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Methods of Creating an Effective Self-guided Mathematics Classroom

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METHODS OF CREATING AN EFFECTIVE SELF-GUIDED MATHEMATICS CLASSROOM

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Abstract

There are a variety of ways to offer student-centered learning, self-guided is the one this literature review examined. Through research, a classroom with a self-guided system should include a way for students to access new content without needing the instructor. There should be a way to practice the new skill(s) and check their understanding with formative assessments. These assessments should be self-graded, so the students get immediate feedback. It is also beneficial for students to use the content to collaborate with peers and/or play games to solidify the newly acquired skill(s). During all of this, the students should have the ability to choose where they want to sit within the classroom, possibly with nontraditional furniture options.

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CHAPTER I: INTRODUCTION

Picture a typical classroom from your high school days. Did you picture columns of desks all facing towards the front of the classroom with a chalkboard, whiteboard, or SMARTboard adorning the wall? Unfortunately, the type of board is all that distinguished what era you attended high school. The standard classroom arrangement in middle school and high school really has not changed much since the one-room schoolhouse model of the 1800s. However, classroom instruction has come in many varieties.

In the last decade, education has started shifting from teacher-centered classrooms to student-centered classrooms (Aslan & Reigeluth, 2015). The idea of allowing students to learn at their own pace may seem like a new concept that arrived with technology. However, on record is the use of a self-paced education plan, called the Pueblo Plan, occurring in Colorado from 1884 to 1894 (Januszewski, 2001). The Pueblo Plan involved the whole group sitting through presentations of basic ideas and then individually, the students were to complete a sequence of lessons (Januszewski, 2001). In 1912, creators Frederick Burk and Mary Ward sold self-instructional booklets for "arithmetic, geography, history, language, and grammar for the kindergarten through the eighth-grade" (Januszewski, 2001, p.59). Through this Burk System, students could progress on to the next grade as soon as they completed the subject work for their current grade (Januszewski, 2001, p.59). Self-paced education was tried again in the 1920s by Carlton Washburn with the Winnetka Plan. Washburn described his plan as:

> A general technique [consisting] of (a) breaking up the common essentials curriculum into very definite units of achievement, (b) using complete diagnostic tests to determine whether a child has mastered each of these units, and, if not, just where his difficulties lie

> and, (c) the full use of self-instructive, self corrective practice materials. (as cited in Januszewski, 2001, p.61)

Educators have been attempting to put individualized, self-paced systems into place almost since the birth of grouping students into grades happened in the American school system (Coxe, 1931). None of these attempts really succeeded, possibly due to the costs and overwhelming amount of time needed to manage a system of individualized learning (Kerr, 2017).

With the introduction of one-to-one devices for students, where each student has a device dedicated to his or her learning, the self-paced system became more feasible. The push for self-paced learning has been revived and it is coming from educators. Although this system goes by many different names, such as differentiated instruction, individualized learning, or personalized learning, it still has the same purpose: helping students learn by customizing the process based on each student's needs (Basye, 2018).

Various methods of instruction can be used to create student-centered classrooms: self-directed, self-paced, project-based learning, and inquiry. In the realm of self-paced learning there are many different terms used. For our purposes, the term 'self-paced' is defined as students moving through a set of tasks within a unit at their own rate (Kerr, 2017). Then once completed, they are assessed on the tasks. If they can show understanding of the new skills on the assessment, the student moves on to the next unit. If not, they work within that same unit until they can be successful on the assessment. There is no predetermined time frame for each unit. Students move on when they are ready.

The focus of this paper is self-guided learning, of which self-paced learning is a significant part. Self-guided learning encompasses all the areas the student has to navigate as a

learner including setting goals, monitoring progress towards those goals, self-assessment, self-reflection, and making good choices in a learning environment that allows for more freedom (Boekaerts et al., 1999). The ultimate goal is for the students to become self-sufficient learners where they can work through the entire learning process without the guidance of an instructor.

Rationale

In 2016, I attended a Minnesota Council of Teachers of Mathematics conference. There my colleague and I attended a session on self-paced learning. We thought we hit the jackpot of ideas. The two of us convinced our third course-alike teacher that self-paced was the way to go. The three of us spent the summer rewriting our curriculum to allow for students to move through the units at their own pace.

