder in the self-system that results in decreased efficiency of that system” (p. 157). Allocation of attention in too many directions at once or pointing attention inward creates disharmony and conflict. In flow, a person experiences the opposite effect of psychic negentropy. Psychic negentropy is “a condition in which the information processed in consciousness does not conflict with other information available to the self. The self-system is in harmony, and no attention needs to be allocated to its internal functioning” (p. 157). Finally, in addressing an understanding of flow, in general, LeFevre and Csikszentmihalyi (1989) state three predictions that come out of the flow model: “(a) flow can be experienced in a variety of situations, including work; (b) people differ greatly in terms of where and how often they experience flow; and (c) those who experience flow more often, regardless of context, are more involved and more satisfied with their lives” (p. 820).

2.6 COMPONENTS OF FLOW

Moneta (2012) qualifies the nine components of flow as “correlated dimensions of the flow construct that can trade off in determining the intensity or level of flow” (p. 41). He further explains that the variations in intensity among the nine components of flow where some components are stronger than others will produce a flow state that "will be overall less intense, complex, and ordered than the ideal flow state" (p. 41).

Synopses of each of the nine components of the flow experience are expanded below. It is worth noting that Czikszentmihalyi (1990) originally defined them as "elements of enjoyment" (adapted from Czikszentmihalyi, 1990, pp. 49-72):

2.6.1 A Balance of Challenges and Skills

A person needs to have the fundamental skills associated with the activity to be able to enjoy an activity. This holds true whether the skill is physical skill or mental skill. When a person's skills are challenged as in a competition (mental or physical), a person finds enjoyment approximating an optimal experience from the honing of his own skills. Czikszentmihalyi (1990) indicates that enjoyment decreases when the participant focus shifts to beating the challenger as opposed to honing his own skills. He further states that "enjoyment appears at the boundary between boredom and anxiety, when challenges are just balanced with the person's capacity to act" (p. 52). The design of many subsequent studies to better understand the flow (a.k.a. optimal experience) base their research on the balance of skills and challenges.

2.6.2 The Merging of Action and Awareness

When in a situation with multiple people talking, a person is biologically incapable of processing all of the stimuli simultaneously impacting his brain. This limitation forces the individual to screen out stimuli to focus on what is important to them at that moment. As a result, he is incapable of understanding more than two people at a time. As this relates to the flow experience: When a person is engaged in the process of creating something new such as approaching an optimal experience, he has no attention left over to focus on the needs of self. Therefore, he becomes part of what is happening around him, and action and awareness merge (Csikszentmihalyi, 2004, p. 44). The participant is not aware he is separate from the actions around him and actions become spontaneous (Csikszentmihalyi, 1990, p. 53).

2.6.3 Goals

To experience flow, the participant needs to have an understanding for himself what his goals are in participating in the activity in order to determine what his next move will be and to develop a strategy for reaching his goal. This goal can be apparent or not and sometimes can be negotiated in the moment as occurs with players in a game (p. 56).

2.6.4 Feedback

It is impossible to experience flow unless the participant has an internal understanding of what works and what does not work in the context of the activity. The kind of feedback is not necessarily important. Rather, the importance lies in the message it contains in order to make the participant feel success in achieving his goal. Feedback in this sense can come from a wide range of information during the flow experience such as hitting a tennis ball between the white lines or immobilizing the enemy king on a chessboard. What is of value is that the feedback be "logically related to a goal in which one has invested psychic energy" (p. 57).

2.6.5 Focus

One of the reasons that flow contributes to the quality of an activity is concentration. “Clearly structured demands of the activity impose order, and exclude the interference of disorder in consciousness” (p. 58). Once a participant enters into a mental state of concentration, all of the cares of the world begin to disappear due to the limited capability of the mind to focus on too many concerns at once. The activity then becomes a world unto itself and begins to appear to the participant as though it is his total world (p.59).

2.6.6 The Paradox of Control

The paradox of control implied by Csikszentmihalyi (1990) means that while a person may feel a lack of control over daily experiences in ordinary life, the relative perception of control during an activity approaching a flow state becomes the antithesis of this state of mind. Rather than worrying about mistakes and failure, the participant develops a sense of control, or the “lacking [of] the sense of worry about losing control that is typical in many situations of normal life” (p. 59). Csikszentmihalyi clarifies that this sense of control is the participant’s perception of calmness and of the possibility of being in control, not what necessarily happens in actuality. Anyone participating in a risk-taking activity (whether it be a chess championship or hang gliding) is in essence taking the risk of actual loss of control through defeat, mistake, or injury (p. 60).

2.6.7 Loss of Self-Consciousness

It is not uncommon for a person to have normally occurring preoccupations based in personal vulnerability many times during the course of the day. Self-scrutiny occurs as a self-protection mechanism to protect the psyche against threats no matter how trivial the threats may be. These preoccupations consume a lot of psychic energy. During a flow experience, the absence of the self occurs as a loss of self-consciousness. This absence of self intensifies the experience as the participant becomes hyper-focused on the experience itself. Csikszentmihalyi (1990) indicates that a paradox occurs relative to the loss of self-consciousness in that on completion of the activity and self-consciousness returns, the participant on reflection has become transcended by the experience with an improved self-concept (p. 65-66).

2.6.8 Distortion of the Perception of Time

The perceived passage of time during a flow experience does not correlate to conventional time. Sequences of events, a hyper-focus on elements of time (such as the time allotted for a chess move or the counting of passing minutes and seconds for a long-distance runner), or the necessary focus on multiple aspects of a task at once are examples that would distort the perception of the conventional passage of time for someone experiencing flow. Csikszentmihalyi (1990) posits that while in the state of flow, the loss of the sense of passage of time is liberating and contributes to the elation experienced during flow (p. 67).

2.6.9 Autotelic Experience

The autotelic (Greek: “self-goal”) experience is described as an experience that is an end in itself. Csikszentmihalyi (1990) describes experiences in general as being primarily a combination of autotelic and exotelic experiences. Exotelic experiences are ones that are essentially done for external reasons such as receiving a monetary reward. Autotelic experiences are based in intrinsic motivation. An autotelic experience is one where life is lifted to a different level from what is experienced day to day. It is accompanied by involvement, enjoyment, control, and a reinforced sense of self. It is an experience that is not held to future reward. It generally consists of exploring new opportunities utilizing the skills available to the participant (p. 68).

The nine components of the flow experience: balance, merging, focus, control, feedback, goals, loss of self-consciousness, loss of time, and autotelic have appeared in most of the studies reviewed to date from their first appearance in 1990. Taken as individual components, each of the above conditions could explain many kinds of experiences not related to flow. This assumption can also be made for any combination of individual components related to flow. As an example, someone could be very goal-oriented and highly focused in an emergency situation yet feel incredible anxiety and out of control which would not be indicative of a flow experience. Engeser and Scheipe-Tiska (2012) conclude that “flow cannot be reduced to a single component, and all attempts to take one component of flow as the definitional aspect of flow will consequently disregard essential parts” (p. 4).

2.7 MODELS OF FLOW

The study of flow theory during the last forty years inspired at least five models of the flow experience. Moneta (2012) consolidated previous research that employed each of the following models and explained through the use of graphical representations the development of flow theory from its inspiration to the present. A summary of three of these models will provide an understanding of the nature of flow theory and how it has been studied and presented in the literature. The models will include: a) Csikszentmihalyi's first model, b) the absolute difference regression model, and c) the hypothetical hybrid componential model. The quadrant and octagonal models are worth mentioning as they were designed on the premise of the observation of multiple flow experiences, but will not be the focus in this study. Both of these models represent flow as a function of a balance between skills and challenges and divide z-score results of multiple flow observations into four and eight quadrants respectively representing flow, anxiety, boredom, and apathy (or the addition of worry, arousal, control, and relaxation in the octagonal model).

The First Model: Csikszentmihalyi (1975/2000) observed that experiencing flow is dependent upon the balance between two variables: the skills the participant brings into the action and the degree of challenge the participant meets while in the moment of action. Skill is represented on the x-axis of a Cartesian map while Challenge is represented by the y-axis. Flow occurs when there is adequate skill to meet the challenge. The impact of having an imbalance between skill and challenge is as follows: If the challenge of the activity is beyond skill level, then the participant experiences worry (increased self-consciousness) followed by anxiety. The result is the participant begins to lose the experience of one or more of the components of flow such as a sense of control and falls out of flow. When skills exceed challenges, the participant becomes bored, loses one or more of the component experiences of flow such as becoming acutely aware of the passage of time (the opposite of “loss of time”), and falls out of flow (Nakamura and Csikszentmihalyi, 2001, p.90). He might then experience anxiety and try to seek out challenges to regain the flow experience. Maintaining the flow experience as represented by the Cartesian map appears as a diagonal channel that moves from bottom-left of low challenge and low skill to the upper right of high challenge and high skill. In terms of the previously mentioned dichotomy of entropy and negentropy, a stronger degree of flow with greater complexity and order would be movement toward negentropy. Whereas, a lower, less complex degree of flow would be movement toward disorder, or entropy (see Figure 4) (Moneta 2012; Csikszentmihalyi 1975/2000):

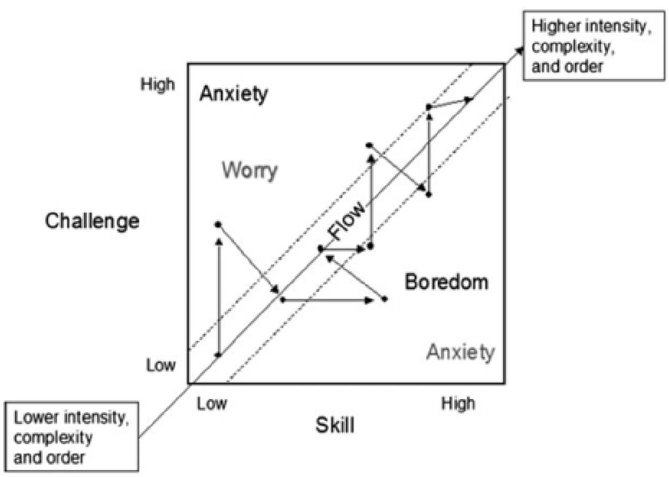

Figure 4. Skills-Challenge Balance to determine flow. Reprinted from *On the Measurement and Conceptualization of Flow* (p.26) by G.B. Moneta in *Historical Lines and an Overview of Current Research on Flow,* S.Engeser and A. Shipe-Tiska (Ed.), 2012, New York, NY: Springer. Copyright 2012 by Springer. Reprinted with permission.

Moneta and Csikszentmihalyi (1999) explored an idea based on Csikszentmihalyi’s previous conclusions regarding the connection between the skills/challenge balance and flow. Csikszentmihalyi (1975) concluded that flow experiences can occur whether the balance of skills to the challenge reflects high skills and high challenge or if the balance reflects medium skills and medium challenges. This observance generated the question as to if there exists a range of intensity of the flow experience as it would correlate to the intensity of the skills/challenge balance. In other words, does a balance of high skills/high challenge equate to a more intense experience of flow (Moneta and Csikszentmihalyi, 1999, p. 631)? As a result, the following model was developed with a visual representation (Moneta 2012):

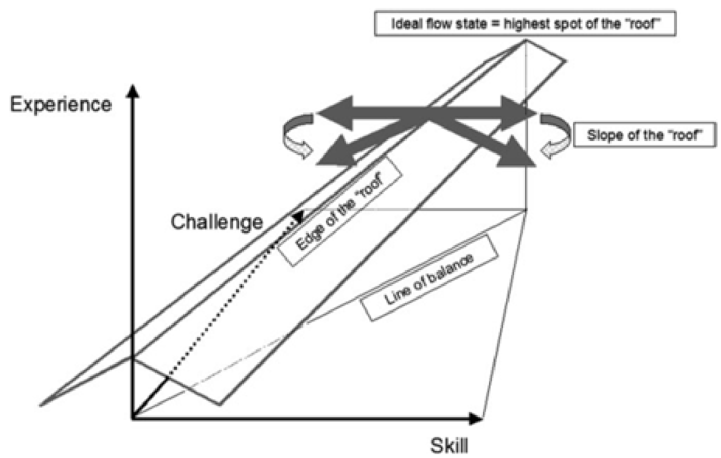

Figure 5: Absolute Difference Regression Model. Reprinted from *On the Measurement and Conceptualization of Flow* (p.38) by G.B. Moneta in *Historical Lines and an Overview of Current Research on Flow,* S.Engeser and A. Shipe-Tiska (Ed.), 2012, New York, NY: Springer. Copyright 2012 by Springer. Reprinted with permission.

The Absolute Difference Regression Model shown above utilizes the skills/challenge balance as a foundational starting point for determining the existence of flow as did the previous models. The increase of skills is represented along the x-axis and the increase of challenge is represented along the y-axis. The difference this model represents compared to previous models is that it changes the perception of the nature of the flow experience from a static representation to a dynamic process. This change is manifested through the introduction of the dimension of subjective experience as represented along the z-axis. Subjective experience has many facets and can be defined in many ways. Massimini and Csikszentmihalyi (1987) employed examples of subjective experiences as part of the development of the previous model. Examples of the subjective experiences identified for the 1987 study included concentration, control, alert, happy, cheerful, strong, friendly, active, sociable, involved, free, excited, open, clear, etc. (p. 547). Moneta and Csikszentmihalyi (1999) focused primarily on subjective experience through the lens of concentration, interest in the activity, enjoyment of the activity, or happiness to develop the above absolute difference regression model (Moneta, 2012, p. 39).

The componential model utilizes the nine components of flow as a basis to increase the understanding of the nature of flow. This model, a more psychometrically sound model employed by Marsh and Jackson (1996) and Jackson and Csikszentmihalyi (1999), resulted in the creation of two sets of questionnaires in order to provide insight into flow as a state and flow as a trait. Flow as a state is indicative of observing all of the components of flow as they are occurring approximating their highest state. Flow as a trait is indicative tendency of flow that occurs frequently and intensely over a range of situations. Moneta (2012) explains the componential model to measure each state or trait as an individual component contributing to behavior as a multi-faceted construct and as a single factor construct designed by Jackson and Eklund (2002, 2004) (Moneta, 2012, p. 42). Moneta (2012) suggests a hybrid componential model (shown below) that identifies from the nine flow components antecedents to flow and separates them from facets of flow. He posits that a path exists from concentration to flow that is moderated by goals, feedback and balance. Once in the state of flow, facets of flow emerge to various degrees including control, merging of action, autotelic experience, loss of self-consciousness, and the loss of time (p.44).

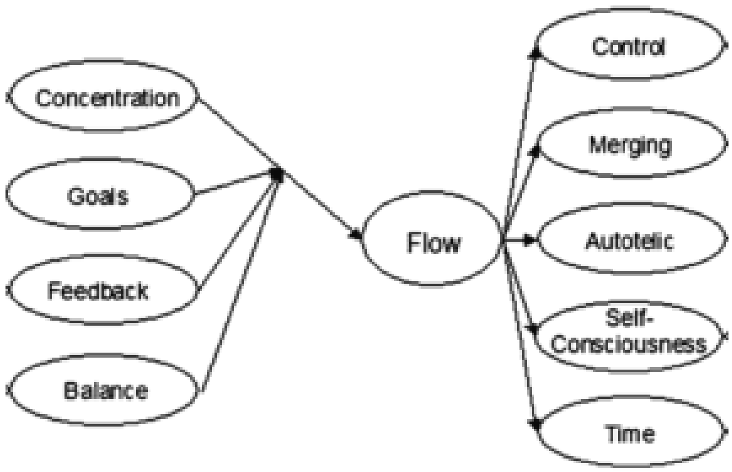

Figure 6: Hybrid Componential Model. Adapted from *On the Measurement and Conceptualization of Flow* (p.44) by G.B. Moneta in *Historical Lines and an Overview of Current Research on Flow,* S.Engeser and A. Shipe-Tiska (Ed.), 2012, New York, NY: Springer. Copyright 2012 by Springer. Reprinted with permission.

Moneta (2012) supports the conclusion that this model is the most psychometrically sound with the fact that this method has good construct and content validity and has generated measurement methods for the intensity of flow. All of the models of flow are designed to provide insight to the abstract concept of flow, and each serve to increase the understanding of flow through different lenses (p. 48).

2.8 FLOW AND ENGAGEMENT

There are many proposed models of student engagement. A recent model (Fredricks in Zimmer, 2012) outlines four components to contribute to student engagement: academic, social, cognitive, and affective. Zimmer found that not only is there an importance of engagement/disengagement to learning, research shows that without intervention behavioral and academic risk progress simultaneously as students progress to higher grade levels. Furthermore, engagement can protect students from harm that may accrue (p. 107). Disengagement is attributed to students who do not actively participate, who are not cognitively involved, who have little sense of belonging, and who practice counterproductive behavior. Ocumpaugh et.al. (2016) characterize disengaged student behaviors as boredom, confusion, frustration, carelessness (careless errors; student possesses knowledge but answers incorrectly), gaming the system (intent to succeed without learning), and off-task behaviors. Disengaged students, due to various contributing factors, risk a cascade of a process of disengagement that leads to dropping out of school (p. 99). Exploring novel and effective means for educators to identify and monitor engagement of students in classrooms as it supports learning is critical.

The perception of engagement and disengagement in a learning environment as an all or nothing proposition would be short-sighted. As proposed earlier with play theory, engagement possesses both characteristics and at the same time can be perceived as a process unfolding and fluctuating in intensity over a period of observation. The challenge becomes the ability to observe both the characteristics and the process of engagement in a given environment. A further complication to this challenge is finding a means to adequately represent engagement in a measurable way as it would lead to learning. Flow theory provides the necessary building blocks to design a study that will satisfy these challenges.

2.9 PLAY, FLOW, AND ENGAGEMENT IN A MAKER SPACE

A review of the literature revealed insight to play, flow, and engagement contributing to a comprehensive and thorough understanding of the components and mechanisms of each.

Csikszentmihalyi (1990) described flow, an aspect of play, as a means for culture to play out a ‘great game’ of life manifesting flow experiences with frequency. Schrank (2010) connected Csikszentmihalyi’s ‘great game’ to proceduralism describing the concept as though everything we do in a culture essentially equates to a virtual reality game. Employing this concept of reality in the context of a learning environment, one can draw many parallels. Schooling in many ways intends for the participants to ‘practice’ in preparation for ‘real world’ experiences. Students are preparing for future academic and social challenges and interactions as they learn concepts and develop skills, practicing them in a simulated environment, that will help them to become fully functioning adults and positive contributors to society. Schools, and learning environments within and outside of school, become the virtual reality for the game of life where students play out their roles in hope of mastering new levels of academic and social success.

This literature review outlined previous models of play and flow that delineated individual components and characteristics of each that lead to play and flow. This review also identified through previous research the processes of play and flow in action. The challenge to previous research is to conceptualize models of play and flow that reflect both components and processes.

Previous research that utilizes flow models as a means to discover occurrences of flow in a classroom setting have had mixed results. Traditional classroom settings based in a didactic approach modeled after industry do not provide learning environments that yield strong results. Education researchers over the last decade began a resurgence of constructivism in education. The maker movement is an example of constructivism in action. Maker spaces are becoming the norm for many communities and base their approach to learning in the problem-solving and critical thinking skill development often associated with constructivism. The next section of this study proposes a qualitative exploratory study that uses a maker space that is embedded in a public middle school program as the primary study site to look for reported evidence of engagement that leads to learning as observed in the context of flow.