A self-paced system requires different physical needs within the room. We needed stations for students to take quizzes and work on devices, furniture configurations for collaborative and individual work, and comfortable spaces for when students are watching videos. We all pulled in different types of furniture for flexible seating.

We came across some challenges, one of which was that we could not bring ourselves to allow students to do only online practice or to take quizzes digitally. As math teachers, we want students to show their work. Thus, we had to have paper assignments and assessments. However, it was neither feasible nor desirable to spend every night grading all of those practice sheets and quizzes, but it was important to us that students receive timely feedback on their work. Our solution was to create answer keys for formative assessments and leave them out for students to self-assess, so they could receive immediate feedback. We were grading for learning, so students

were not given any points for simply completing the assessments. Thus, although they had the ability to cheat, in the end, that lack of effort would show up when they took the summative assessment.

That brings me to our next challenge: how do we allow students to take the unit tests in a classroom where other students could be talking about the content and still maintain the integrity of the test? Additionally, how do we create a testing environment for students taking tests? Our best solution, as of yet, is to have silent work days every Friday. Then those who are ready to take tests can do so in a testing environment, yet it does not force students to take a test before they are ready.

Another challenge we faced was managing all the materials for multiple units at one time. To house the practices and quizzes, we had either file boxes or shelving with labels. The materials needed for hands-on games and activities were set out on the counter as needed. Without organization, a self-guided system can be daunting to manage.

Over the next three years, we improved upon our system, adding new elements that we thought were best practices. We had always had a sheet for students to track which sections of work they had completed, but we developed an approach to actually teach the students how to set and track goals. We became more intentional about teaching students how to self-assess and what to do with the information they discovered from self-assessing. A reflecting piece was added to the practice-quiz cycle, asking the students to think about their thinking, metacognition, in addition to asking students to rate themselves on how productive they were during class each day. With the changes we made, we moved our self-paced system into more of a self-guided one.

The fact that we were successfully using a self-guided system of learning in our classrooms, caught the attention of our administrators. We were asked to present the self-guided system to our colleagues on multiple occasions. Self-guided learning seemed to be beneficial to our students. However, with all the work we had put in and now we were spreading the news to our colleagues, I wanted to make sure that what I was doing in my classroom was what was best for students, based on research. Therefore, this literature review is specifically looking at what methods create an effective self-guided classroom.

Definition of Terms

The important terms used throughout this paper, are defined as follows:

Self-Guided/Self-Regulated Learning: "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behavior, guided and constrained by their goals and the contextual features in the environment" (Boekaerts et al., 1999, p.453)

Self-Paced Learning: students complete a set of tasks, test, and move on to the next set of tasks at their own pace (Kerr, 2017)

Differentiated Instruction: offering a variety of pathways to gain knowledge (Basye, 2018)

Feedback: "information provided by an agent (e.g., teacher, peer, book, parent, self, experience) regarding aspects of one's performance or understanding" (Hattie & Timperley, 2007, p.81)

Self-Assessment: "a process in which students collect information about their own performance and see how it matches their goals and/or the criteria for their work" (Andrade & Du, 2007, p.160)

Statement of the Question

This literature review will seek to provide answers to the question: What effective methods can be used to create a self-guided mathematics classroom?

CHAPTER II: LITERATURE REVIEW

According to an article in Mathematics Teaching in the Middle School, a self-guided classroom is beneficial when it contains specific components (Edwards, 2013). Students need to be able to work at an individual pace, yet still have opportunities to collaborate with peers (Edwards, 2013). The formative assessments must include a system with immediate feedback, so the students know where they are at in reaching an understanding of the concept (Edwards, 2013). Differentiation in all classrooms is beneficial, but does not need additional focus as it is inherently a part of this type of classroom (Edwards, 2013). Finally, there must be a way to measure students' progress with a summative assessment (Edwards, 2013). According to Edwards (2013), by piecing all of these components together, you will have a successful self-guided classroom.