3.0 PROCEDURES

This study was an exploratory inquiry about how students describe engagement in three activities—the DREAM Factory, other classes, and outside of school activity. Observations, small focus group interviews, and teacher interviews served as the primary means of gathering evidence. This exploratory study is embedded within a larger research initiative conducted through a National Science Foundation initiative by the University of Pittsburgh's Collaborative for Evaluation and Assessment Capacity (CEAC) (2017). The larger initiative is conducting an evaluative case study titled *Making Success: Researching a School District's Integration of the Maker Movement into its Middle and High School*. The NSF CEAC initiative is participating in a two-year evaluation of Elizabeth-Forward School District's integrated Maker Space with Dr. Cynthia Tananis and Dr. Keith Trahan serving as lead researchers. This research aligns the study design and procedures to support the larger initiative serving as an embedded exploratory study with Elizabeth-Forward School District's Maker Space Dream Factory as the primary observation site. Jeffrey T. Zollars conducted this study as the primary researcher who serves as part of the team of researchers of the larger NSF CEAC initiative. This embedded study serves a dual purpose of fulfilling the requirements in preparation for a dissertation defense and to support the larger NSF CEAC initiative. Therefore, this study aligns and adheres to the research protocols as outlined and required for the NSF CEAC initiative's IRB compliance.

3.1 NSF CEAC RESEARCH INITIATIVE OVERVIEW

Making Success: Researching a School District's Integration of the Maker Movement into its Middle and High School has as its primary goal to observe and analyze the critical components and capacities that have allowed Elizabeth-Forward School District (EFSD) to integrate the Maker Movement into its middle and high school, and to consider how these might apply to additional settings and collective formal-informal initiatives. The researchers proposed the two-year study to explicate how EFSD has transformed itself into a pioneer and leader in the integration of the Maker Movement in schools. The overarching focus will be on three basic questions:

1. What are the characteristics and capacities of EFSD's integrated Maker Movement at the middle and high school, and which are critical for success?
2. How has EFSD's integrated Maker Movement generated a productive nexus of informal and formal education?
3. What is the effect of this integrated Maker Movement on student and teacher learning, confidence, and capacity in STEM?

The premise behind the NSF CEAC initiative is the promise that the integration of the Maker Movement into schools has in regard to its potential to the area of instruction and learning. Aside from its potential, there are many characteristics that have made Maker Spaces successful that are problematic in formal education settings such as voluntary versus compulsory participation, grading, and the subject/class structure of schooling. These examples highlight the challenges of integrating Making into formal education due to fundamental differences between formal and informal education. There exists a high level of interest and investment in Maker integration into EFSD that makes this site an intriguing environment for research. The NSF CEAC research will focus on three main areas in order to explicate this integration: *maker integration into formal education*, *nexus of informal and formal learning*, and *environment (space and culture).* One key area of exploration of the NSF CEAC research is the institutional, educator, and student experience at the nexus of informal and formal learning. The following exploratory study embedded within the NSF CEAC research study focused primarily on the student experience within the Maker Space of EFSD, and supported the research related to the third research question: What is the effect of this integrated Maker Movement on student and teacher learning, confidence, and capacity in STEM? Insights from the embedded study will contribute to the overall findings of the NSF CEAC two-year research initiative.

3.2 DESCRIPTION OF THIS STUDY

The embedded study focused primarily on student learning, confidence, and capacity. This study explored the key factor of active engagement by students as a necessary precursor to student learning. Shernoff (2013) explained engagement as always connoting a relationship—one of involvement—to something. He summarized the value and connection of engagement to learning when he stated "engagement provides a useful lens for viewing the promotion of psychological well-being as an important end of education in addition to academic achievement, and examining *optimal learning environments* helps us to discover the characteristics of educational setting that are effective in fostering this end" (p. 11).

Researchers and educators voiced concerns since the year 2000 that the increased standardization associated with NCLB in addition to the traditionally practiced industrial model of schooling has inadvertently created loss of an ineffable element often described as a loss of the joy of teaching and learning coupled with an increase in fear of failure. Ryan and Weinstein (2009) argued that high stakes testing created a learning climate that amplified many characteristics contrary to learning with hidden costs to both the students and the educators. The performance outcomes of the NCLB environment linked with rewards and sanctions became controlling and unmotivating to students. At the systemic level, it lowered teacher morale and innovation. They found that not only did high states testing undermine intrinsic motivation and deeper forms of learning, it also resulted in the diminished ability for concept integration and depth of processing in comparison to students in a non-controlling learning situation (p. 227). Consequently, school became a top-down, highly structured culture of work and drudgery for educators and students with punitive actions taken for non-compliance. Dewey (1913) posited that at some point during the last century the convergent ideas of what was considered simultaneously work and play diverged into two separate ideas where work and play were mutually exclusive. This approach is limiting—especially when negative connotation is placed on work and when going to school and learning is perceived as "work" (Csikszentmihalyi, 2014). The aforementioned limiting approach to learning where play and work diverge (or in the context of school: play and learning) has implications when perceived from the perspective of the student.

3.2.1 Maker Culture

Maker Culture is constantly evolving and includes many developing platforms and formats both associated with educational institutions and apart from a structured educational framework. An online article published on the Open Education Database web site titled "The 4 Flavors of Makerspaces" (2017) explains four types of Makerspaces defining them each by a set of unique characteristics. The first "flavor" is FabLabs. FabLabs provide the means for makers to create anything using various equipment such as laser cutters, routers, electronics equipment, and milling machines. Hackerspaces, also called hacklabs function as a means for knowledge sharing in the form of workshops, presentations, and lectures in order to build and make things. Tools and resources vary with location.

Hackerspaces often develop and use alternative media, open hardware, and free software. Tools and projects often associated with hacker spaces include audio-video equipment, machine tools, sewing and crafting tools, art fabrication, game consoles, and other equipment that would support creative collaboration. Guthrie (2014) explains the difference between a FabLab and a HackLab in this way: A hackerspace brings technical and artistic cultures together through a common sub-culture. Fablabs change working behaviors and practices that inspire multiple cultures to work around the same project.

The third “flavor” of Maker Culture is TechShop. According to their web site, TechShop (2017) is located in many cities throughout the United States and internationally. It is an open-access, DIY workshop and fabrication studio that is in a community-based space. It is also listed as a for-profit organization that provides training to develop and improve technical skills for entrepreneurs in order for them to develop their own skill sets. The fourth described “flavor” of Maker Culture is the Maker Space. Maker Spaces can be school related or not. Maker Spaces used by schools and libraries provide valuable skills in a setting where people can gather to create, invent, and learn in many contexts including math and engineering. These spaces often have 3D printers and other equipment supporting woodworking, metalworking, and traditional arts and crafts. This last category of Making aligns to the type of integrated Maker Space investigated in this exploratory research.

3.2.2 Maker Spaces

Researchers in the field of education developed alternatives to the traditional, industrialized approach to education. During the second half of the twentieth century the United States began to transition to career readiness and the improvement of education in the areas of science, technology, engineering, and mathematics (STEM). The focus in education began to shift to more constructivist initiatives giving attention to a world experience from the student perspective where learning becomes something personally meaningful (Martin, 2015). Maker Spaces, informal learning environments where people could engage in design and fabrication, began to appear. Halverson and Sheridan (2014) explained maker spaces as a manifestation of the maker movement. The maker movement, originating from Deweyan constructivism, focuses on problem solving and digital and physical fabrication. Maker spaces are environments both within and outside of the public-school system dedicated for creativity, problem solving, craft and skill development, and learning through experimentation and play (Moorefield-Lang, 2014). Examples of types of maker spaces include technology programming, hacking, crafting and the arts, music recording, and 3D printing among other areas of interest (p. 584). As the maker movement and maker spaces are a recent phenomenon, the underlying mechanisms that support its success are not fully understood or explored. Anecdotal evidence from recent studies conducted on maker spaces indicated participant satisfaction, increased participant interest in maker space programs, and potential benefits to learning both within and outside of the maker space.

3.2.3 Student Engagement

There are many proposed models of student engagement. A recent model (Fredricks in Zimmer, 2012) outlined four components to contribute to student engagement: academic, social, cognitive, and affective. Zimmer found that not only is there an importance of engagement/disengagement to learning, research shows that without intervention behavioral and academic risk progress simultaneously as students progress to higher grade levels. Furthermore, engagement can protect students from harm that may accrue (p. 107). Disengagement is attributed to students who do not actively participate, who are not cognitively involved, who have little sense of belonging, and who practice counterproductive behavior. Ocumpaugh et.al. (2016) characterized disengaged student behaviors as boredom, confusion, frustration, carelessness (careless errors; student possesses knowledge but answers incorrectly), gaming the system (intent to succeed without learning), and off-task behaviors. Disengaged students, due to various contributing factors, risk a cascade of a process of disengagement that leads to dropping out of school (p. 99). Exploring novel and effective means for educators to identify and monitor engagement of students in classrooms as it supports learning is critical.

3.2.4 Flow

One potential means to explore how engagement that leads to learning manifests itself in students is through the identification of the presence of components associated with Flow Theory.

Researchers investigated, over the last few decades, a concept called “Flow”. “Flow”, also known as “optimal experience,” is most familiar in the context of sports acquiring its own catch-phrase “being in the zone.” Someone who experiences being “in the zone” believes s/he is performing at his/her best and obtains the greatest satisfaction and joy from this experience. There are nine components that affect a perceived flow experience: a balance between perceived skills and perceived challenges, the merging of action and awareness, a hyper-focus on the task, a paradox between being in control and being controlled by the action, immediate and clear feedback, clear goals, the loss of self-consciousness, a perceived loss of time, and the participation in an activity for sheer enjoyment also called an ‘autotelic’ experience (Csikszentmihalyi, 1990). These components have consistently appeared in most of the studies reviewed to date from their introduction in 1990. Taken as individual components, each of the above conditions could explain many kinds of experiences not necessarily related to flow. However, in their totality, they describe a fuller and important experience. Engeser and Scheipe-Tiska (2012) concluded that “flow cannot be reduced to a single component, and all attempts to take one component of flow as the definitional aspect of flow will consequently disregard essential parts” (p. 4). Exploring where flow experience manifests itself and how learning conditions where students would experience “being in the zone” in a learning situation merits investigation as it has potential to allow for recognition of growth occurring in a learning situation.

Play and flow have key aspects that parallel one to another. Eberle (2015) explained the process of play as self-directed enjoyment that begins with anticipatory curiosity, moves to fun as the unknown deconstructs meaning. Then, fun progresses to exhilaration when meaning is reconstructed and order restored while in play. Likewise, someone approaching the experience of flow (an aspect of play) follows a path where intrinsic motivation coincides with the person increasing concentration on a task that is balanced to his/her skills which can build toward a flow state. Once in the state of flow, facets of flow begin to emerge such as control, merging of action and awareness, loss of time perception and loss of self-consciousness (Moneta 2012).

Csikszentmihalyi (2014) referred to this culminating state as the autotelic experience or an "ecstatic state" meaning "standing to the side of" or apart from normal reality—similar in description to what happens during play when previously deconstructed meaning is reordered resulting in exhilaration. Flow is an aspect of play. This study extended the idea that the process of play and the process that leads to flow when placed in the context of a learning environment, a range of engagement that leads to learning can be revealed by the presence or absence of observable flow components.

3.2.5 Flow and Middle School Maker Spaces

The challenge becomes being able to observe how this range manifests itself in the Maker Space learning environment of a middle school. The figure below illustrates the concept of range of engagement and flow as it would lead to learning in a middle school Maker Space learning environment (see Figure 7). The illustration suggests a model similar to previous flow models that employ a foundation of a balance of perceived skills and challenges. The flow model design shows an increase of flow intensity dependent on the level of skill and challenge. It also shows that where there is an imbalance between perceived skills and challenges the participant is likely to fall out of flow due to anxiety from too high of a challenge or due to boredom from too low of a challenge. The model below is contextualized to suggest a range from non-engagement to full engagement. The opportunity for flow to occur and the opportunity to learn due to greater engagement in a middle school maker space increase parallel to the increase in the balance of skills and challenges. Furthermore, disengagement would occur if the skills-challenge dynamic is out of balance where too great of a challenge would manifest in disengaging behaviors related to anxiety and too little of a challenge would manifest in disengaging behaviors related to boredom:

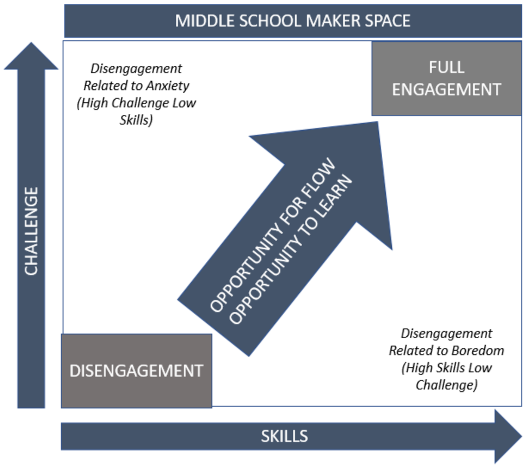

Figure 7: Flow theory illustration in terms of engagement in a learning environment

3.3 STATEMENT OF THE PROBLEM

Whether student engagement occurs in a structured or unstructured learning environment, there exists a clear distinction between the terms “learning” and “schooling”. Halverson and Sheridan (2014) cautioned to not conflate learning with schooling and suggested tensions emerge when this type of learning experience crosses the boundary between informal and formal learning environments. They further suggested “changing the conversation from being about the design of schooling as informing learning to, instead, the design for learning as informing schooling” (p.503). Therefore, the relationship between engagement and a “learning” environment does not necessarily equate to the relationship between engagement and a “schooling” environment.

An essential component to learning is engagement in the learning process. If the previously mentioned proposal to change the conversation from one that informs learning based on school design to a conversation that designs learning to inform schooling, engagement needs to be an integral part of that design. The challenge becomes the ability to recognize engagement that leads to learning in a variety of learning contexts and contents, both in informal learning environments and formal learning environments. Stripping away the traditional conventions of what it means to be engaged, a new perspective can be developed that sees engagement that leads to learning as a fundamental process of growth. A person who possesses a skill set, when challenged at his/her potential and who has the capacity for intent focus and setting goals should exhibit characteristics of engagement that lead to a potential flow experience. This study explored the components of flow as engagement in the unconventional learning environment of a Maker Space.

3.4 RESEARCH QUESTIONS

The purpose of this study was to explore engagement as it occurs in the sample of middle school aged students situated in a learning environment of a Western Pennsylvania public school with and integrated Maker Space. Flow theory, also called optimal experience theory first introduced in 1975 by Mikhail Csikszentmihalyi, played a critical role in this study. The importance of this study can be framed in the context of increasing understanding in how middle school students are engaged in learning within a Maker Space that is situated within a traditionally structured educational setting. This research explored student engagement from the middle school student perspective as observed through the lens of flow theory. The research questions that follow were filtered through the lens of Flow Theory. Evidence gathered included the presence of the nine components of Flow Theory (balance of challenges and skills, merging of action and awareness, clear goals, clear feedback, intense focus, paradox of control, loss of self-consciousness, autotelic experience, and loss of time) with an emphasis on balance of challenges and skills and concentration on task as principle indicators of the potential for flow to occur. The researcher tailored the protocol to gather evidence from the middle school students in a way that supported the following research questions respectful of the capabilities and understanding of the participants:

1. How do middle school students describe their experiences in the DREAM Factory?

    a. How do these students describe this experience as being similar to or different than their experience in other classes?

    b. How do these students describe experience in the DREAM Factory compared to their experience in other similar activities in which s/he participates during her/his time away from school?

2. Do middle school students' self-reported experiences in the DREAM Factory, in other classes, or during an outside-of-school activity evidence engagement that align with elements of flow theory?

The preferred method of research for this investigation is a qualitative exploratory method. Stake (1995) recommends qualitative research over other methods of research when the investigator is searching for 'happenings' rather than 'causes'. Qualitative research presses for an understanding of the complex relationships that exist among all of the components of a phenomenon. This approach contrasts with more quantitative approaches to research that presses for explanation and control of a phenomenon (p. 37). Nevertheless, previous research in Flow Theory provides a foundation of evidence based in quantitative methods to define the flow components to consider when looking for evidence of flow through qualitative means. The study design that follows expands on how this exploratory inquiry addressed the research questions.

3.5 RESEARCH METHODS AND DESIGN

The investigation collected evidence through observations and focus groups from a public middle school with a maker space incorporated into its curriculum. The rationale for choosing the site location was two-fold. The site selected provided the researcher with an established, integrated Maker Space. This site, called The Dream Factory, operates within a traditional school. This embedded study is an integral part of a larger NSF research initiative conducted by the CEAC. Therefore, the site location serves to support the requirements of and remain in alignment with this larger initiative.

This research employed convenience sampling that was also purposeful. Convenience sampling is used when there are constraints to time, money, location, availability of sites, and other factors (Merriam, 2009). Maker spaces are a recent phenomenon with sites that vary in degree of development and availability for observation. Also, at this time maker spaces are an exception to traditional learning. Therefore, a convenience sample became the most viable option. This study used purposeful sampling. This research, as a focus of the larger CEAC-NSF study in Elizabeth-Forward School District, directed the sampling selection for this study to be purposeful. The study explored student engagement in the context of the learning environment as it related to the influence of traditional schooling structure from the participating student perspective. Purposeful sampling provided for the observation of phenomena that is unique, extreme, or atypical.

3.5.1 Evidence

The research questions asked how middle school students describe their experiences while in DREAM Factory and how these experiences were different than what they experience in other classes and different than what they experienced outside of school. This study also asked if there is evidence of engagement that aligned with flow theory in each of these environments. The evidence collected was observational evidence of student experience in DREAM Factory classes and a connection investigated as to the experiences with what is known of middle school students' experience of flow. The researcher collected evidence of student perception (focus group) data from middle school students about their experience in other classes and out of school experiences. Analysis of the evidence mapped these experiences to align with the occurrence of flow.

As previously mentioned, multiple researchers of flow employed specific components used as indicators of flow that need to be present during a flow experience to consider the participant to have experienced flow (Csikszentmihalyi, 1990). One of the foundational components is balance between the skills that the participant has with the challenge to which the participant is presented. The skills-challenge balance is a transferable component to many contexts whether it would be performance in a sport, the sophistication needed to create a piece of art, or the growth that occurs in learning. Central to the study was the identification of the manifestation of these components as evidence supporting student engagement as measured by flow experience. Engagement in the environment manifests in the learner in terms of flow through the observance of high concentration, loss of track of time, and the expression of an autotelic experience that emerges when one feels a sense of accomplishment or growth. Growth occurs as the result, in part, of the balance of the skills s/he possesses in that content with the challenges that are presented to that student and other contributing factors that lead to flow.

3.5.2 Research Design

The research design was based, in part, on the recommendations made by Yin (2009) as related to design protocol and data gathering. In preparation for exploratory observation, interviews and other evidence gathering, the researcher arranged a first visit with the contact person from that site. This step the researcher and site representative collaboratively designed a formal agreement including the establishment of ground rules for those involved in the study, the addressing of confidentiality concerns, an agreement on the sharing of an action plan, and review of the costs and benefits to case study host site. The learning site will benefit from participation in the study. New insight will be gained from an outside perspective as to how middle school students learn and are engaged. Furthermore, the study will provide a relatively new program with tools to evaluate curriculum, teacher-student interaction, and professional development for the program educators.

3.5.3 Procedure

The study began in the spring of the 2016-2017 school year. The researcher conducted a preliminary observation of activities at the case site with participants identified for the study. This first visit helped to formalize the subsequent study procedures and answer questions concerning timing of future observations and participant sample identification and other preliminary preparations.

Subsequent site visits included observations. The researcher and the participating teachers scheduled each observational visit in advance. The duration of each visit depended on the schedule of the sample participants and aligned to the participating school schedule corresponding to a full class period and availability of the sample participants. During these observational visits, the researcher observed for evidence of student engagement.

The researcher conducted two focus group interviews of approximately six to eight student participants at a time from the classroom sample of middle school students at the site. The duration of each focus group included a limit of thirty minutes per group. A final site visit provided the opportunity for the researcher to complete any gaps of evidence not gathered during the previous site visits in order to synthesize data through triangulation and to validate key observations (Flick, 1992). The researcher scheduled a follow-up visit with the contact person of the site to review the insights derived from the study and the overall CEAC-NSF study team once the study data had been analyzed. The following table illustrates the timeline of case study events (Table 1). The larger NSF-CEAC study pre-determined parameters such as site location and some aspects of study design:

Table 1. Case study site visit order of investigation per site

1.	Initial Site Visit-**E.F. location**	Mid-March
2.	Observational site visit 1	1st week of May
3.	Observational site visit 2	2nd week of May
4.	Observational site visits 3-5	3rd week of May
5.	Focus Group Interviews	4th week of May
6.	Final (post study) site visit	August

3.6 RESEARCH SETTING AND THE PARTICIPANTS

The study site was Elizabeth-Forward School District's Dream Factory and SMALLab (Situated Multimedia Arts Learning Lab). Elizabeth-Forward School District is a rural school district located to the southeast of the city of Pittsburgh serving approximately 2,500 students from Kindergarten through grade 12 with a graduation rate of greater than 90 percent in the working-class rust belt region of Western Pennsylvania surrounding Pittsburgh, Pennsylvania. The demographic composition of the school district 96% White and 4% African-American with less than 1% of students who are of Latino or Asian descent.

The school district's maker space, the DREAM Factory, is within the school grounds and is part of the school program. Middle school students transition into and out of the maker spaces while attending Elizabeth-Forward Schools.

3.7 DATA COLLECTION AND INSTRUMENTS

This exploratory inquiry study included four data source recommendations (Yin, 2009): interviews (focus groups), direct observations, documentation, and physical artifacts.

3.7.1 Observations

The researcher conducted direct observations at the study site. The purpose of conducting observations is two-fold. First, observations allowed for the gathering of evidence to develop a deeper understanding of the factors that contribute to engagement and non-engagement in the learning setting. Second, the observer identified engagement and non-engagement of participants in preparation for focus groups and asked participants to clarify their thoughts, feelings, and actions based on the observed behaviors. The observer gathered evidence of the physical setting; the participants; activities and interactions; conversations; and, subtleties such as informal and unplanned activities, symbolic and connotative meanings of words, nonverbal communication such as dress and physical space, unobtrusive measures such as physical clues, and both expected and unexpected occurrences (Merriam, 2009). Analysis of observations included applying coding categories aligned with the nine components of flow (Csikszentmihalyi, 2012). The researcher collected further evidence of engagement/disengagement from observations of disengaged student behaviors as boredom, confusion, frustration, carelessness (careless errors; student possesses knowledge but answers incorrectly), gaming the system (intent to succeed without learning), and off-task behaviors (Ocumpaugh, et.al., 2016).

3.7.2 Documentation

The purpose for documentation is to provide the researcher with evidence recorded from multiple resources. The evidence the documentation provides allows the researcher to better triangulate data in order to develop a deeper understanding of the phenomenon. Documentation included, but was not limited to, the following: Researcher records included direct observation and interview notes. Interview transcripts with annotations were included. Ancillary materials shared with the public such as program agendas, media releases, special event outlines, maker space partner agreements, and any other document that may provide insight to the case study site was gathered and catalogued as available.

3.7.3 Artifacts

The purpose for collecting physical artifacts is to draw connections between the student produced work and the evidence of engagement that led to the student work. Evidence included physical artifacts collected in a virtual manner either through photograph or video recording. Physical artifacts incorporated photographs of each learning environment and student generated products related to the learning environment. Coding of examples of artifacts collected applied to three contexts: DREAM Factory generated, traditional school program generated, out-of-school activity related. The artifacts comprised of recorded images of student work in the Maker Space DREAM Factory program.

3.7.4 Focus Groups

The purpose for conducting focus groups is to draw out essential information from the participants that would not otherwise be available through observation. The focus groups provided the researcher opportunity for clarification of observed behaviors provided by first-hand knowledge of the experiences in the learning environment from the participants. Four inventories designed by flow theorists were consulted to design a series of questions to include in the focus group interview (see Appendix A). The format of the focus group with the use of guiding questions based in flow theory provided evidence to support the thick description necessary for qualitative research. The three resourced inventories included Flow Dispositional Scale Inventory (DFS-2), Short Flow State Scale-2 (S-FSS-2), and the Core Flow Dispositional Scale (C-DFS). A fourth contributing quantitative component was derived from the findings determined by an adapted previously designed interview protocol Flow Questionnaire (FQ) by Moneta as seen in Engeser and Schiepe (2012, p. 25).

The nature of a focus group is such that the moderator asks a set of targeted questions to elicit collective views about a specific topic where the participants interact with each other and the moderator. Focus groups can be characterized as a group interview or as a collective conversation composed of typically six to eight participants and can have a duration of sixty to ninety minutes per session. There are generally two types of focus groups, though most focus groups fit into a range between the two extremes. Type A focus groups (Individualistic Social Psychology Perspective) elicits a range of opinions, beliefs, or preferences about a program where the researcher maintains an objective stance. Data analysis focuses primarily on verbal content with little analysis of participant interactions or the social construction of knowledge. Type B focus groups (Social Constructionist Perspective) invite participants to explore beliefs, and understandings about a program through a form of collective sense-making. Knowledge is constructed from shared ideas, opinions, beliefs, experiences, and actions (Ryan et.al, 2014)

The type of focus group employed by this study was a hybrid approach of Type A and Type B focus groups. Although socially constructed meaning is helpful for specific aspects of the study, a mix of personal opinion and collective experiences is necessary to gather evidence of flow like experiences within and apart from the learning environment. The researcher acts as an empathic interviewer with authority and is able to subsequently build a rich description based on both the simple evidence of described experiences that code to flow characteristics and engagement/disengagement characteristics in combination with the evidence provided by narratives of the participants (2014).

Kitzinger (1994) summarized the advantages of overt exploitation and exploration of interactions in a focus group discussion. These interactions both encourage open conversation that leads to insight of the social processes, elicits a variety of communication among participants and highlights respondents' attitudes, priorities, language, and framework of understanding. Differences between group participants can be ascertained, conflict can clarify individual assumptions, factors can be identified that influence individuals and their opinions. Analysis of speech can inhibit or facilitate peer communication that may confuse or clarify an issue.

Two focus groups of six to eight students each included approximately 14 middle school students between the ages of 12 and 15 from the Elizabeth-Forward DREAM Factory. The questions had three goals: to ascertain how each student describes their experience in the DREAM Factory as compared to other school courses, to determine if each student describes having experienced flow in the Maker Space environment, and to discover if and how each student may have experienced flow outside of the school environment. The interview included an adapted set of questions designed by previous flow researchers to elicit responses that support the clarification of a flow experience. The adapted interview questions were as follows (Moneta in Engeser and Schiepe, 2012, p. 25):

> Please listen to the following quotes:
>
> I am so focused—in the zone. I am not thinking of something else. I am totally involved in what I am doing. I feel good. I don't seem to hear anything else going on around me. It is like the rest of the world doesn't exist. It is like I get to escape for a moment from anything I am worried about.
>
> I am so focused, is like breathing in that I don't have to think about it. When I am into what I am doing, I really do shut out the rest of the world. Nothing really distracts me, then.
>
> I am so involved in what I am doing, it is like I am part of the action.

1. Have you ever felt similar experiences to the ones that I read to you while in the DREAM Factory?
2. Have you experienced something similar outside of Dream Factory?
3. What about other times? Have you experienced something like I described in other places?
4. Is the DREAM Factory experience different than other school experiences? How?
5. Additional questions that will explore deeper meaning to the experiences of these middle school students will be drawn from anecdotal records of participants in the learning Dream Factory learning environment. Questions will be designed based on the noted observations of the presence or absence of observable flow components and engagement/disengagement behaviors (examples listed below):

a. “Jackie, when you were working on X you seemed intense. What were you feeling? What were you thinking about? What do you remember was going on around you at the time? Did class time seem shorter or longer to you than normal?”
b. “Michael, when you were learning about Y, I noticed that you were looking at your phone a lot and were having difficulty sitting still. What were you thinking at that time? What were you feeling?
c. Alyssa, when you presented Z to the class yesterday, what was that experience like for you?

Analysis of responses to the above questions comprised of coding for Flow and engagement characteristics. The following are examples of some key expressions to be coded: ‘feeling totally involved’, ‘tuned in to what I am doing’, ‘feeling in the zone’, ‘feeling like I was in control’, ‘feeling like nothing else mattered’, ‘totally focused’, ‘lost track of time’, ‘was bored’, ‘could not stay awake’, ‘was confused’, ‘was frustrated’, ‘didn’t care’, ‘just wanted to get done’, ‘was more interested in X’. A more comprehensive guideline to the coding of the potential responses including cross references of the flow component and how it relates to research may be found in Appendix D.

A pilot of the focus group protocol occurred with a small group of eighth grade students from another district in the region in order to gage the applicability of the guiding questions, the pace of the focus group interview, and the effectiveness of the protocol to generate student discussion. Since the resources for a focus group were scarce, Breen (2006) suggests setting up two sessions with the pilot focus group participants extending the first session to elicit input from the participants for clarification of questions. The second session will follow the initial analysis in the event of further questions arising not included in the original session. It was determined through this pilot that the question order regarding the experience of flow needed to be reversed. Therefore, the focus groups in the study employed a protocol where prompts to the students asked for examples where they had experienced flow outside of school first, followed by questions of flow related experiences in DREAM Factory (the Maker Space), and finally where they had experienced flow-like experiences in other classes in school.

3.7.5 Semi-structured Teacher Interview

A semi-structured teacher interview protocol was followed to interview the teacher(s) of the student participants from the DREAM Factory involved in the study. The interviewer asked the same core questions of the teachers interviewed. This allowed for the ability to capture evidence of aspects of the program that are reported as similar among the teachers interviewed as well as insight to unexpected differences that come up in the conversations. The interview protocol requested teacher(s) to respond to several questions pertaining to student engagement. The responses helped to identify the presence or absence of flow components and elements of engagement/disengagement in the student experience as observed by the teacher(s). Coding of questions aligned to flow components and engagement and disengagement behaviors. The resulting data was triangulated with other evidence for the purpose of discovering emergent themes. A teacher unaffiliated with Elizabeth-Forward school district agreed to participate in a pilot of the questions designed for the semi-structured teacher interview.

3.8 DATA ANALYSIS AND INTERPRETATION

Yin (2014) suggests creating analytic memos including observations about data and diagramming information. This initial process will help to develop a general analytic strategy. Merriam (2009) suggests devising categories organized chronologically or topically to create a narrative that moves from concrete description to a more abstract level using concepts involved in the phenomenon. The researcher extends the analysis to develop categories, themes or other taxonomic classes that interpret the meaning to the data (pp. 188, 193). The strategy for analysis involves being inductive and comparative (p. 197). Yin (2014) also suggests using one of four analyzing strategies: relying on theoretical propositions, developing a case description, using both qualitative and quantitative data, and examining rival explanations. He also suggests five analytic techniques: pattern matching, explanation building, time-series analysis, logic models, and cross-case synthesis.

This study employed some of these strategies and techniques to systematically analyze and interpret the data collected during this research. Many of the research psychologists who study flow theory developed the groundwork for data collection and analysis. Analytic memos created from notations of evidence found in the data were categorized in themes moving from the concrete to the abstract. Evidence of presence or absence of the nine flow components (an intense focus, the merging of action and awareness, clear goals, loss of self-consciousness, paradox of control, immediate feedback, an autotelic experience, loss of time awareness, and the balancing of challenges and skills) were compared among the data sets created from observations and interviews. Relying on the theoretical propositions outlined by the flow theorists and using both qualitative and quantitative data, pattern matching among the data sets helped to develop the primary themes of the study. Through pattern matching, explanation building emerged as the evidence was interpreted in the context of the case site.

The following research table illustrates the research process by research question in terms of evidence observed, the data collected to support the evidence, the analysis used to provide insight to the data collected, and the literature that supports each aspect of the research. This research used a research data collection and protocol designed by Stake (1995) including a chronological breakdown of research accounting for anticipatory actions, first site visit protocol, additional preparation for observation of a site, methods for further development of conceptualization of the case, the process of data gathering and validation, data analysis protocols, and reporting (p. 52-53). Refer to Appendix D for a more thorough description of the coding processes employed in this study. h

Table 2. Research and Data Collection Table Research Question 1

Research question	**Evidence**	**Data Source**	**Analysis**	**Literature**
1. How do participating middle school students describe their experiences in DREAM Factory? 1.a. Do these middle school students describe this experience as being different than their experience in other classes? 1.b. Do these middle school students describe this experience as being different than their experience in similar out of school experiences?	**A.** Flow occurs in the setting if the participants experience a combination of the following nine components of flow: Autotelic experience, the perception of balance of skill level to the challenge, clear and immediate goals, loss of perception of time passage, clear and immediate feedback during the task, a hyper-focus on the task at hand, a sense of automated control, a loss of self-consciousness and the merging of action and awareness—feeling a part of the surrounding environment. **B.** Degree of real time participant involvement **C.** Expressed enthusiasm **D.** Vested interest in the details of the process **E.** Persistent participation over time **F.** Verbal expression of the participants **G.** Resulting products demonstrating engagement in the process **H.** Reported change in attitude, engagement, performance by students, parents, mentors, and/or teachers	**A.** Documentation **B.** Interviews Students (structured interviews—focus groups) Teachers of Maker Space (informal interviews) **C.** Direct observations of the middle school students in a school affiliated Maker Space **D.** Physical Artifacts Images of Maker Space student work involved in study	**A.** Documentation will include written records of setting and interactions with participants **B.** Interviews will be conducted in a focus group format with 4-6 of the participants per focus group (a total of 5 focus groups). Teachers of Maker Space resulting data to be coded for flow components **C.** Documentation of four, one-hour direct observations will be conducted, recorded, and transcribed. Data from the transcriptions will be categorized and coded according to flow components. **D.** Physical artifacts will be collected via photographic archive and labeled by student participant.	**A.** Documentation *(Yin, 2009); (Merriam p. 139-163);* Interview transcripts Curriculum plans Program agendas, media releases, special event outlines, partner outlines **B.** Interviews Middle school students (Moneta in Engeser and Shipe, 2012, p.25). Teachers of Maker Space *(Merriam p.87-108)* Mentors of Students *(Merriam p.87-108)* **C.** Direct Observations *(Merriam p. 117-137) (Shernoff 2013)* Middle School students in a school affiliated Maker Space Students in a non-school affiliated Maker Space **D.** Physical Artifacts *(Yin p.113)* Catalog of Maker Space products associated with the middle school students involved in study

Table 3. Research and Data Collection Table Research Question 2

Research question	Evidence	Data Source	Analysis	Literature
2. Do middle school students report evidence of engagement that aligns with flow theory in a DREAM Factory, in other classes, or during an outside-of-school activity?	A. If the participants express experiencing a combination of the following nine components of flow in either the school setting or outside of their school experience, then it suggests that potential flow is present: Autotelic experience (i.e. enjoy doing the activity because they like it) The perception of balance of skill level to the challenge (i.e. it wasn't too easy or too hard, felt they could do it with some effort) Clear and immediate goals (i.e. knew exactly what I needed to do) Loss of perception of time passage (i.e. it seemed like time slowed down/or it seemed like time flew by) Clear and immediate feedback during the task (i.e. knew exactly what was coming next and how to do it) A hyper-focus (i.e. it was as if nothing else mattered) A sense of automated control (i.e. like everything worked like part of a machine) A loss of self-consciousness (i.e. I didn't care what people thought) The merging of action and awareness—feeling a part of the environment. (i.e. I felt like I was part of something bigger)	**A.** Documentation Anecdotal researcher records Interview transcripts **B.** Focus group with 4-6 of the participants per focus group (a total of 5 focus groups). **C.** Physical Artifacts--Images of Maker Space student work involved in study	**A.** Interview responses coded for flow components **B.** Analyzed for evidence of similarities and differences among experiences. **C.** Based on outcomes of interviews, student artifacts will be recorded associated with the middle school students who describe their experiences of flow. These artifacts will be documented by student with anecdotal records taken by the researcher for future coding and triangulation of data based on the 9 flow characteristics. As these artifacts are not associated with the school setting, rather are outcomes of flow experiences outside of school (i.e. awards from sports participation, etc.) access to these artifacts may be limited to descriptions provided by the student participants.	**A.** Documentation Anecdotal researcher records Interview transcripts *(Merriam p.109-115; 128-137)* **B.** Interviews of Middle school students *(Merriam pp.87-113; Yin p.106-9; Stake pp. 64-7)* (Moneta in Engeser and Shipe, 2012, p.25). **C.** Physical Artifacts--Images of Maker Space student work involved in study

3.9 RESEARCH PERSPECTIVE AND PROFESSIONAL KNOWLEDGE

The United States has completed one era of high stakes testing with the introduction of No Child Left Behind in the year 2000 and followed that era with a second era of high stakes testing with the Common Core movement. Both of these attempts to quantify the education our nation provides to its children are attempts to create a universal standard of minimum academic performance for students. The standardization of academic performance brings into question whether education policy should consider other areas related to learning such as self-efficacy and innovation. The approaches supported and driven by education policy in the past may need to be revisited when considering the world our children live in today—a world that encourages self-sufficiency, creativity, critical thinking, and innovation. Measuring student performance and teacher efficacy through standardized measures may not be sufficient to capture the engagement and the potential of progressive learning environments. Progressive learning environments include innovation, creativity, and critical thinking as essential components of their curriculum. The research of phenomenon of flow in the context of maker spaces is a novel approach without research precedent. Therefore, the research method employed is exploratory in nature.

Beginning to explore how to encapsulate the phenomenon that is occurring in innovative learning environments such as maker spaces through the measurement of optimal experience, or flow, could influence the manner to which policy makers and educators approach learning. The way in which middle school students perceive their own learning, the perceptions teachers have of how they practice the art of teaching, the means to evaluate a learning environment, and the overall goals educators and policy makers will have for education could experience a complete metamorphosis. Specific to this study, it is important to recognize the extant of the value of the results inclusive of limitations, assumptions made, and the meaning it can bring to the field of education.

3.10 METHODOLOGICAL ASSUMPTIONS AND LIMITATIONS

This study did not seek to make generalizations to a greater population. Rather, this study was designed to explore in depth a phenomenon that was occurring in a learning environment of middle school-aged children in Western Pennsylvania. Even though case studies are not generalizable, they are particularistic and meaningful. Stake (1995) suggests that there are two ways researchers reach new meanings about cases—either through direct interpretation of the individual instance or the aggregation of instances until something can be said about them as a class. Exploring this learning environment suggests a previously unexplored dynamic that merits formal evaluation. The goal of this study was to analyze the phenomenon, interpret the evidence, and produce a clear representation of the insights derived from the evidence to the various interested audiences. In other words, the evidence gathered helped to develop meaning through increased understanding of the phenomenon. As a result, the insights this study provides shall increase authenticity of the phenomenon as it relates to this study and future research of similar cases.

This study employed evidence gathered through observation, focus-group interviews, and artifacts. As mentioned, none of the insights gleaned from the evidence are intended to be generalizable to a population. The flow experience, as previously stated, is individualistic. Each data point that leads to evidence serves to capture a snapshot of the phenomenon from a different perspective. Conclusions of the learning environment can only be drawn from pattern matching from among the data sets inclusive of the observations of the researcher as outlined by Yin (2009).

Middle school students of various performance levels and interest levels and degrees of engagement were observed. The richness of the study further developed in the recognition of patterns of similarity and differences discovered among the participants within the learning environment.