An analysis of previous studies was conducted, specifically focusing on the first three components Edwards (2013) stated to be beneficial - individual pacing (self-guided), collaboration, and immediate feedback. Since differentiation and assessments are interwoven within the other three, their inclusion in a self-guided classroom is indirectly supported through the mentioned studies. Studies that support self-guided (Bautista, 2015; Brydges, Carnahan, Rose, & Dubrowski, 2010; de Jonge, Tabbers, Pecher, Jang, & Zeelenberg, 2015; Hsieh & Cho, 2011; Tullis & Benjamin, 2011) and collaborative learning opportunities are provided through flexible seating (Adedokun, Parker, Henke, & Burgess, 2017; Bicard, Ervin, Bicard, & Baylot-Casey, 2012; Blume et al., 2018; van den Burg & Cillessen, 2015), partner and group work (Crouch & Mazur, 2001; Morgan & Wakefield, 2012), and playing games (Cagiltay,

Ozcelik, & Ozcelik, 2015; Chang, Evans, Kim, Norton, & Samur, 2015). Immediate feedback through self-assessment is also supported by the research as a benefit to students' learning (Andrade & Du, 2007; Boekaerts, Pintrich, Zeidner, & Pintrich, 1999; Griffin, 1989; Koriat & Bjork, 2006; Sanchez, Atkinson, Koenka, Moshontz, & Cooper, 2017; Urdan & Mestas, 2006). The following research will show the best methods for creating an effective self-guided mathematics classroom.

The basic need for a self-guided classroom is a way for students to learn the material through self-guided means. Research supports greater retention of new learning when students can go at their own pace (de Jonge et al., 2015; Tullis & Benjamin, 2011; Hsieh & Cho, 2011; Brydges et al., 2010). Flexible seating allows all learners to choose what works best for him/her that day. Since students are at different points in the curriculum, the classroom may look a little chaotic, but students are learning. Working with others can deepen knowledge (Crouch & Mazur, 2001; Morgan & Wakefield, 2012), so a self-guided classroom needs to have a way for students to work together. Along with working in groups, comes the research behind playing games for learning. Games engage the students and make learning more fun (Cagiltay et. al., 2015; Chang et. al., 2015). Finally, research on immediate feedback and self-assessment will be discussed. Each section will talk about how the research ties into a self-guided classroom.

Self-Guided Learning

Will my students allocate the right amount of time to each topic or skill, if they can move at their own pace? According to a study completed by de Jonge et al. (2015), students will spend more time on what they believe to be the more difficult items. Thus, not all students will spend

the same amount of time on each skill. Time spent will be based on how hard the skill is for each student. Tullis and Benjamin (2011) found the same results, when students have control over their study time, they perform better than when students' study time is controlled by someone else. Thus, students will allocate the amount of time *they* need on each skill, not the amount the instructor thinks they need.

The de Jonge et al. (2015) study had college students learn Dutch words by pairing Dutch and English words together and viewing them for a period of time. Each student was assigned to a different group: self-paced to fixed or fixed to self-paced. The fixed rate was delivered in four ways: 24 times for one second, 12 times for two seconds, six times for four seconds, and three times for eight seconds. Results show that students on the self-paced rate had a recall rate of 70-80%. A rate of three times for eight seconds was just below self-paced with 12 times for two seconds closely in third place. The worst way to learn was fixed at 24 times for one second each, therefore quickly flipping through flashcards is inefficient (de Jonge et al., 2015).

Through self-paced, 86% of participants were able to spend more time on harder problems, they were considered discrepancy reducers (de Jonge et al., 2015). This suggests that the possible advantage to self-paced is the ability to reallocate time to harder problems. Not only were they able to adjust their time based on difficulty at the beginning, but self-paced individuals were able to "speed up the presentation rate over study cycles as learning progressed" (de Jonge et al., 2015, p. 857).

To further support self-paced learning, Tullis and Benjamin (2011) completed a study where students were given a list of words from the MRC Psycholinguistic Database to study. They were told they needed to recall the words later during a memory test (Tullis & Benjamin,

2011). The experimental group could allocate their study time based on their own needs. The control group was yoked to one member of the experimental group. The control participants' allotted time per word was based on their yoked partner's average study time per word. The same overall study time was allowed to each partner. The self-paced group outperformed the control group during the memory test (Tullis & Benjamin, 2011).

Tullis and Benjamin (2011) noticed that most subjects devoted more time to normatively difficult words. Thus, a second experiment was conducted. This time with three groups - self-paced, fixed-rate, and normative allotment, where their time allowed to view words was adjusted based on normative difficulty. The self-paced group again, outperformed the control group (Tullis & Benjamin, 2011). However, an interesting outcome was that the normative allotment group did not outperform the control group (Tullis & Benjamin, 2011). Thus, giving people a set amount of study time based on what others perceive as difficult, did not help, but hurt performance.