The study provided specific information in depth with examples of how each of the factors of flow influences the other and why the relationships among the factors exist. Triangulation of observational data, interview data, and artifacts provided information about the prevalence of these factors and helped to provide understanding of the complexities of engagement and disengagement as it occurred in the learning setting. The qualitative methodology of this exploratory research provided a complex and rich understanding of the phenomenon.

This study is significant on many levels and will therefore, generate reporting to audiences that may benefit from its derived insights. The chapters that follow this study report these insights to many audiences inclusive of academic colleagues, a thesis committee, research funders, and the site contact. First, this study is a part of a larger National Science Foundation study (2017). Adherence to the reporting requirements and conventions outlined by this larger study was essential. Second, this research was part of a dissertation. Doctoral research requires reporting to the doctoral committee in the form of a doctoral defense. Third, the context used for this research on flow theory is Maker Spaces. The maker movement is relatively new and has not been adequately evaluated. Reporting was tailored for multiple audiences inclusive of those who support and guide the development of Maker Spaces and could benefit from the results of this study.

4.0 EVIDENCE, ANALYSIS, AND INSIGHTS: FOUR VIGNETTES

The following chapter applies techniques adapted from narrative inquiry to ground the insights derived from this study. The narrative inquiry approach allows the vignettes to serve as a metaphor for the teaching and learning relationships occurring at this study site. Connelly and Clandinin (2017) explain that narratives help to fulfill the need to understand life experiences in that they create the context for making meaning of school situations. They further state that it brings theoretical ideas about the nature of human life to light as it is lived in the educational experience. Narrative inquiry is a collaborative relationship, giving voice to both the researcher and the practitioner. Narrative inquiry is a form of empirical narrative in which empirical data is central to the work utilizing data such as interview transcripts, journal records, others' observations, documents, writing, and personal philosophies. The narratives that follow include contributions from all of the aforementioned evidence. Empirical narratives require a narrative truth that consists of continuity, closure, aesthetic finality, a sense of conviction, and are perceived as plausible and adequate to the task. Furthermore, the narrative shall seat the data in context with the past, present, and future. Finally, the researcher's role in narrative inquiry is "to interpret the stories in order to analyze the underlying narrative that the storytellers may not be able to voice to themselves" (Riley and Hawe, 2005).

Connelly and Clandinin (2017) warn against the risks, dangers, and abuses of narrative inquiry. They warn the narrative researcher to listen to critics and to avoid “the Hollywood plot” where everything works out in the end. Another warning is to avoid broadening, or what is considered making general comments about a person’s character, values, or way of life. They recommend instead the action of burrowing, where the intention is to reconstruct a story of an event form the person’s point of view at the time of occurrence.

Caine, Murphy, et.al. (2017) outline three purposes for fictionalization of narrative inquiry. The first purpose is to fulfill ethical concerns for the protection of anonymity and confidentiality. This study provides anonymity to the participants through the creation of pseudonyms. The second purpose is to create a sense of ‘other’ in order to reveal experiences that might otherwise remain silent. For example, a fictionalized character may contain composites of data elicited from two or more participants to more accurately illustrate a phenomenon as it occurred. The second purpose leads to the understanding of the third purpose for fictionalization that creates “as if” worlds. This purpose can be understood as another manner of analysis that creates another layer of deepened awareness of the phenomenon to encourage future research to understand more and inquire more deeply. The primary purpose of the series of vignettes that follow are to analyze, interpret, and represent a collaborative perspective of the phenomenon as it occurred at that time providing voice to the researcher, the teachers, and the students involved.

One departure from the conventions of the previous chapters is the use of the first person. The value in narrating in first person attends to the technique of addressing the multiple levels of complexity to which the narration proceeds. Connelly and Clandinin (2017) describe it as the portrayal of the ongoing stories being told and retold as described by each participant, researcher, and teacher as they are engaged in living, retelling, and reliving their stories. The challenge becomes such that the researcher becomes the development of a narration that accounts for this "plurivocal" approach, yet maintains a clear, dominant voice when we write "I". The intention of the use of "I" in the following vignettes is to narrate with the voice of the researcher as the dominant voice.

The following vignettes are composites of the observations, student focus groups, and teacher interviews conducted with fourteen eighth grade students. These students are participating in the Technology Education rotation of a three-classroom 30-day rotation at Elizabeth-Forward Middle School's DREAM Factory. The other two rotations aside from Technology Education include Art and Computers. The vignettes are fictionalized primarily only by the assignment of pseudonyms. In fact, nearly all of the narrative within each vignette was derived directly from observation of the four student groups. The exceptions to the direct transposition of observation notes to the narratives include the compression of time for the sequence of events in a couple of instances and the inclusion of a few parts of dialogue among students into the narratives that actually occurred during the focus group interview rather than during observation.

The project-based "Speaker box" assignment for the students in the DREAM Factory's Technology Education rotation included the following:

1. Through self-selection, students chose "business partners" to form a "company" of three or four partners.
2. The teacher provided a challenge to each "company" that included the following:
    a. As a group, decide who is the team leader and what positions each team member holds in the company (vice president, engineer, etc.)
    b. Decide as a group and create a company name, logo, and business card to be etched with a laser engraver on a notecard size piece of plywood.

c. Collaboratively design a 2-speaker speaker box out of any material (or combination of materials) using computer software.
d. Create a 3-dimensional cardboard mock-up of the collaboratively created 2-speaker box design.
e. Solder and create the internal speaker electronic components.
f. Using the approved cardboard mock-up design as a model, work together to determine how to transfer the design into a speaker box with the chosen design materials ensuring the speakers and internal components correctly fit (mathematical calculations including geometry skills needed).
g. Finish the details of the speaker box for presentation by your team members.

The goal of this study was to observe for evidence of flow as reported by students as it occurs in a middle school integrated maker space, in other classrooms in the school, and outside of the school setting. There exists an emergent theme in the analysis of each vignette. Each vignette reveals that the participating students exhibited behaviors and/or reported in their own words evidence that parallel components that would lead to flow or away from flow. I anticipated that all nine components of flow may or may not have been concurrently present or observable with the observed behavior. Flow is a dynamic process that not only depends on circumstance, but also on the disposition of the learner in the context of the learning environment. Each of the four vignettes to follow are designed to illustrate the interplay of behaviors that can be aligned to flow characteristics in the context of the timeline, the immediate learning environment and the disposition of the learners during that time.

4.1 VIGNETTE 1: MALIA (INTEREST, FOCUS, AND CONTROL)

Malia is team leader of a 3-person team including Jenna and Diana. The three girls are top academic performers in their grade. When presented with the speaker-box challenge, Jenna immediately thought of a Mission-style clock on her fireplace at home. She took a picture of it on her phone and brought it in to show her team members. They created a computer-generated design of a "Mission-style" speaker box. Diana, who loves art and drawing, designed scrollwork to add to the front of the box design. All three are intensely focused on achieving a perfect outcome.

Figure 8. The Mission-Style Speaker Box created by Malia's Group near completion.

At this point in the project timeline, the group already completed the company business cards, finished the cardboard mock-up of their speaker box design, soldered the internal components, and cut the wooden pieces ready for construction. They are focused on sanding the panels and preparing the finer details of their design:

Malia— [sanding] "OK. Once we get this done, what do we need to do next?" "If we sand this down with 80 and 120; then, what will be the back piece?" [Student teacher explains next steps]
Malia— "But, what will the back piece be made of?"
Student teacher— "It will be constructed of regular plywood."
Malia— [hesitates and looks disappointed] "Really?"
Student teacher— "Yes. Most of them are constructed that way." [Malia looks unhappy, but accepts the response without argument]
Student teacher— "It's OK, Malia. The back is usually made of a cheaper grade of wood because it is never seen. You won't even notice the difference once it is finished and displayed. [redirecting] "Did you all have the same design when you created it or did each of you have a design and combine it in the end?"
Malia— "We combined them. We put all of our designs together and made it into one."

[A couple of days later]

Malia's group is working independently. Malia takes the lead and discusses with the two other girls in her group what they need to do next. They debate three aspects of the design. Diana, who designed the scrollwork to be laser cut in the front thinks it should be bigger than what they originally designed. They concur and finalize the design. Malia wants to cut the ends of the top piece to be flush with the side pieces. Jenna wants the top to overhang on each side like the clock on her fireplace mantel at home. They also cannot decide whether the edges should be straight or rounded.

Malia— "Mr. C! …We have some questions!"
Mr. C.— "Ask away—anyone!" [Mr. C. leaves the group he was working with to help Malia's group]
Malia-- "Well, we wanted to put this design here [points to design], and place it here." [pointing to the front piece]
Mr. C.— "OK, Malia. Bring your group and we can look at it on the computer. Show me what you want and we can set it up to engrave."
Malia— "Before we do that, can you help us with something else? Jenna wants to leave the top overhang, but I think it will look better if it is flat with the sides."
Mr. C.— "Well, you need to make some decisions as a group, here. You can have this overhang a little at the top, which is fine. But, you could also clean it up by making the top piece flush with the side pieces if you cut it at an angle. It is up to you and your team. You need to decide what is best for you and what you want it to look like in the end. You can do it either way."
Malia— "But, is that going to look alright?" [the other two girls in her group are focusing on what Mr. C. is saying]
Mr. C.—It will look fine either way. What is important is that you decide as a team what you think would be best for the product you are designing, OK? You, together, are going to have to decide what you want to do there." [They decide to leave the overhang at the top to look like Jenna's clock at home]

[3-days before the end of the 6-week rotation]

Malia and her team are patiently waiting for consultation time with Mr. C. who is busy with other groups. The only step they have left to do before putting together their speaker box and staining it is to round the edges. Using the router is too dangerous for them to operate. The student teacher intervenes:

Mr. T. (student teacher)— "Malia, bring your group and your box panels over here and we can work on routing those edges for you." [Mr. T. explains how the router works and that he will gradually soften the edges until they are at the roundness that the team wants]
Mr. T.— [after running one pass on the router] "Is this how you want it?"
Malia— [after looking the piece over] "Yeah. That's good…it could be a little more."
Student teacher--"What do you think?" [to other 2 students in group— Jenna and Diana]
Diana-- "Yeah. A little more would be good."
Jenna— "Yeah. A little more rounded would be better."

Student teacher— "Notice that you need to sand the end grain first, then the sides. Otherwise, the corners will chip and it will mess up your piece." … "What side do I want to face up when sanding? The top or bottom?" [The girls take a beat to think about it and respond] -- "The top. No, the bottom!"

The student teacher sands and shows the girls the finished sanded piece for approval. Without prompting all three girls look at each other than say: "Yeah. Like that. That's good."

As the researcher, I observed groups not expecting to find evidence of all components of flow. Rather, I expected to find examples of a few strong components of flow exhibited consistently by the groups. I noticed that the skills possessed by Malia's group appeared to match the challenges the speaker-box project expected of them. The student behaviors were consistent with their perceived skills and challenges as being relatively in balance throughout the period of observation. Malia's group seemed very interested in the outcome of the project (interest) and they were highly focused (concentration), even more with Malia and Jenna. Malia and Jenna were very detail-oriented and goal-oriented. Malia had in her mind what she expected the outcome of the project to be and challenged the student teacher on the use of materials. Her disappointment at the use of pine wood was apparent to me as if she did not trust the student teacher to have the best interests of the project in mind. She appeared uncomfortable that she would need to relinquish that control (balance of control). The student teacher redirected Malia when she challenged him about the control of the direction of the project.

The teacher and the student teacher balanced both the issue of control (paradox of control) and the balance between skills and challenges (balance) through various interactions with this team. Mr. C. was able to maintain the dynamic of student control by making them take the lead in the next steps of the project. I further observed the student teacher near the end of the observation period (while rounding corners on the wooden edges of their project with a router) skillfully trying to maintain for the students a perception of the student group being in control. Even though the students could not use the router, themselves, due to safety concerns, he provided the students choice (control) in the degree to which the task was executed. He kept the dynamic of a balance of skills and challenges by encouraging students to use the knowledge they gained from previous demonstrations to apply to the design of their piece. As a result, the integrity of the paradox of control and the balance of skills and challenges appeared to be the most readily apparent of the nine flow components as observed in this student group. The two primary components of control and balance allowed for other components of flow such as enjoyment, interest, and focus to remain part of the process and additionally reveal themselves as evidence.

4.2 VIGNETTE 2: NATE (INTEREST, CONTROL, AND THE LOSS OF SELF-CONSCIOUSNESS)

Nate, Jacques, Mick, and Jonathon at this point completed the requirements of designing their business cards, constructing online the computer-generated design of their speaker box, and cutting wood panels for the box. Nate, Mick, Jacques, and Jonathon are called into the design room. Mr. C. asks Nate (the team leader) what the team goals are for the day. Nate explains that Mick and Jonathon are going to finish designing the business cards in the design room while he and Jacques finish sanding the panels for the 'superhero' speaker box in the shop area. [While two of the boys are working]:

Figure 9. The “Superhero Speaker Box” created by Nate’s Group near completion

Mick--“Nate! What is my job?”
Nate-- “Engineer”
Mick– “What are Jacques’s and Jonathon’s jobs?”
Nate– “Engineers, too.”
Mick— “How can they be engineers, too?”
Nate [to Mick]— “Well, you can be Vice President, then. Make Jonathon an Engineer and Jacques, Head Engineer.”

Once the business card design is approved, all of the team members huddle around a laptop while Mr. C. troubleshoots preparing the file for the laser engraver while the students focus on the steps he is explaining to save, resize, and prepare to send the image for printing by the laser engraver.

[A few days later]

The next step is to figure out the angle of slant of a cover panel designed and cut like a superhero mask to attach to the speaker box and to cut out 2 holes for the speakers. The four of them debate and hold the box and the face plate at different angles to determine how it would be supported and the slant it needed. They tried drawing several lines. Mr. C. intervenes:

Mr. C— “You boys are going to have to make some decisions about what to do here. Let’s take a look at the placement of these holes for your speakers. Now, if you are going to place this face panel (shaped like a mask) over the speaker box you are going to have to determine what angle will work for you.”
Nate— “Well, we wanted to place it at an angle like this [demonstrates].”
Mr. C.— “OK, now. You see if you place it too high, then you are not leaving enough wood at the top. Also, if you do that, what are you going to use to support it at the bottom?”
Nate— “We thought of that. Jonathon thought we could place wooden supports underneath it, here, and here [demonstrates]”

Mr. C.— "OK. That might work. Now, what you need to do as a group is angle the front piece to the box and strike a line across where you want it to hit so that you can create the template to cut your circles out for your speakers. What you could do is cut out larger holes and create inserts for the holes afterward if you want. Let me show you with Malia's group's box [demonstrates]"
Mick— "Yeah, that might work."
Mr. C.— "You all are going to have to work together on this to figure this out. You need to talk about it to make some progress. You boys decide from your design what angle you want it, strike your line, and then we will cut it."

[The boys go back to the computer template design to figure it out further. On making a decision, the four boys hover around the box and wolf shaped face plate. One holds the face plate, one holds the box]

Nate— "Mick, hold it up like that. At more of an angle."

[Mick tries to hold the wolf-shaped face plate against the box so that it is setting on the table straight and level across the top. To Jacques:] "There, draw the line there."
[Jacques tries to draw a straight line across the top edge of the box on the back of the wolf-shaped faceplate]

Nate— "No! That is too high. Look! It is not going to leave enough wood at the top. Let's put it lower."
Mick— "How about here?" [lowering it a half inch]
Nate— "Well, that's better, I guess. I still think it should be lower."
Jonathon— "That will work. I cut these pieces to use as supports underneath [holds two rectangular pieces against the box the other three are holding together].
Nate— "Mr. C.?"
Mr. C— "Looks good."
Nate— "OK. Let's do it."

[Three days before the end of the 6-week rotation]

Some of the students filter into class before the late bell rings and immediately get out their projects to begin working. Within a minute of the bell, all of the students are getting started on their projects. Nate, without direction, created a 3-D generated hinge out of plastic for the box outside of class and brought it in to show Mr. C. He wanted to get Mr. C.'s approval to use the hinge as a means to get to the interior of the speaker system (superhero box design).

Nate— "Mr. C.! I need to show you something for our project!"
Mr. C.— "OK. What's up?" [Nate shows him the hinge] "Where did this come from?"
Nate— "I designed it during lunch and Mr. T. [the student teacher] 3-D printed it for me. I worked on cleaning the hinge up at home last night. I want to add it to the design of the box and I wanted to attach it like this." [demonstrates to Mr. C. the way he wanted to attach it]
Mr. C – "I had no idea you were doing this."
Nate— "No. I just thought of it, myself, and thought it would make the speaker better."

Mr. C.— "Well, that is really good, Nate. I am glad you are thinking outside the box. Your group only has two days left, though. I wonder how you are going to find time to add it?"
Nate— "We [Nate's group] could do it if we could get the box together today."
Mr. C.— "Well, why don't I work on that part with you right now. That way, you could work on the hinge."

[at the end of the period]

Mr. C.— "So, you are really crunched for time because of PSSA testing. What are we going to do? How are we going to finish your projects? How many of you have come down during lunch?" [a few students respond that they have].
Mick and Nate— "Hey! I came down…. Yeah, I came down, too!"
Mr. C.— "Yeah. That's right. I forgot. You two did come down. But, where was the rest of your team?" [asking in a light-hearted manner] "I didn't see any of them come down with you."
Jacques— [quietly] "I wanted to come down, but I needed a pass."
Mick [to Mr. C]— "Yeah. Jacques wanted to come down, but he needs a pass."
Mr. C.— "Ok, ok, we can do that. I can write you a pass. Who do I put on this pass?"
Boys answer-- "All of us." [They are crowded around him to get the pass, looking very excited about the idea]
Mr. C.-- "Who is going to be in charge of this pass?"
Tate--"I will!" Mick--"Me!"
Mr. C.-- "OK. Here's the pass for all four of you. Come down during lunch."

As mentioned previously, I observed groups not expecting to find evidence of all components of flow. Rather, I expected to find examples of a few strong components of flow exhibited consistently by each group. I also expected to see with minor variance the same components manifested in their group dynamic as would predictably appear in the other groups as the assignment and expected outcomes were the same for each group. The above exchange among the members of Nate's group evidenced behaviors that suggest several components that lead to flow. Control became dynamic with an underlying set of ground rules. The students were both in control of their progress, but were also controlled by the parameters of the assignment and by the project design and the materials used. The students were in control only as much as they are able to get the outcome of the project to conform to their expectations (paradox of control). The balance of challenges to skills was activated and also became a dynamic force. During the above exchange, I recognized that for brief moments an increase in concentration where the intensity increased, the smiles decreased, and the interpersonal dynamic became momentarily strained. Once that brief moment passed, though, the group returned to their happy and excited demeanor. The momentary struggle can be explained by their need to both control the project outcome (paradox of control) and meet the challenge in order to maintain the balance of skills and challenges (balance). I observed the teacher monitoring the challenge level and with finesse providing minimal, but carefully calculated, assistance to quickly redirect the control back to the team leader and his group. The students recognize the level of control they had in the moment and on the project with the autonomy to assign roles (paradox of control). These students were not challenged too far beyond their abilities consistently maintaining a balance between the skills they possessed and the challenges presented to them (balance).

One apparent difference between what was observed in Nate’s group that was not as strongly apparent in Malia’s group was the sense of play. This behavior occurred consistently as Nate’s group role played as team members of a company taking their roles seriously (autotelic). I noticed that this group of students were energetic, consistently smiling, gregarious, highly engaged, and interested each step of the process. This group was intensely focused (focus) on an outcome (goals), and appeared to be enjoying the class immensely (autotelic). The enthusiasm I saw these four students demonstrate was palpable. These students were so interested in this project and enjoyed doing it so much that they willingly sought time from outside of the classroom to return to the DREAM Factory classroom (interest, loss of self-consciousness, and autotelic). Another example of enthusiasm that surprised me was Nate’s unprompted creation of the hinge outside of class. Furthermore, a loss of self-consciousness occurred in the sense that the needs of the project took precedent over having lunch in the cafeteria and spending time with friends. I watched this group place this speaker-box project as a higher priority than eating lunch with their friends, or doing something unrelated in the evening as in the case of Nate's hinge design. Personal needs took second priority to the project (an aspect of loss of self-consciousness).

4.3 VIGNETTE 3: MICHAEL (FOCUS, LOSS OF SELF-CONSCIOUSNESS, AND THE DISTORTION OF TIME)

Michael's group (hexagonal box with etched plexiglass face pieces) are struggling with measuring and cutting angles. Michael and Alexandria discuss their project:

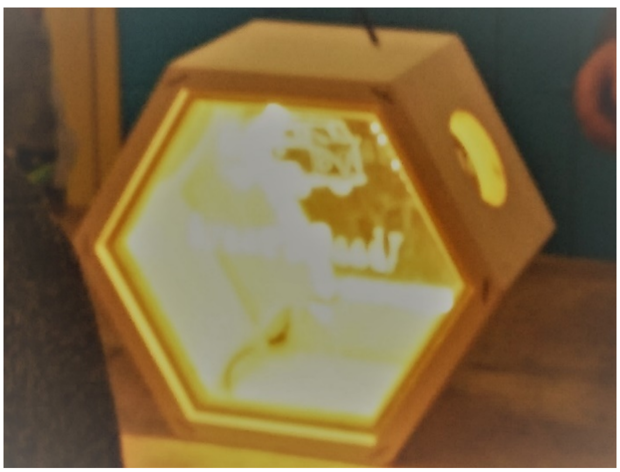

Figure 10. The "Hexagonal Speaker-Box" created by Michael's Group near completion

Alexandria— "I'm sorry. It's my fault. I shouldn't have made it so hard."
Michael—[jokingly] "Yeah. It is your fault. Ha-ha. It's ok. I like your design. It is going to look really good when it is done."
Alexandria— "Yeah, but how many times are we going to have to do it over?"
Michael— "It is frustrating having to measure, cut the angles, put them together, and take them apart again 'cause they don't fit—but, that is part of the process. I am still having fun. If I wasn't, I wouldn't have taken the extra Tech Ed class."
Alexandria— "I am, too [having fun], and it is beginning to look like I wanted it to. It will look even better when we add the rope lighting inside. Do you think we should ask Mr. C. to help us with cutting the trim angles?"
Michael— "Yep. I don't want to have to re-cut those six times like we did the other ones. [to Mr. C.] Mr. C.! Can you help us figure out the angles for the trim?" [Mr. C. stops what he is doing and goes over to the hexagonal box team and begins to demonstrate]:
Mr. C.— "OK. How many degrees in a full circle?" [student response] "360"

Mr. C.— "How many sides in a hexagon? [student response] "6"
Mr. C.— "What is 360 divided by 6?" [student response--after some thought] "60"
Mr. C.-- "So what you are saying here is that I need to cut a 60-degree angle?"
Michael — "Yeah. I think so."
Mr. C.— "Well, let's think about this. How many cuts are you making for each angle?"
Michael— "One…wait. No, two. There are two parts."
Mr. C.— "OK, then. You need to divide 60 by 2 to get the correct miter cut. That would be 30. OK, now you see I am using this [tool] to measure the angle. You take the side of the trim piece from your speaker box and you mark it right here [demonstrating].
Michael— "Wait. Why on that side? Why not on the other side?"
Mr. C.— "Well, that is the side you want to mark because the opposite side is the cut side. Here, let me show you."

[All of the students in that group watch him intently to see exactly what he is doing]

Michael's group focuses on the measuring, marking, and cutting of the other angles (12 total cuts). The bell rings, and no one in the group notices, not even asking about going to their next class. They want to continue to work on their project as long as Mr. C is able to give them the attention he can to help them to make progress.

[15 minutes into the next period to Michael and his team]

Mr. C.— "I need you guys to get some passes and for you to go to your next classes so that your teachers don't get upset with me, again."
Michael's group goes into the design studio to write passes for Mr. C. to sign to go to their next class. The students would have stayed all period if Mr. C would have let them.

As with the previous two student groups, I observed this group not expecting to find evidence of all components of flow. Rather, I expected to find examples of a few strong components of flow exhibited consistently by each group. I also expected to see with minor variance the same components manifested in their group dynamic as would predictably appear in the other groups as the assignment and expected outcomes were the same for each group. As observed with the previous two groups, I recognized skills and challenges to generally be in balance and the students appeared to possess a sense of control over their learning. Interest (goals) and enjoyment (autotelic) were also present as observed in the other groups. I noticed concentration (focus), distortion of perception of time, and loss of self-consciousness as the three most prevalent behaviors that relate to flow components with this group. It began to appear to me that each group had their own interpersonal dynamic unique to their group. Michael's group focused so intently on the task that they did not realize the passage of time going into the next period (distortion of time, focus). I found it interesting that despite the number of times they needed to destroy their work and re-create it due to errors, the frustration that often comes from repeated errors did not deter them and did not remove the joy they got from working on the project (autotelic). There did not appear to be the occurrence of ego injury, either. As occurred with Nate's group previously, a of loss of self-consciousness occurred with this group as it related to choosing the activity above personal regard (loss of self-consciousness). During observation, I began to suspect that once the evidence is reviewed that each group may not only have variations among the types of components of flow manifested, but various degrees to which each component expresses itself and the role it plays in their group dynamic.

It is important to note the teacher role with this group. As with the previous two groups, the teacher was consistent in monitoring in real time the level of skill the students in this group had in relationship to the challenges presented to them. With the previous two groups, the teacher briefly intervened to clarify, walk through a process, or to challenge the students' thinking at that moment. To the contrary, the teacher acted to provide a more in-depth intervention over time with Michael's group. Michael's group experienced an impasse to progress of their design due to the challenge of correctly designing, measuring, and cutting precise angles. Rather than providing the students in this group with the correct measurements or cutting the pieces for them, the teacher helped them to work through the process allowing the students to take the lead. The students took control of creating and re-creating the visual design, measuring and cutting the angled pieces, and trying to fit the pieces together—unsuccessfully, repeating the whole process several times over several days. The teacher did not overly correct them. He did not do it for them. Each time the result would not work, he would sit down with these students and ask probing questions to get the students to use critical thinking to try to determine for themselves where they created a mistake for themselves resulting in an unusable product. The teacher interaction with Michael's group in the above narrative where he walks through the steps with them to determine how to measure and cut the angles was the seventh, and final, time before they did it correctly. The students were very excited to finally find success.

4.4 VIGNETTE 4: HAYLEE, BETH, AND SHANA (DISENGAGEMENT WITH WEAK CONTROL AND LOW INTEREST)

Three girls (Haylee, Beth, and Shana —simple box design) are trying to figure out how to cut out a complete box to insert the mechanism. They come to the realization that they did the steps out of order and, in haste, glued the box together without cutting a hole for the controls to be added. They are discovering that mistakes delay progress and are at an impasse. The two girls appear to be shy. Their demeanor indicates they are waiting for someone to tell them what to do. They appear very patient and not assertive.

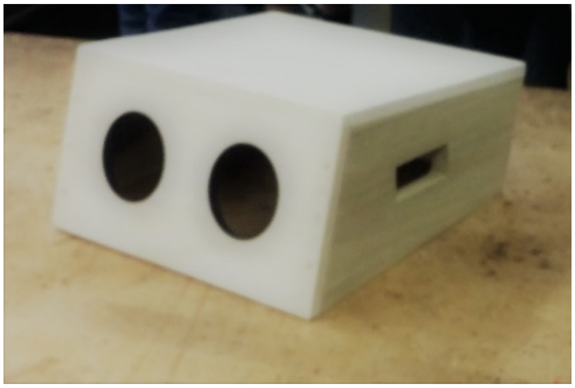

Figure 11. The "Simple Design Speaker-Box" created by Haylee's Group near completion

Mr. C.— "So what is it you two are working on today?"

Haylee and Beth — [referring to the wooden box] "This is supposed to be our speaker. We put it together already, but forgot to cut out the hole for the controls."
Mr. C.— "OK. As a team, you run into these problems sometimes. You need to get your team together and try to figure out your options for fixing it. Think about what you can do now that it's put together. Try to figure out what you can do without having to completely re-do the box. Ask yourselves, how are you going to cut the hole? What other options are there for placing the controls? Let me know what you come up with."
Haylee and Beth go back to their table with the third member of their team, Shana. Shana says nothing mindlessly flipping a sanding block in her hand. Haylee and Beth discuss:
Beth— "We shouldn't have rushed to get it together so fast."
Haylee— "I know, but I just wanted to get it done. I liked Art and Threads, better."
Beth— "Yeah. Those classes go by fast. In Art, it was like just as I got into what I was doing the bell would ring. I am only taking this class because I had to so I could get Art in my schedule."
Haylee— "Me, too. This is going to sound stupid, but I hate those things." [refers to shop area of saws, routers, etc.] "They are loud and scary. I always think someone's going to get hurt."
Beth— "I know, right?! At least with Art I could take stuff home to work on. My mom would get mad at me, though, 'cause I'd be drawing and forget to come down from my room to eat.
Haylee [laughs]— "Yeah. Same, here, when I draw anime. I can stay up all night doing that."
Shana [interrupting]— "So…what are we going to do about this?" [referring to unfinished speaker box]
Beth— "I dunno. I am over it. …So, Haylee, did you hear about Matt on the bus this morning?"

Shana returns to mindlessly flipping the sanding block while Beth and Haylee continue talking off to the side for the rest of the period. After two days, the student teacher intervenes by providing the team with a solution, creating a woodcut template, and walking them through the process of cutting the final hole. At the end of the period Mr. C. asks Haylee and Beth (the two girls who talk during the whole period and are disengaged most of the time)

Mr. C.— "Do you want to come down during lunch today to finish this?"
Haylee— "No."
Mr. C.— "Why not?"
Haylee— "Just…No." [An awkward moment passes]
Mr. C.— "You need to get this project completed. You need to come down to finish it. How about I write you two a pass to come down during lunch and finish this project."

The girls comply and go with him to the design room to get a pass. Mr. C. finds out that the reason they did not want to come down during lunch is that Haylee is not going to be in school next week and Beth would not get to eat lunch with her.

I observed this last group not expecting to find evidence of all components of flow as I had expected before observation with the other three groups. Rather, I expected to find examples of a few strong components of flow exhibited consistently by each group. I also expected to see with minor variance the same components manifested in their group dynamic as would predictably appear in the other groups as the assignment and expected outcomes were the same for each group. I began to observe Haylee's group with the expectation of finding to varying degrees evidence of the components of flow as I had recorded for the other three groups: especially the balance of skills and challenges and the sense of control the other student groups appeared to readily demonstrate.

I recognized right away that Haylee and the two friends in her group often had their heads down, seemed distracted, and spoke softly. Their speaker-box, when compared to the other speaker boxes in the group seemed overly simple. I recognized that they appeared to be having trouble and had some difficulty competing for attention from the teacher and his student teacher. I asked them on the first day what they were working on. They explained to me that they glued their project together before cutting the holes and were trying to figure out how to fix it. In their haste, the students in this group made mistakes. The consequence of the mistakes became an impasse during subsequent classes. The result was these three students were not able to meet the challenge of rectifying the mistake with the skills these students possessed at the time (imbalance of challenges and skills—challenge too high). The students originally appeared goal-oriented in wanting to complete the project by designing, measuring, cutting, and gluing the project pieces. Nevertheless, they shut down when the challenge became too great for them to solve (loss of immediate goals/ interest).

I saw their interest decline further subsequent to the impasse. I discovered later that rather than having genuine interest in the project, the group members told me they had little interest in the project other than wanting to complete it quickly (absence of interest). Enjoyment was low (absence of an autotelic experience). The students in this group chose to enroll in this course out of obligation and were not enjoying the project or the process for its own worth (lack of control regarding the paradox of control). Where a previous group exhibited a loss of self-consciousness, this group was not willing to choose the project over other personal needs—in this situation, the need to take time to eat lunch in the cafeteria and to socialize with friends had a higher priority for them than to work on the project (no loss of self-consciousness).

I saw this group struggle with assertiveness in getting the attention of the teachers resulting in two days of inactivity. This inactivity allowed the three students to self-protect from ego-injury over the inability to meet the challenge leading to a situation whereby they could blend into the background of the classroom. The teacher and student teacher interacted with this group in a similar manner as they did with the three other groups. The teacher would check in with Haylee's group to ascertain their progress, suggest potential 'next steps' for the group to take, carefully return the responsibility back to the students to collectively use critical thinking skills in order to make progress, and make sure the students knew to report their progress back to the teacher. This approach did not work for Haylee's group. The student teacher stepped in to break the impasse after two days of inactivity and finished the next steps for them.

I recognized that for this group of students, distortion of time occurred differently. The distortion of time associated with flow was not present. What was present was boredom. The students experienced inactivity that seemed to elongate the period of time for them to the point where they found distractions (flipping the sanding block and talking).

Previous studies on flow experiences indicated that flow occurs more often in participants who have a strong internal locus of control, are challenge-mastery minded, and are action-oriented. The students in this group did not show that they felt they had control over their environment. In fact, they were intimidated by aspects of the environment such as speaking up to the teacher, expressing an opinion, and being near the machines they perceived as loud and dangerous. They also did not appear to perceive the project as one they could successfully master. Rather, they chose to attempt the minimum requirements to complete the task quickly. And finally, they were timid in demeanor and waited for others to take action on their behalf. This last group was a distinct departure from the previous three groups I observed.

4.5 CONCLUSION

Observation and interviews with four groups of students developed into four vignettes that closely paralleled the observed actions by these students in each of their designated groups. The above vignettes illustrate the progression of observed flow components beginning with the recognition of two most evident components of flow, a balance between skills and challenges and a paradox of control. These two components revealed themselves consistently in the first three of the vignettes. The second vignette (Nate's group) became a variation from the first vignette (Malia's group) in that enjoyment (autotelic) played a stronger role in the student dynamic. The third vignette (Michael's group) revealed a more complex interplay of flow components than the previous two vignettes. Measuring and cutting twelve angles with precision, and having to repeat the process until correct, challenged this group above their skill level. The observation of this group yielded a higher intensity of focus (focus) and a loss of perception of time (time distortion) more than occurred in the previous two vignettes. The last vignette (Haylee's group) showed how under the same conditions and the same assignment, this group dynamic had a distinct outcome from the other three groups. Once challenge exceeded skills, this last group's performance seemed to cascade into boredom, disengagement, and finally to resistance to participate.

The teacher (and student teacher) interaction with the students followed a general pattern: check in with the student group to ascertain progress, challenge the students to critically think to resolve any impasses, charge the students with verbalizing the ‘next steps’ of the learning process, and make sure the students know they need to report back to the teacher the subsequent progress they make. The teacher (and student teacher) consistently in their interactions with the student groups monitored the balance between the skills the students had and the immediate challenges each group was facing at the moment. They also consistently redirected the control of the learning situation to each group leader and his/her group. It is important to note that while the balance of skills to challenges and the paradox of control are two key components that lead to flow, neither the teacher nor the student teacher had an understanding of flow theory or its components at the time of the study. It is fascinating that these two components occurred frequently during observation. Both the balance of skills to challenges and the paradox of control presented naturally in the classroom during observation and appeared to be organic to the learning environment and the teaching practice of the teacher and his student teacher.

5.0 ANALYSIS AND INSIGHTS

The purpose of this study was to explore student engagement in a middle school embedded Maker Space through the use of flow theory. This study was an embedded study within the framework of a larger initiative by the University of Pittsburgh's Collaborative for Evaluation and Assessment Capacity (CEAC). CEAC, in conjunction with the National Science Foundation, conducted a more comprehensive evaluative case study of Elizabeth-Forward School District titled *Making Success: Researching a School District's Integration of the Maker Movement into its Middle and High School* (2017). I collected evidence for this embedded study that would indicate the presence of one or more flow components in an eighth-grade classroom comprising of fourteen students participating in the Technology Education six-week rotation of the DREAM Factory. The following inquiries guided the study:

1. How do middle school students describe their experiences in the DREAM Factory?

    a. How do these students describe this experience as being similar to or different than their experience in other classes?

    b. How do these students describe experience in the DREAM Factory compared to their experience in other similar activities in which s/he participates during her/his time away from school?

2. Do middle school students' self-reported experiences in the DREAM Factory, in other classes, or during an outside-of-school activity evidence engagement that align with elements of flow theory?

The following chapter outlines the evidence for flow components determined from the investigation of the Technology Education Dream Factory 6-week rotation course with fourteen eighth-grade students. I collected data collection from six classroom observations, two student focus group interviews, and a semi-structured teacher interview conducted with the teacher and his student teacher. The sections that follow outline insights developed in four ways: analysis by flow component, across focus groups, from observations, and through teacher interview. First, I provide an explanation of how I recorded the evidence of the flow components in the context of this Maker Space. Second, through the triangulation of data, I address emergent themes as revealed through the observed patterns from the degree of presence of flow components in the Dream Factory Maker Space by method (observation, focus groups, and teacher interview). Third, I share student described experiences relevant to the presence of flow for classes outside of the Dream Factory Maker Space and for outside of the school setting. And, finally, I outline conclusions and insights into how I perceive the role of the components of flow as they played out in this maker space during that time period.

5.1 BEHAVIOR THAT ALIGNS TO FLOW COMPONENTS

I gathered evidence from six days of classroom observations, conducted two student focus group interviews, and interviewed the technology education teacher in charge and his student teacher.

The data was coded by flow component and disaggregated by behavior leading to and away from flow. The evidence was further analyzed to ascertain any trends according to frequency of observed or reported behavior by flow component and to determine what method or methods of data gathering yielded results. Analysis by individual flow component:

5.1.1 Balance of Challenge and Skills

I recorded the *Balance of Challenge and Skills* as data for evidence when the following occurred: the teacher(s) reported the importance of this balance in terms of the design of the project, the students reported the skill level compared to the challenge, the behaviors of the students led to either boredom or frustration due to the level of challenge and skill change in process, or the actions of the teachers to re-direct students when the challenge level became too high or too low while in process. In a few instances, I recorded evidence where students began to feel frustrated or bored due to an imbalance of challenges to skills. I noted this evidence as not responding to teacher redirection and therefore leading away from a flow experience. Evidence from the six classroom observations conducted indicated ten examples of a clear balance between the challenges presented to the students and the skills the students possessed. I also noted five imbalances between skills and challenges manifested during observation showing both examples of where challenges were too high for student skill and vice-versa. I cross-referenced this evidence with supporting information clarified through the data collected from the student focus group responses and the teacher interview. I observed in this Maker Space, with this group of students a skill-challenge balance that leads to flow as compared to an observed imbalance with a ratio of 2:1 in favor of a balance of skills to challenges. I originally thought that there would be more evidence of both a balance and imbalance of skills to challenges in anticipation of conducting the study. On reflection, I realized that when put into context, the actual number of skill-challenge balance occurrences is not the important piece of this evidence. Taking into consideration the factor of the passage of time, skills and challenges can be in balance for a period of time during the learning process and become out of balance when faced with a new challenge. I realized that the ratio of what I observed to be in balance to what was out of balance over a period of time had more value than the actual recorded frequency. In this case, the students appeared to experience a balance of challenges to skills as observed twice as often as I observed an imbalance to occur. Future research may consider the ratio value as a more revealing indicator than actual observed occurrences.

5.1.2 Paradox of Control

The *Paradox of Control* is the internal sense where one feels as though s/he is in control of his/her environment while at the same time feeling as though the environment is controlling the action. I recorded data as evidence for this component when the following occurred: students reported the value of being in control of their project while the parameters of the project dictated the outcome, the behaviors of the students indicated that they did not need direction from the teacher to make progress, the students “owned” their student group and designed and completed tasks through negotiation among the members of the student group, and the teacher(s) in their interactions with students would re-direct “ownership” of the project and its processes back to the students while maintaining a level of expectation of progress on the projects. I also recorded where students appeared to be experiencing a conflict of control that would lead away from a flow experience. The evidence I gathered from observation, focus groups, and teacher interview indicated the likelihood of a student experiencing the flow component *paradox of control* that would lead to him/her experiencing flow as five times the experience a participant would have where s/he would believe him/herself to exhibit measured control over this Maker Space learning environment. I began to realize that this finding is a significant finding when considering this classroom of students in comparison to what might occur in a traditional classroom of students. The students in this classroom told me what makes this class different for them. In the words of Michael, “In a normal class, they [the teachers] would say ‘OK. Now we are going to do this’. And, then, you just do it…In here [DREAM Factory] you have more flexibility.” This sentiment was expressed by nearly everyone in the group. I expected on reviewing the evidence that I would find a significant difference in the student perceived control over the learning process in the classroom. What I did not expect was the passion with which the students expressed this difference when interviewing them. To them, it seemed, being able to have some control over their learning is a primary factor that determines why they like a DREAM Factory class over the other traditional classrooms they experienced during that time period.

5.1.3 Focus (Concentration)

I recorded *Focus* or *Concentration* as data for evidence when the following occurred for a reasonable period of time: time on task, students would physically be engaged in their project such as body stance or huddling together, leaning over their table to observe. I also observed if their eyes were focused on the project or the teacher or the student team member speaking, the tool or machinery used, or the computer screen. I also included evidence that indicated a lack of focus or concentration that would lead away from a flow experience. I found evidence to be consistent among the observations, focus groups, and teacher interviews to indicate that focus (concentration) played a significant role in the student experience in this Maker Space. The evidence suggests that students were three times as likely to be focused on the experience than not.

5.1.4 Goals (Interest)

Goals or *Immediate Goals* as a component of flow refers to the goals of the individual in the action of the experience. In the context of the learning experience in this Maker Space, immediate goals and interest in the project run parallel and found myself recording the same data point for both and concluded that I needed to combine them as a single component. This component was recorded as a data point for evidence each time the following occurred: one or more students took initiative to direct his/her student group to take the next step in the process of the project, student(s) expressed enthusiasm over the project or the process, students expressed concern over the outcome or the process of the project, students requested to remain in the classroom beyond normal time to work on the project, students took the initiative to work on the project outside of class, and the student(s) expressed interest in not wanting to move on to the next rotation of classes. I also recorded evidence that indicated a lack of interest that would lead away from a flow experience. Evidence in this learning situation indicated that students were up to five times more likely to have immediate goals and a high interest in the course than to show disinterest that would lead to disengagement. On reflection, I also concluded that interest and disinterest appeared to cluster by group. The students in each group tended to feed off of the energy from other members of their team. In the case of the “superhero speaker-box” team (Nate’s group), each of the members of the team while interacting with each other would appear to reach a crescendo in excitement as they progressed through each step of the process. The students on the “simple speaker-box” (Haylee’s group) appeared to shut down when faced with a challenge and interest would stagnate and decline to the point of boredom for long periods of time.

5.1.5 Autotelic (Enjoyment)

I recorded *autotelic experience (enjoyment)* when a student expressed enjoyment of the experience of the Maker Space for the sake of the experience itself. This type of enjoyment is not to be confused with enjoyment of the experience for external reward. Repeated physical signs of enjoyment such as smiling, laughter, and positive interaction among students and between the students and the teacher were also indicators of enjoyment. Students in this Maker Space expressed both *autotelic* and *exotelic* experiences. Delving as a questioning technique helped to distinguish between the two types of experiences for accurate recording of data. There were three observations of enjoyment during the observation period. This may seem low, but is not unusual. Although there was evidence of students smiling and happily working, a person in flow does not recognize enjoyment at the time of the experience. Rather, the *autotelic* experience is often on reflection post-experience (Csikszentmihalyi, 1990). Twice as many reports of an *autotelic* experience emerged during the focus group interviews and as reported by the teacher(s) during the teacher interview. This insight is not surprising, either, when taken in the context of flow theory. Enjoyment is expressed as a reflection of an aspect of experience. Students were able to articulate the type of enjoyment that they experienced as similar to what was previously experienced while making accomplishments in outside-of-school activities such as performing successfully in hockey, baseball, and drawing anime.

5.1.6 Distortion of Time

I observed the *distortion of time* to occur in the context of flow in two manners: the slowing down of time at an intense moment and the perception of the loss of time while concentrating for a period of time. I recorded this component leading to flow as data in the following instances: students expressed directly that they lost track of time or that time slowed down to the point that they remember every detail of an experience, or the students rushed at the end of the class period to clear their stations because they did not realize the class period was ending. Expressions of distortion of time was evident in both the Maker Space setting and as expressed by the students as occurring outside of school. The distortion of time that leads to a flow experience should not be confused with the elongation of time that occurs out of boredom. I saw evidence of students who expressed latter type of distortion of time during observation. I recorded this evidence as leading away from a flow experience. There were two instances of a perception of loss of time indicated during observation and three instances reported by students in the focus groups as occurring during time in the Maker Space. Outside of the Maker Space environment, two students reported to me a perceptual loss of time (an indicator of flow) as related to creating artwork at home and while in art class. Two other students also shared with me a perceived elongation of time during an intense moment while playing sports. In total, evidence of a distortion of time was indicated in this Maker Space five times, in another classroom once, and outside of school three times. The insight I gained from observing for this flow component was not surprising. The students who were enthusiastic and highly engaged lost track of time. The students who felt overly challenged and bored watched the clock until the class period would end.

5.1.7 Feedback

Feedback in this context refers to immediate feedback from the environment during the experience. I recorded data as evidence when the following occurred: students received immediate feedback from the teacher(s) or from their peers, students received feedback in the form of a gain in the process of their project or a challenge that presented itself while in the process of constructing their project, students received feedback outside of school while participating in an activity such as feedback from the actions and words of players on a team while in the moment or feedback from the environment related to actions taken by the participant.

5.1.8 Loss of Self-Consciousness

I observed the *Loss of Self-Consciousness* to occur in two forms. The participant either disregarded personal need by choosing the activity as the priority, or the participant showed a lack of concern for external perception of him/herself through action or verbal expression. I recorded data as evidence for both forms of *loss of self-consciousness*. I also recorded evidence of a significant degree of self-consciousness that would lead away from a flow experience where the student(s) intentionally chose to prioritize personal concern over active participation in the process of the project. I observed evidence of a loss of self-consciousness in the Maker Space in one repeated instance where students would forego lunch with their friends in order to go to the technology education classroom to work on their project. Another example of a loss of self-consciousness occurred when one of the groups of students reported in the focus group interview that they did not care how many times they made mistakes, that making mistakes was part of the process showing lack of concern for ego injury. The opposite manifested itself with one of the groups of students who not only was not willing to work outside of class on their project, but refused to come to the technology education classroom on their own time choosing the preference of spending time with their friends. What I found fascinating about this evidence on reflection is the clustering of extremes. On one end of the spectrum of prioritization of personal concern there were students who would give up lunch, friends, leisure-time activities, and other priorities to get to be in that classroom and work on the project. On the other end of the spectrum, a few students practiced avoidance. The latter students would avoid making progress, would not make good use of the time they had in the classroom, and found arguments to justify not coming into the classroom to complete the project on their own time. What is fascinating being the fact that this range with the clustering of prioritization occurred in the same small classroom of sixteen students, during the same class time, with the same project parameters, and the same teachers. It would be interesting to study in the future this phenomenon as it would occur in another Maker Space classroom.

5.1.9 Merging of Action and Awareness

This component is most easily explained as when a person is so involved in an activity that they develop what is commonly referred to as tunnel vision where perception is narrowed to the exclusion of external stimuli. I found this component to be the most challenging to observe. I recorded limited evidence that indicates the merging of action and awareness as observed. This result does not preclude the probability of this component of flow occurring throughout the study. The conditions were present to where students very likely experienced tunnel vision. Nevertheless, I chose not to record this component as data without a strong degree of certainty. I observed two instances during observation which indicated that certain students were experiencing a *merging of action and awareness* as explained by tunnel vision. One instance was where two students were so intently working on the construction of the angles for a hexagonal design speaker box that they seemed to completely tune out the other students and the teacher(s). Another instance of indirect observation of this degree of focus was when one of the students spontaneously leaped and twirled from one end of the classroom to the other. The other thirteen students were so involved in their small groups, they did not seem to notice, care, or react.

5.2 OBSERVATIONS, FOCUS GROUPS, AND TEACHER INTERVIEW

The following section is an outline of the insights gained by data collection method. This section includes a summary of the most prevalent flow components observed by method, data collected by method that indicates behaviors that lead away from flow, and a comparison across data collection method of the evidence gathered.

5.2.1 Observations

Taking into consideration the three means of data collection, observations produced the most evidence followed by student focus groups. Teacher interviews showed less evidence of flow components. I was able to record evidence for behavior leading to and away from flow through observation for flow components. The most readily apparent flow components were immediate goals (interest), followed by a balance between skills and challenges, focus (concentration), and the paradox of control. Recorded as evidence through observation to a lesser degree included enjoyment (autotelic), distortion of time, loss of self-consciousness, feedback, and the merging of action and awareness.

Observation yielded evidence leading away from flow inclusive of evidence reported as an imbalance of skills to challenges, the lack of immediate interest or goals, the lack of focus (concentration), and to a lesser extent an imbalance of control (paradox of control) and an increase in self-consciousness. It is worth noting that throughout observation the evidence in this classroom of students yielded in favor of demonstrating behaviors of components leading to flow twice as often as behaviors leading away from flow and toward disengagement.

5.2.2 Focus Groups

Data recorded from the two student focus groups yielded substantial evidence of examples of components leading to and away from flow though not as strongly as the evidence from observation. Students reported behavior that aligned most strongly, and nearly equally, with four components leading to flow: goals (interest), focus (concentration), control of their own learning (paradox of control), and enjoyment (autotelic). Other components were present to a lesser degree including the reporting of a perceived loss of time during class (distortion of time), a balance of challenges to skills (balance), immediate feedback from the environment (feedback), and a loss of self-consciousness.

Students reported behavior leading away from flow in the context of flow components, but to a lesser degree. The behaviors reported include a lack of focus (concentration), diminished interest (interest/goals), an imbalance of skills to challenges, and a sense of not being in control of the learning process (paradox of control). As reported by the students, the ratio of behaviors leading to flow outnumbered the behaviors leading away from flow two to one. This insight is very similar to what was discovered while analyzing the data from the observations.

5.2.3 Teacher Interview

The teacher interviews yielded evidence of components that led to and away from flow, but not nearly as much evidence as the previous two methods. The teacher (and student teacher) indicated three areas of behavior that they reported in their students as strongly supporting components that would lead to flow: goals (interest), the importance of allowing the students to be in control of their learning (paradox of control), and the understanding that the students are truly enjoying the learning experience (autotelic). Also reported to a lesser degree were the balance of skills to challenges (balance) and concentration (focus).

The teachers in the interview indicated to me a couple of instances where the challenges exceeded the skills of the students (balance) and a lack of interest in a couple of circumstances (goals/interest) that would lead away from flow and toward disengagement. The evidence reported by the teacher and his student teacher indicated a ratio of three to one favoring the occurrence of components leading to flow as compared to the observation of components that would lead away from flow and to disengagement. As a researcher, I recognize that this disparity from the two to one ratio found from classroom observation and from the student focus groups could indicate limitations to the method of teacher interview. Limitations could occur from factors such as interview question design, time limitation of the interview, and/or the teachers interviewed could have been trying to answer in a way that they believed I wanted to hear. The latter would introduce bias in the responses provided by the teachers.

5.3 STUDENT DESCRIBED EXPERIENCES IN THE DREAM FACTORY

I triangulated the evidence from the focus groups, the teacher interview, and the classroom observations to look for potential themes. The evidence from student impressions of DREAM Factory yielded several student perspective themes: opportunities for collaboration, control and flexibility as it leads to learning, the application of skills learned in other classes, and fun.

5.3.1 Opportunities for Collaboration

Evidence indicates students place a high value on working with others on a team in DREAM Factory. Although students recognized in each other that some students prefer to work alone, the majority of students expressed an appreciation for not sitting by oneself during a class period. Several students indicated the importance of having the opportunity to cooperate with other people with the goal of designing and making products. They recognized and embraced the fact that as a team member you use skills that some other people on the same team may not have and vice-versa. The prevailing understanding by these students is that they need to work together to weigh the advantages and disadvantages of each decision toward the goal of creating a product. This insight is not surprising. Rather, it is affirming. I surmised from my interactions with these students that they equate collaboration with success. In fact, most of them expressed to me that when given a choice, collaboration as opposed to working alone was the clear winner for them.

5.3.2 Control and Flexibility

The students indicated that there are varying levels of control over the learning process. One limitation is the danger involved in the use of the equipment and tools. Some students qualified that even though they did not get to use some of the tools and equipment themselves they observed while the teacher did the work. Nevertheless, they believed they were able to have control over the process by directing the teacher as to the outcome of the action and the refinement of the process taking place. This appeared to be an acceptable precautionary compromise to them.

Students also explained they were provided with the project directions and expectations, in advance, and did not have a choice on the project itself. Nevertheless, they welcomed the structure of the assignment because of the flexibility it provided. The students were enthusiastic about being able to design their own, small group, collaborative version of a two-speaker speaker box. They recognized that the parameters of the assignment such as having a team leader, designing business cards, creating a computer design of their project followed by a cardboard mock-up, and finally manufacturing the product did not inhibit them from playing a strong role in the creative process.

The students expressed their appreciation for the flexibility of being able to work with different people on teams. They recognized the potential challenge of working with someone you may not get along with, but overall indicated that working on teams was better than working alone. The reality is that as the teacher gave them the control on the first day of class to choose two or three other classmates as business partners, most of the students within a design team worked well together. This flexibility extends to the procedures used to complete the project goals. They liked being able to work on different parts of the project on any given day depending on how they were feeling that day further emphasizing that there is always something to work on that is meaningful.

What I found to be most significant regarding choice and flexibility for this classroom of students at that time is the tone the teacher told me he set the first day of class. Classroom teachers often use various means of grouping students for small group work. The teacher told the students in this classroom on the first day to create their own teams of three or four students per team. Naturally, these students who knew each other from previous years in this school, from other classes, and from sharing other interests such as art, music, and sports gravitated to include people with whom they felt most comfortable. It did not take very long for me to recognize that Malia's team included students who valued grades and academic performance. I realized quickly that on Nate's team all of the members participated on sports teams together or on opposite teams of the same sport and competed against each other. Haylee's team of three students included three friends who only took this class so that they could schedule Art and Threads. As far as an outlier team in team construction where a less common thread was evident, it appeared to me that Michael's team did not seem to have an apparent commonality. Two of the team members appeared to highly value academics, one team member had a high interest in sports, and the fourth team member did not reveal to me from my observation what she valued. The flexibility for the students to control who they worked with appeared to allow them to control the tone, enthusiasm, and focus of their own groups.

5.3.3 The Ability to Use Skills From Other Classes

Skills from other classes contributed to the learning process. Students frequently used mathematics skills for measurement and skills from geometry in order to determine angles and circles for design cuts. Students employed skills learned in computer classes to create the design for their product using design software. Skills acquired from art classes helped them to create a cardboard mock-up of their design and to determine the best finishes for their products. The students demonstrated other newly acquired skills such as the basic principles of learning how to run a business and how to use various tools and equipment found in a technology classroom. I was surprised that the students not only welcomed being able to use what they learned in other classes, but they expressed an appreciation for actually being able to use the skills they learned in other classes to create something that seemed "real" to them.

5.3.4 Fun

The majority of the students (11of 14) chose the course because they wanted to take it. These same students frequently used the same phrase--It is fun. I asked them on more than one occasion as to what makes the class fun. The responses included that you get to run your own business and design a product, you get to work with other people, you get focused on what you are working and run out of time sometimes, the class goes by more quickly than other classes, and it is a break from the rest of the day. It was clear to me that the fact most of these students saw this class as fun meant that for the majority of them if given a choice, they would not want to be anywhere else during the school day. What is more intriguing, but does align with flow theory, is that while they were in the midst of working on their projects, they seemed intensely focused most of the time and their thinking challenged—two behaviors that do not intuitively conjure "fun" as an initial descriptor. According to their own reflection while not in the action of class time, though, the students perceived the classroom experience as "fun".

5.4 STUDENT DESCRIBED EXPERIENCES IN OTHER CLASSES

The experience in DREAM Factory differs than what the students report experiencing in other classes. The primary difference conveyed could be summed up in one word, "choice." The students expressed that being able to choose and to have control over the learning process was important to them. In other classes, students explained that "they have everything lined up for us." In a "normal" class "they [the teachers] say 'ok, now we are going to do this' and you just do it." Another student expressed that with other classes "like in Language Arts" you have "the same kids every single day, regardless if you're in the mood." When asked as to whether there are experiences in other classes where they get to work together on a project that are similar to DREAM Factory experiences, one student replied that "we kind of do some stuff like that…I guess. Like, if we do group projects, are assigned to stations, and then get back together."

It is important to stress that what the fourteen students expressed regarding their compared experiences in other classrooms needs to be understood as the context of their own experiences as eighth-grade students. Their understanding is limited by their lack of knowledge of flow theory and how flow manifests itself in a learning environment. This embedded case study is a part of a larger National Science Foundation study through the University of Pittsburgh's CEAC (2017). The larger study in progress should reveal how the integrated maker spaces within the Elizabeth-Forward School District influence non-maker space classrooms and instructional delivery. Current classroom instruction does not rely on lecture format as the primary mode of instructional delivery. Opportunities for flow or "optimal experiences" may not be recognizable to these fourteen students or easily articulated by them although they may be present in other classrooms not associated with the DREAM Factory. Further research needs to be conducted that identifies how and to what extent non-traditional learning spaces such as DREAM Factory impact the instructional delivery of traditional classrooms located within the same learning institution.

Three students indicated they did not choose DREAM Factory, but took the course because they needed it to complete their schedules. They told me that, despite that fact, they enjoyed this rotation of technology education. As a caveat, I was skeptical of the self-assessment of enjoyment relayed to me by the three students who told me they did not choose DREAM Factory. The three students were the students from Haylee's group who demonstrated boredom and frustration during observation. These three students wanted to make sure I knew that they preferred art class to the technology education rotation. They explained their experiences in art class as the experience corresponds to emerging flow components in similar ways the other eleven students explained their experience in the technology education rotation of DREAM Factory. They indicated that in art they sometimes get so focused they lose track of time, they get to make something productive and meaningful, they get to work at their own pace, and they are having fun.

5.5 STUDENT DESCRIBED EXPERIENCES OUTSIDE OF SCHOOL

The guiding questions during the focus group interviews drew from the components leading to flow in order to form a common bridge of comparison between outside-of-school activities and in-school activities. Students described experiences outside of school that were similar to the components of flow evidenced in DREAM Factory and one or two other classes in two contexts: sports and art.

One student described his experience with hockey and baseball to me in that he likes the energy when the team works together (focus, paradox of control). He also related the joy at getting a goal in hockey as he remembered all of the details of the event and it seemed like time stood still (autotelic; distortion of time). Another student also told me of a similar experience while playing soccer and hockey. He conveyed to me that he preferred hockey because it is harder and more rewarding (balance of challenge and skills). It means more to him to actually get a goal because he said that he does not score as much. He, too, remembers the details of every goal as if time slowed down because “each one is different” (distortion of time).

Two other students described experiences to me where flow components are present in the context of art. One student said that she becomes so focused on her drawing that she loses track of time until her mother tells her to go to bed (focus). The other student agreed. In her situation, she explained to me that she draws anime at night and plays online games. She intimated that her mother would get angry at her because she loses track of time and forgets to come down for dinner after being called for over an hour or more (distortion of time).

All of the students who shared their experiences outside of school demonstrated the emergence of several of the nine flow components. Flow is fluid in that it varies in intensity over short periods of time. Flow also is individualistic and is triggered by and experienced differently from person to person. Flow components that I observed as emergent in these instances as reported are the distortion of time, an intense focus, immediate goals, a balance between skills and challenges, the paradox of control, feedback from the environment, loss of self-consciousness, and enjoyment (an autotelic experience).

5.6 SUMMARY: COMPONENT, METHOD, AND PARTICIPANTS

The previous analysis reviewed the evidence from many perspectives: through the lens of individual component, through the lens of data collection method (observation, student focus group, and teacher interview), and through the insights gained from the collective points of view expressed by the students. Flow components revealed themselves in all of the above evidence, but varied in degree among data collection method and also within each data collection method. The flow components of balance of skills to challenges, paradox of control, focus (concentration), goals (interest), and enjoyment (autotelic) were the most prevalent of the nine flow components. The method of searching for expression of flow components also led to the revealing of behaviors that led away from flow and to disengagement. The data collection method used that yielded the most insight was classroom observation, followed by student focus group interviews. Teacher interview provided further insight, but to a much lesser degree. The student participants directly expressed their value of being able to control their own learning as a high priority along with enjoyment of the class (autotelic), and high interest (goals). The same students expressed little occurrence of flow component behaviors in traditional classrooms. They also indicated experiences related to sports and the arts outside of the school setting that included behaviors that would support components leading to flow.

The section that follows addresses conclusions from the insights gathered from this study. It also includes implications this study could have on flow theory, for maker practice, and for further study. Limitations to this study are discussed including limitations to the parameters of the study and suggestions for further mixed-methods studies that include quantitative instrumentation.

6.0 CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

Two primary research questions guided this study. The first research question, “How do middle school students describe their experiences in the DREAM Factory?” expanded to include the investigation of how students describe their experience in DREAM Factory as being similar to or different from their experience in other classes, and how students describe their experience in similar activities in which s/he participates during her/his time away from school. The second research question asked “Do middle school students’ self-reported experiences in the DREAM Factory, in other classes, or during an outside-of-school activity evidence engagement that align with elements of flow theory?”

6.1 CONCLUSIONS

After reviewing the triangulated data from the teacher interview, classroom observations, and student focus group interviews evidence appeared for students experiencing many flow components in this integrated Maker Space classroom. The evidence for what the students experienced supported previous research on flow theory and provided new insights to how flow can occur and be observed in a classroom setting.

Eleven of the fourteen students participating in this study indicated that for them, experiences were limited that would lead to evidence that indicates flow components as occurring in other classrooms on a regular basis. Three of the students indicated they experienced similar experiences in Art class (one of the DREAM Factory rotation courses). The evidence that students reported as occurring in a traditional classroom that approximates flow components are when students get to work in short-term, small group activities and report out to the rest of the class. The dividing line between what they expressed as the difference between what happens in DREAM Factory and what happens in group work in other classes appeared to be the perception of student control and flexibility with their own learning. The previous findings of flow theory for at least the last decade indicate a low probability of finding the occurrence of reported behaviors that parallel flow components in a traditional classroom (Shernoff, 2013). A limitation of this study is the students from this sample group of fourteen students may not be able to articulate or to completely understand the parallels of experience when verbalizing the comparison between DREAM Factory and a traditional classroom. Neither should any generalization be made to speak for the experience of the students in the rest of the school outside of this group of fourteen eighth-grade students. Further research may flesh out any influence an integrated Maker Space has on instructional delivery of non-Maker Space classrooms unrecognized by the sample of students in this embedded study. It would seem illogical that the instructional practices that elicit flow components in students would be isolated to DREAM Factory. This integrated Maker Space has been a part of the instructional program for many years. It will be interesting to discover through the larger NSF-CEAC study the influence this integrated Maker Space has on traditional classroom instruction in the same school.

Student reported evidence in this study indicated that in comparison to the traditional classroom environment students more readily and more frequently described behaviors associated with flow components in leisure-time activities such as playing a sport or creating something related to fine arts. Students reported the distortion of perception of time as in time slowing down when making a goal in hockey as in Nate’s experience or time passing by more quickly when drawing anime until being told to go to bed as experienced by Haylee. Students also reported a hyper-focus where each detail is remembered as in the remembrance of details leading up to making a goal in hockey reported by Michael during the focus group interview. Other flow components revealed themselves in the context of leisure-time activities such as a balance between perceived skills and challenges, and an autotelic experience. The participants grew in their knowledge, developed skills, and had fun. This finding is not surprising in that it supports previous research on the presence of flow in the context of sports and leisure-time activities (Csikszentmihalyi, 1990).

Flow is individualistic and dynamic (Csikszentmihalyi, 1990). The intensity and presence of components that lead to flow over short periods of time can manifest themselves to the observer or not. Identifying flow components as they occur is challenging to researchers. Previous studies used the ESM (Experience Sampling Method) where study participants were randomly interrupted to answer survey questions on their experience in the moment. Post-experience surveys designed to identify flow components also tried to meet the potential gaps where evidence was either not apparent to an observer or missed during observation. This study observed classroom dynamics, consulted with student group participants, and interviewed the teacher to develop a well-rounded perspective on the phenomenon that was occurring during that time. The evidence from this study observed behaviors that support previous research that indicated flow components vary in intensity compared to each other when manifested, and also each flow component can vary in intensity within the flow component itself as the phenomenon occurs over even a brief period of time. The four constructed vignettes demonstrate this point.

Each of the four vignettes reflected the periodic manifestation of flow component behavior throughout the scenario, but in differing relative intensity to the remaining theoretical flow components. Also, each observed flow component related behavior functioned dynamically as a single component during the period of time each vignette takes place. Each of the four groups represented in the vignettes adopted a distinct group personality. Malia's group tended to be high-achieving students who are perfectionistic in nature and very detail oriented. Nate's group consisted of energetic athletes who were highly imaginative and playful. Michael's group was a mixed group consisting of members who shared characteristics of high-achievers similar to Malia's group and the energy of Nate's group. Haylee's group members were shy, introverted, and reluctant participants.

Behaviors that align to multiple flow components throughout each scenario appeared, strengthened, and disappeared at various intervals reflecting what was observed during this study. In this particular study, the self-selected student groups manifested some of the flow component behaviors more prominently than other components. Malia's group, along with the components of a balance between perceived skills and challenges and high interest, consistently demonstrated intense focus and a high need to control the direction of the project. This suggests a correlation to what might be expected of the personality of someone who is a high-achiever, goal-oriented, and pays attention to detail.

Nate's group presented elements such as the balance between perceived skills and challenges, focus, and goals. In addition, they revealed stronger and consistently prevalent behaviors of high interest and an autotelic experience for this group. Nate's group fully embraced the role play of working as a new business trying to design, manufacture, and market a product. They took their roles seriously and found a sense of fun in every challenge. Their enjoyment derived not only from getting to play the roles, but the fact that they had the control to design how they played those roles, what they were doing each day, and what the final project would be. The assignment became very empowering to them and fostered capacity to use the learning and interpersonal skills acquired in new contexts in the future.

Michael's group exhibited many of the flow component behaviors as the previous two groups with one difference. Michael's group manifested an intensity similar to Malia's group regarding focus, but to such a degree that it created a situation where a distinct loss of self-consciousness and a perceived distortion of the passage of time occurred. The students did not want to leave class, did not realize they were fifteen minutes into the next period, and were focused on their goal of accurately calculating, measuring, and completing the cuts for their hexagonal speaker box project.

The first three scenarios present important conclusions to consider. The first conclusion is many flow component related behaviors were present and observable in this Maker Space classroom. Second, as flow is individualistic and an internally experienced phenomenon, some flow component related behaviors may have been present, but not readily observable. Third, each of the nine flow components revealed themselves in student behavior on their own timetable during the course of the session and often in combination with other flow components. Fourth, the appearance of some stronger student behaviors related to flow components during the course of a session as they relate to a specific group of students seemed to align with the perceived personality of that group. And, finally, the conditions of this classroom environment including teacher interpersonal skills and curriculum design contributed to students being able to exhibit flow component related behaviors that lead to flow, but not all students.

The fourth vignette reflects the small proportion of students observed in this classroom who did not respond to the learning situation in a way that reflected either flow components or engagement. The students in this scenario (Haylee, Beth, and Shana) had low interest in the project and low interest in the class. Their goal was to finish the project with minimal effort and to meet the minimum requirements so that they could get a grade. Comparing the four speaker box projects in the observed classroom their project would be the simplest in form and an obvious standout revealing minimal effort.

Evidence suggests that low interest in the class negatively influenced the engagement of each of these students. They manifested fewer flow component related behaviors that would lead to flow. Along with the anxiousness of not knowing what to do, and the subsequent boredom of having hit an impasse with their project, these students shut down and either talked the whole period or found a mindless activity to do such as flipping the sanding block. The students in this scenario also shared personality characteristics such as introversion that may have contributed to the limiting of an overall potential to exhibit behaviors associated with flow components in this learning environment.

The additional consideration of the fourth vignette adds an important nuance to the understanding of flow and engagement in this Maker Space. Regardless of group, several observed flow component related behaviors played key roles to varying degrees in engagement: the balance of perceived skills and challenges, interest in terms of having immediate goals, the paradox of control, focus (concentration), a distorted perception of the passage of time, loss of self-consciousness, and an autotelic experience. When a balance between perceived skills and challenges was high, interest was high, a sense of control was high, and focus was high, the students remained engaged and reported having had fun (autotelic). When perceived skills and challenges were out of balance, and in the situation with the students from the fourth vignette where interest was low, other flow components did not manifest themselves. These students moved away from flow and became more disengaged from the learning process.

6.2 IMPLICATIONS FOR PRACTICE

The expectation for flow to occur all the time, every day is unrealistic. Shernoff (2013) recognizes this limitation in his most recent research. The evidence gathered from this Maker Space classroom suggests that in this instance, providing a learning environment that strongly considers fostering the existence of components leading to flow in the students of that classroom appeared to lead to higher engagement for most students that is meaningful and could be supportive of learning. Future studies could explore the role curriculum and instructional delivery could have in enhancing a learning environment where opportunities for students to exhibit components that lead to flow.

The insights gained in this study imply that there are certain practices that can lead to this end. Establishing a teacher mindset where s/he engages students while consistently having the awareness of the need to maintain that balance between the students' perceived skills and the challenges that classroom content provides could be a future area for exploration. This balance occurs on many levels and would be realized in different classrooms and content areas in many different ways. The basic premise remains the same. At the curricular level, educators and researchers could review how curriculum is designed to experiment with how a relative balance between the skills the students entering the classroom and the challenges the curriculum creates for those students approximate the abilities of those students. This concept of balance is not new. It closely relates Vygotsky's zone of proximal development (Smagorinsky, 1995). In order for a teacher to observe for variations of skills and challenges such as too high of a challenge leading to anxiety and too low of a challenge leading to boredom, a need exists for exploration of instructional design that could contribute to greater understanding of this balance in real-time instruction. Finally, I observed that individual student intervention during instruction in this instance was important to either challenge individual students when needed, or to mitigate the frustration to a manageable level for the student to succeed when challenge is too high. Future professional development for educators to recognize the dynamic of balance during instruction and to develop interactive techniques that help to maximize the benefit of this flow component, has the potential to show promising results in subsequent classroom engagement.

Equally important is the paradox of control. The one component that students strongly emphasized as being the difference between the Maker Space DREAM Factory class and other classes is control and the flexibility that comes with that control. Students recognized that control over aspects of the learning that occurred in the classroom did not equate to absolute freedom. They understood the parameters that were set by the teacher to both ensure safety and to adequately guide them through the learning process. In this situated study, control fostered interest as the students were able to tailor their assignment to more closely align to their interests.

The maintained balance between perceived skills and challenges, the paradox of control, and heightened interest established conditions that led the students to be able to more readily and willingly set immediate goals in the action of engagement. As observed, when multiple components of flow became apparent, other components of flow such as a loss of self-consciousness and the distortion of the perception of passage of time emerged to an observable state in some situations. Moneta (2012) observed the phenomenon of antecedent and emergent components of flow where some components of flow contribute as antecedents to create a flow state while other components emerge as a flow state is reached by the participant. Researchers and educators alike may consider exploring further the ways to recognize and foster antecedent flow components in a classroom setting to discover the prevalence of subsequent emergent components. Furthermore, the framework of antecedent and emergent flow components could be developed as a means to consistently gage the degree of engagement occurring in a learning setting.

6.3 IMPLICATIONS FOR MAKER PRACTICE

The integration of the Maker Movement into schools has potential impact on instruction and learning. There are many characteristics that have made Maker Spaces successful that are problematic in formal education settings such as voluntary versus compulsory participation, grading, and the subject/class structure of schooling. These examples highlight the challenges of integrating Making into formal education due to fundamental differences between formal and informal education. Students are preparing for future academic and social challenges and interactions as they learn concepts and develop skills, practicing them in learning environments, in both traditional and Maker Space learning environments. The hope is these environments will help them to become fully functioning adults and positive contributors to society. Schools, and learning environments within and outside of school, become the virtual reality for the game of life where students play out their roles in hope of mastering new levels of academic and social success.

Maker spaces are environments both within and outside of the public-school system dedicated for creativity, problem solving, craft and skill development, and learning through experimentation and play (Moorefield-Lang, 2014). An essential component to learning is engagement in the learning process. If changing the conversation from one that informs learning based on school design to a conversation that designs learning to inform schooling, engagement needs to be an integral part of that design. The challenge becomes the ability to recognize engagement that leads to learning in a variety of learning contexts and contents, both in informal learning environments and formal learning environments.

This study was an embedded study within the larger University of Pittsburgh's CEAC-NSF initiative. It focused on one Maker Space, technology education classroom of eighth-grade students. The site for the study, Elizabeth-Forward School District, was chosen in part because it is a traditionally designed school with a fully-functioning, successful Maker Space program integrated in the traditional program and footprint of the school. The premise of the choice of site for this embedded case study was that if flow components were to reveal themselves in a middle school Maker Space classroom, this school would be a location where this phenomenon might be most prevalent.

Maker Spaces exist in schools throughout the United States and in many places in the world. Many questions remain unanswered as to factors such as the assessment of student engagement and to what degree is engagement voluntary versus compulsory. Assessment of student performance is another factor that challenges educators as to how to evaluate student performance in a semi-structured learning environment. Another factor at play is the impact of the difference between a traditional learning environment and a Maker Space environment on the student as s/he experiences these divergent class structures during the course of the same day. Finally, an additional factor is whether the student engagement (in either a traditional or a Maker Space classroom) is meaningful engagement that engenders both an academic intensity and an emotional response. This study suggests the development of a framework of understanding through the use of flow theory that attempts to address primarily the last factor of student engagement.

Therefore, this study has implications for Maker practice by suggesting a means to gain new insight into student engagement in the non-traditional, semi-structured environment of a Maker Space. This insight is based on the premise that engagement is meaningful where academic intensity and an emotional response are present. The framework designed to enlighten as to what degree and how engagement manifests itself can be understood through the lens of flow theory. Maker Spaces are environments dedicated for creativity, problem solving, craft and skill development, and learning through experimentation and play (Moorefield-Lang, 2014). One ideal goal of the learner in that environment becomes one where s/he seeks the "ultimate experience" that accompanies the process of creating something original or solving a previously unresolved conundrum. This "ultimate experience" is synonymous with flow. One ideal goal of the educator or facilitator of learning is to provide the conditions for the student to reach that goal.

6.4 LIMITATIONS

The conclusions from this study observed for flow components in a very specific learning environment. The study observed eighth-grade students in a technology education class serving as one of three classes in a six-week rotation as part of an integrated Maker Space in a suburban, traditional middle school in Southwest Pennsylvania. This study was particularistic and not intended to be generalizable to other content areas, grade levels, or demographics. Not all Maker Spaces are the same. Even Maker Space classrooms within the same building can vary in many different ways such as student expectation and environmental complexity. One goal of this study was to find a means to observe behaviors that lead to or from meaningful engagement in a way that uses flow theory as a platform to generate insight to an individual site's phenomenon.

Limitations exist as a limited knowledge base on the subject for educators. Previous research did not yield strong results in capturing flow on a consistent basis for a majority of students in traditional classrooms (Shernoff, 2013) Classrooms with a traditional instructional framework and structure may not lend themselves to recognizing or fostering components of flow in students in that type of learning setting. The re-emergence of constructivism in education over the last decade has contributed to teaching practices in some content areas that allow for developing student capacity and collaboration. Nevertheless, current educators do not have the knowledge or understanding of engagement in the context of flow components to internalize a framework of understanding from which they can adequately practice fostering engagement in their students. Or, as in the teacher and student teacher who participated in this study, they naturally and skillfully practice fostering engagement in their students using techniques that align with flow components without the self-knowledge of what they are doing or how it works. Recognition of the underlying mechanisms could only help them to further develop those skills and support more meaningful engagement of their students.

Another limitation exists in relation to the students' understanding of their own learning process. Traditional schools modeled after early twentieth century industry conditioned students over the last several decades to a style of learning that reflects the measurement of learning as the subtraction from a perceived perfection. Assessment of skills and knowledge are often based on the subtraction from a 100% score. Success is based on what percentage of the knowledge or skills acquired and what percentage s/he failed to acquire. The introduction of a learning approach that is constructivist where learning is built on the challenging of previously acquired skills with the attainment of new knowledge has merit. This approach may be an unfamiliar one to them. Students may not possess an underlying framework of understanding of this approach to learning, let alone the lexicon to explain it. The eighth-grade students who participated in this study were introduced to the idea of flow by the attempt to draw a parallel to similar experiences outside of school. Most students were able to make that connection to experiences they enjoyed in sports or the creative arts. Apart from the in-school experiences in DREAM Factory they were limited as to finding parallel experiences in other classes. The self-knowledge of recognizing in a learning situation whether the challenges are too hard or that they are not being challenged enough and are bored could help those students to gain more control over their own learning. The self-knowledge that comes from awareness of how they experience the ability to focus on a project, their level of interest, their experience of losing track of time, or their level of enjoyment could empower them to gage and redirect their own learning. None of this would be possible without students developing a related lexicon and framework of understanding designed for their level of comprehension.

This exploratory study revealed several potential areas for further research. The parameters of the study limited the generalizations that can be made outside of the sample of students. Therefore, further study needs to be conducted to observe for findings that would either support, refute, or enhance what was found in this exploratory research. Specifically, replication of this study in Maker Spaces integrated in middle schools could reveal patterns of findings to embolden or refute positions and enlighten the direction of utilizing flow components as a means to understand engagement. Research should not be limited to middle schools as students of different age groups and maturity levels could present different results than what would be found at the middle school level.

This study was conducted with students who are from a suburban/semi-rural, primarily working-class population. The majority of students were Caucasian with only one African-American student and one student of Asian descent. This racial composition reflects the reported demographics of the school. A study that would take into consideration different socio-economic backgrounds and diverse racial and cultural demographics could add depth to the understanding of how students experience and report components of flow in a Maker Space classroom.

6.5 QUANTITATIVE INSTRUMENTATION

Previous studies of flow in learning environments used both quantitative and qualitative methodologies. There are many options to choose from in flow research to discover flow components in a learning environment and how these components could relate to engagement in a Maker Space utilizing quantitative instruments. The Flow State Scale-2 (FSS-2) or the Flow Disposition Scale-2 (DFS-2) are two examples available through Mind Garden (Jackson, 2010). These first inventory (FSS-2) measures the occurrence of flow as reported by the participant soon after having an experience. The intention is to discover the components of flow as they may have manifested themselves during that particular experience. The second inventory (DFS-2) is designed to provide insight to the feelings and thoughts a participant may experience during participation in a designated learning environment. A third option is the Observational Log and Assessment (OLE-OLA) designed by Shernoff (2013). This instrument allows for the analysis of video recorded observations that can be analyzed based on coding categories and subcomponents. The characteristics analyzed include environmental complexity (a measurement of the combination of environmental challenge as in high task challenge and expectations for mastery, to the supportiveness found in relationship, emotional, and motivational support) and other characteristics that closely align to the original nine components of flow.

A quantitative method to include in consideration of future research is the Experiential Sampling Model (ESM). The ESM allows for the researcher to gather real-time data of flow as the participants are interrupted in the middle of an experience randomly by a signaling device. When interrupted, the participant completes a short survey that is later analyzed for flow. The model, itself, has advantages and disadvantages. While real-time data is gathered, the flow process is interrupted (Shernoff, 2013). Available instruments could support studies that use mixed-methods and add depth to the understanding of flow and engagement in Maker Spaces and other learning environments.

6.6 FURTHER STUDY

Taking into considerations the limitations of the study, further research is necessary to better understand the phenomenon of flow and engagement. The most apparent areas of continued research include the replication of the study in similar Maker Spaces, the experimentation with methodology while conducting research on flow and engagement, and developing research that would reflect different perspectives on flow and engagement by various stakeholders in the learning environment.

6.6.1 Replication

This study was limited by the content taught (technology education), by the age of the students (grade eight), the geography of the study (Western Pennsylvania), and other factors such as limited socio-economic and racial diversity. First, this study could be replicated in other school integrated Maker Space technology education classes to explore the insights gained from these future studies and compare them to the insights garnered from this study. Replication of the study into non-technology education Maker Spaces could provide insight as to how flow components manifest themselves similarly or differently depending on the content of the classroom. This study could be conducted in non-integrated Maker Spaces to discover insights of how engagement in terms of flow occurs in a Maker Space that is not closely associated with the structure of a school setting. And, finally, similar studies could be conducted with students at different ages to better understand how flow components play out in a learning environment for students at different points of development.

6.6.2 Methodology

This study was a qualitative study using data collection including observation, student focus group interviews, and teacher interview. Insights were conveyed using narrative inquiry techniques. The insights from the evidence suggested more evidence became apparent through observation and the student focus group interviews and less from the teacher interview. Replication of this study using similar data collection techniques could help to provide insight into what data collection techniques are the most effective in contributing to the outcome of the study. Future studies could expand to include a mixed-methods approach where data collection employs one or more of the previously mentioned quantitative tools from the last section. Finally, there are innumerable means to approach the study of flow components as they reveal themselves in a learning environment that could add to the body of learning through different lenses.

6.6.3 Perspective

The intent of this study was to discover from the student perspective if flow and its components occur in the Maker Space to which they are enrolled, in other classrooms, and outside of school. The teacher interview conducted provided insight that suggests that in this case more evidence could be gleaned through observation and student focus groups than from the teacher interview. Many factors may contribute to this insight. The teacher and his student teacher were unaware of flow theory and the components during the study. Several studies could be developed from this new information. A study could be designed that would explore flow components and how the manifest in students solely from the perspective of the educator. A further study could be designed where classroom engagement is evaluated using flow components as a framework both before and after professional development is provided to educators regarding flow and its components. Another study could be designed where students, themselves, are educated in flow and its components at their level. Data could be gathered to evaluate changes in engagement in the classroom for these students. Finally, many studies could be constructed to shed new light on the understanding of flow and its components and how the understanding of flow by the stakeholders of the learning environment could change the manner and degree of student engagement.

6.7 CONCLUSION

Flow is many-faceted with nine components that manifest themselves with fluidity over short periods of time. It is for this reason that flow challenges the researcher. Nevertheless, this study demonstrated that the components of flow can be observed, recorded as data, and can provide revealing insights as to how flow correlates to engagement in a classroom environment. Furthermore, in this non-traditional Maker Space classroom, flow components revealed themselves in students with frequency and varied among the four groups of students within that classroom. Further study is necessary to gain new insights to the role flow plays in student engagement.

7.0 IMPLICATIONS FOR RESEARCHER PRACTICE AND FUTURE STUDY

I have a distinct memory of myself as a small child playing in the backyard of my home in my small town, swinging on swings, creating stories, learning. About August of the summer before third grade, the swing stopped swinging and dread of going back to the very controlled environment of East Ward Elementary School turned my heart cold. I remember counting the years until I could graduate high school at that time and feeling imprisoned in my own life. Fast forward to Fifth Grade, a Language Arts teacher gave me my first opportunity to choose the direction of my learning: to read a book and do a five-minute book report on why the book is important to me. The book was Richard Bach's *Jonathon Livingston Seagull*. The premise of the book was a seagull who did not fit in with the other gulls and did not see value in learning what he was expected to learn in regard to flying like a gull, fighting like a gull, and eating like a gull. He found value in looking beyond the expected, exploring, taking risks, acquiring new skills, and discovering beauty beyond the standard and the basic.

The theme of looking beyond the standard continued when I left the country at eighteen to learn a new culture and language in Quito, Ecuador. I extended this theme later in life through inspiring high school students to learn Spanish and to travel and to make genuine attempts to discover a world beyond the one the Southwestern Pennsylvania world they had only known. Past students traveled with me to Costa Rica, Mexico, and the Caribbean. Many previous students since then expanded their worlds by learning new languages and exploring cultures. Yet, back in Pennsylvania inequity in educational access played a strong role in public education.

The early 2000's brought the attempt of our country to standardize education so that every student would at least be brought to a minimum standard of learning performance. I spent many years writing grants and designing curriculum to integrate technology for all students, provide remediation for students who could not reach the standard, and to prepare students and teachers for the standardized state assessments. Though noble in effort, there existed some underlying albatross that made me feel dead inside. The turning point for me was when as assessment administrator I was consulted by one of the elementary principals and her guidance counselor because one of their fifth-grade students was having panic attacks every day that escalated as the standardized testing dates grew nearer in time. I had to ask myself if we, as educators, had lost our way. Learning should be joyful. Learning should not be threatening.

I embarked on this doctoral level journey to search for a means to find a structure for learning that was joyful and meaningful. I eventually discovered Dewey constructivism and began to understand that intentionally or unintentionally the path American schools forged was based in logic that paralleled industry. American education, contrary to Dewey, metaphorically created perfect cogs to be pushed through school and assembled into society. Damaged or poorly manufactured cogs were tossed aside. This didactic approach favored the few and subjugated the masses. Learning and schooling can do better. When we educate each child, we can empower them, we can build capacity for them, we can change the whole trajectory of their lives. Unfortunately, our society and the educational institutions are conditioned to perform in a traditionally industrialist manner.

Maker Spaces provide one means for which educational researchers can explore a non-traditional learning environment that is intended to be constructivist in approach. The learning I observed in the classroom of DREAM Factory built upon the existing skills of the students infused with knowledge and skills learned in previous classes, and culminated in new learning growth. Learning was structured, but flexible. Students were responsibly in control of their own learning. Students were engaged with intensity, but were having fun. Learning was meaningful for them in a positive way.

As educators, we are adult learners in a long line of adult learners over centuries trying to find a way to make learning accessible and more meaningful for the generation that follows us. This study on exploring how engagement is described by eighth grade students in the context of the components of flow theory is a minor study among many. Nevertheless, I hope that it serves even in a small way to make a significant step in progress for our students. In practice, I plan to continue finding ways to explore the incorporation of flow components to instruction whether it is in classroom delivery, the provision of professional development, or as a consultant, researcher, or as an administrator.

Challenges abound for educators to adapt to a constructivist approach. Teacher preparation and existing teaching practices condition them to an education system that is grounded in a standards-driven, didactic, and industrialist foundation. Assessment and evaluation becomes one looming question. Csikszentmihalyi and flow theory suggest an opportunity to address that question. The nine components that contribute to a flow experience may provide a means for educators to observe for authentic and meaningful engagement in real time. Even though observing for nine components in student engagement presents a challenge, there is promise in observing for some of the most revealing components such as the paradox of control, a skills-challenge balance, focus (concentration), interest (immediate goals), and enjoyment (autotelic). Other components such as time distortion and loss of self-consciousness may concurrently reveal themselves and enrich the experience.

The experience of researching and preparing for this dissertation during the last few years led me to many flow experiences where I found myself completely immersed. Hours would pass without realization (time distortion), concentration was often very high to the exclusion of the perception of what was happening around me. The autotelic experience for me supported Csikszentmihalyi's point that it is often reflective and not perceived during flow. The process of research became addictive. The more I researched, the more I returned to it. This behavior in myself supports the research that the more flow experiences one has, the more desire the participant has to repeat the experience.

Hopefully this study and others like it will help to influence policy in a progressive way that will consider the tenets of constructivist learning as viable options for incorporation into the greater educational system. Giving voice to the components of flow and how singularly and together they relate to engagement as it supports learning will assist this progress. Future study of flow theory and its relationship to engagement in learning will serve to enrich the learning process and ultimately the joy of learning.

APPENDIX A

FLOW AND ENGAGEMENT CLASSROOM OBSERVATION

Observations of a classroom of student participants in the DREAM Factory (an E-F Maker Space class) and engagement as observed in the context of the nine elements that lead to a flow experience. The observation instrument is designed to include multiple opportunities to record flow indicators as they might occur in each student by time of occurrence, the activity involved, and a description of the activity. The following components will be noted (coding in parentheses): The balance between skills and challenges (Balance); Disengagement manifesting as boredom (Boredom); Disengagement manifesting as anxiety (Anxiety); Intense focus on the task (Focus); the appearance of anticipatory behavior as feedback is provided from the environment (Feedback); the appearance of goals while completing a task (Goals); a loss of self-consciousness (Loss of Self); evidence of not being distracted by the environment (Merging); exhibits calm with a lack of concern for mistakes or failure (Control); Appearance or expression of a misperception of time passage (Time); and, the appearance or expression of enjoyment of the activity (Autotelic).

FLOW COMPONENTS	Name	Time	Activity	Description
Key Codes:	**Balance; Boredom; Anxiety; Focus; Feedback; Goals; Loss of Self; Merging; Control; Time; Autotelic**			

Figure 12. DREAM Factory Classroom Observation Instrument

APPENDIX B

SEMI-STRUCTURED TEACHER INTERVIEW—FLOW AND STUDENT ENGAGEMENT

This semi-structured protocol will begin by asking all teacher participants from the DREAM Factory who are instructing the student participants the same core questions with interviewer(s) asking follow-up questions that build on the responses received. This will allow us to capture those aspects of the program that are the same as well as investigate surprising or unexpected differences that come up in the conversations. The teacher(s) will be asked several questions pertaining to student engagement. The responses will help identify the presence or absence of flow components and elements of engagement/disengagement in the student experience as observed by the teacher.

1. Student engagement

1.1. How are the middle school students assigned for participation in the DREAM Factory? *(coding: locus of control; action-oriented; challenge mastery)*

1.1.1. Prompt: Do students get to choose to participate? How does that work?
1.1.2. Prompt: Are students invited to participate?
1.1.3. Prompt: What do students need to do to be considered for this program?

1.2. Could you describe a typical DREAM Factory student? *(coding: goals; focus; merging of action and awareness)*

1.2.1. Prompt: What about an atypical DREAM Factory student?
1.2.2. Prompt: Can you describe what the students are like when working on a project?

1.3. What happens when students become bored or frustrated with a project? *(coding: balance of skills and challenges; disengagement behaviors)*

1.3.1. Prompt: Do some students find it too difficult? Too easy?

1.3.2. Prompt: What do the students do, then?
1.3.3. Prompt: Does it become a pattern for any students?
1.3.4. Prompt: What happens next?

1.4. Do students ever lose track of time while working on a project? *(coding: distortion of time)*

1.4.1. Prompt: Have you noticed if they leave class saying they wish they had more time?
1.4.2. Prompt: Does the opposite happen? Do some students express that the class is long? *(boredom)*

1.5. What do the students need to do for this class? *(coding: paradox of control)*

1.5.1. Prompt: Do the students get to choose projects?
1.5.2. Prompt: How are deadlines decided?

1.6. Are students enjoying the class? If so, why do you think they enjoy it? *(coding: autotelic experience)*

APPENDIX C

FLOW AND ENGAGEMENT STUDENT FOCUS GROUP PROTOCOL

Focus group of student participants to describe their experience and participation in DREAM Factory (an E-F Maker Space class), and how this experience equates to experiences in other classes and in activities outside of school.

Welcome/Introduction/Purpose

Ground rules:

There are no right or wrong answers to our questions, only different opinions. Because we need to record this, we can only have one person speak at a time, so we'll be taking turns to help us hear the answers better on the recording. You don't need to agree with each other, but you must listen respectfully as others share their views. You will have a chance to add your opinion as well. Although we'll be using your first names here, they will not be recorded in the transcription or in any reports – you will be anonymous. If you have a cell phone, we ask you to turn it off for the time we are together.

Characteristic Data:

1. *How old are you?*

2. *How long have you attended Elizabeth-Forward School District?*

Opening/Ice Breaker

3. *What is your favorite class this year? Why?*

4. *I am going to read a few quotations to you and ask you some questions about what you hear that may or may not apply to you.*

Sample Flow Experiences

> I am so focused—in the zone. I am not thinking of something else. I am totally involved in what I am doing. I feel good. I don't seem to hear anything else going on around me. It is like the rest of the world doesn't exist. It is like I get to escape for a moment from anything I am worried about.
>
> I am so focused, is like breathing in that I don't have to think about it. When I am into what I am doing, I really do shut out the rest of the world. Nothing really distracts me, then.
>
> I am so involved in what I am doing, it is like I am part of the action.

Maker-Space Experience

5. *Have you ever felt similar experiences to the ones that I read to you while in the DREAM Factory?*
    a. *Prompt: When?*
    b. *Prompt: What were you doing?*
    c. *Prompt: What were you thinking at the time?*
    d. *What were you feeling?*

Outside of Maker-Space Experience

6. *Have you experienced something similar outside of Dream Factory?*
    a. *Prompt: When?*
    b. *Prompt: What were you doing?*
    c. *Prompt: What were you thinking at the time?*
    d. *Prompt: What were you feeling?*

7. *What about other times? Have you experienced something like I described in other places?*
    a. *Prompt: When else?*
    b. *Prompt: Where else?*
    c. *Prompt: In school?*
    d. *Prompt: Outside of School?*
    e. *Prompt: What were you doing?*
    f. *Prompt: What were you thinking at the time?*
    g. *Prompt: What were you feeling?*

8. *Is the DREAM Factory experience different than other school experiences? How?*

Deeper Knowledge Flow Components Based on Observation

Additional question will explore deeper meaning to the experiences of the participants drawing from observations of the participants in the DREAM Factory learning environment. Questions will be designed to elicit responses indicating the presence or absence of observable flow components and engagement/disengagement behaviors (examples listed below):

9. *[Jackie], when you were working on [X] you seemed very focused. What were you feeling? What were you thinking? What do you remember was going on around you at the time? Did class time seem shorter, longer, or about the same to you?*

10. *[Michael], when you were learning about [Y], I noticed that you were looking at your phone a lot and were having difficulty sitting still. What were you feeling at the time? What were you thinking about? Did class time seem shorter, longer, or about the same to you?*

11. *[Alyssa], when you presented [Z] to the class yesterday, what was that experience like for you?*

12. *When you were working on […..] did you feel focused on what you were doing? Was it too difficult, too easy, or about right for you?*

13. *Do you enjoy what you were doing? What about it is or is not enjoyable?*

APPENDIX D

FOCUS GROUP CODING FOR EMERGENT THEME DEVELOPMENT

Jeffrey T. Zollars

Title: Flow Theory and Engagement: Observing Engagement through the Lens of Flow in a Middle School Integrated Maker Space

Aims:

The aim of this inquiry is to explore engagement as it occurs in the sample of middle school aged students situated in a learning environment of a Western Pennsylvania public school with an integrated Maker Space from the student perspective.

Inquiry Questions:

- How do middle school students describe their experiences in the DREAM Factory?
    - How to the students describe this experience as being similar to or different than their experience in other classes?
    - How do students describe experience in the DREAM Factory compared to their experience in other similar activities in which s/he participates during her/his time away from school?
- Do students' self-reported experiences in the DREAM Factory, in other classes, or during an outside-of-school activity evidence engagement that aligns with elements of flow theory?

Focus Group Interview Potential Responses to Questions:

The focus group interview questions will seek to uncover the following student perceptions of her/his engagement. The codes are based in the componential model created by G.B. Moneta

(2012) and previously developed nine flow components by M. Csikszentmihalyi (1990). The potential student responses and their corresponding codes and relationship to whether the response indicates a movement towards flow (F) or away from flow (NF):

Emerging Code	**Pre-Existing Theme in Literature**	**F or NF**	**Participant Response**
Focus	The participant enters into a mental state of concentration.	F	'I really have to concentrate on what I am doing' 'I am totally focused'
		NF	'I sometimes work on…while in class' 'I get really distracted' 'It is hard for me to keep working on it sometimes'
Goals	The participant understands immediate goals which can be negotiated in the moment of action.	F	'I am going to do …, then, I need to do….' 'If …happens, I …'
		NF	'I do not know why we are doing…." 'It does not seem to have a point' 'I do not get it'
Feedback	An internal understanding of what works and what does not work in the context of the activity.	F	'I feel like I am in the zone'
		NF	'I get confused on how it works' 'I am not sure of what to do if it does not work'
Balance	When the self-perceived skills of the participant are in balance with the degree of challenge presented.	F	'I can do this' 'It makes me think' 'I have to work at it, but I understand it' 'It is hard, but not too hard'
		NF	'It is way too easy' 'It is way too hard' 'I am bored' 'It stresses me out'
Control	The participant lacks a sense of worry about losing control of the situation exhibiting a sense of calmness.	F	'I feel like I was in control' 'It is as if I am doing it, but it is happening by itself somehow' 'I feel like nothing can go wrong' 'If it does not work, I figure out how to fix it'
		NF	'I cannot do it' 'It would work for me if it were not for…' 'It stresses me out'
Merging	When high concentration does not allow for left over attention to the needs of self. The result is the participant becomes part of the	F	'I feel totally involved' 'I did not realize…was going on, too' 'I do not know what…was doing' 'I was not paying attention to anything else'
		NF	'I spend a lot of time thinking about [anything else other than the activity]'

	environment. Action and awareness merge.		'I talk to my friends a lot' 'There are so many things going on in class I do not really get a lot done'
Autotelic	The participant enjoys the activity for its own sake and not for the extrinsic reward.	F	'I just like doing it' 'I really do not care what grade I get on it' 'It is fun'
		NF	'If I work hard on it, I will get a good grade' 'We get….if we do a good job'
Self-Consciousness	The absence of self-scrutiny results in the loss of self-consciousness.	F	'I feel like nothing else matters' 'I don't care what anyone thinks' 'If I mess up, it does not bother me'
		NF	'I am afraid of what people might think' 'I do not like other people to see what I am working on'
Time	The participant either perceives a loss of time or the slowing down of time due to intense concentration.	F	'This class goes by so fast' 'I thought I would have more time' 'It was as if everything was happening in slow motion'
		NF	'I get bored' 'This class seems to go on forever'

Focus Group Interview Analysis:

The data collected will be coded using a deductive approach. Predetermined codes within the data collected are based upon the themes within the literature. Coded data from the focus group interviews will be triangulated with coded data from the classroom observations and the semi-structured teacher interview to observe for patterns that lead to emergent themes.

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