Research supports students learning through self-paced programs. De Jonge et al. (2015) "found that recall performance following self-paced study was at least as good as, and in most conditions even better than, studying with a fixed experimenter-imposed pace" (p. 858). Tullis and Benjamin (2011) established that "Self-pacing improved performance on difficult items to a greater extent than on the easier items" (Benefits of self-pacing section, para. 1). Thus, using a self-paced procedure in a classroom will help students recall information better than the pace the teacher sets, especially when it comes to more difficult concepts. Students being allowed to choose how long they study a new concept is an effective method to use in a self-guided classroom (de Jonge et al., 2015; Tullis & Benjamin, 2011).

De Jonge et al.'s (2015) research showed self-paced learning to be beneficial. However, they were using a computer program to teach the students new content, which is only one way of managing a self-paced learning environment. Another type of self-paced learning that Hsieh and Cho (2011) researched, is using what they called instructor-student interactive (ISI) e-learning tools. These ISI tools help teachers distribute and exchange information with their students outside of the classroom (Hsieh & Cho, 2011). They include digital classroom management systems like Moodle, Schoology, and Google Classroom. Bretz and Johnson define self-paced (SP) e-Learning tools as "computer or online learning programs that include informational resources of a course topic and assessment mechanisms for self-evaluation" (as cited in Hsieh & Cho, 2011, p. 2025). Hsieh and Cho (2011) wondered which one of these two methods, SP or ISI, was more effective?

Hsieh and Cho (2011) gave surveys to random students in the public areas of seven different higher education institutions in Hong Kong. With a complete response rate of 70%, they ended up with 445 respondents that mostly used SP and 293 that mostly used ISI in their courses (Hsieh & Cho, 2011). The respondents answered questions based on perceived usefulness, learning outcome, satisfaction, and information quality. According to Hsieh and Cho (2011), "ISI e-Learning tools dominated the SP tools in almost all aspects of the success model" (p. 2033), except information quality. This outcome supports the research done by Hattie (2018) that says teacher-student relationships have the potential to accelerate student achievement. Having ISI versus SP would allow for more teacher-student interactions, allowing a relationship to develop. The most important difference between SP and ISI is where the information is coming from - human instructors versus software programs (Hsieh & Cho, 2011).

The definition of self-paced (SP) used in the Hsieh and Cho (2011) research is not the same as the way self-paced is defined previously in this paper. For the purposes of this paper, self-paced is a system used in a mathematics classroom where students can move through the content at their own pace, spending extra time where needed. This looks like a hybrid of the SP and ISI methods from the Hsieh and Cho (2011) study. Self-guided in a secondary classroom would include teacher-student interactions, but have a system for students to obtain information and check-off the skills as they go.

How do students feel about learning at their own pace? A small study done by Inkson and Smith (2001) looked into how students felt about self-paced learning. Four students who were enrolled in a certification course where 30-40 self-paced modules were required, were observed in a Learning Centre computer lab. One requirement for the study was that the students did not have computer access at home, so no practice was done outside of the Learning Centre. The participants were observed in the lab over a one-week period, interviewed, and asked to journal about their experiences and feelings (Inkson & Smith, 2001).

Although there were only four major participants in the Inkson and Smith (2001) study, other students' opinions were asked in a larger focus group. They found that students felt like they did not have as much access to the teacher as they would like. There was only one teacher and 16 students in the room. Another problem the students found was that they just needed specific directions on how to use the self-paced learning software, not the content. In addition to needing time with the instructor, students wished the teacher would have benchmarked them to make sure they were making progress. The overall theme of the findings is that students need to

be taught how to do self-paced learning before throwing them into a self-paced curriculum (Inkson & Smith, 2001).

The Inkson and Smith (2001) research supports students wanting instructor face-to-face interaction, which would be an important piece to a self-guided mathematics classroom. In addition, students need the tools in order to "work" the self-paced system. The students in this study were not taught the skills, nor were they assessed to see if they already possessed them. The wait time on how to use the system set students back on their progress towards completing the modules. In a self-guided classroom, students will also need to be taught how to problem solve when the instructor is not available. The students in this study immediately put their hand in the air when they did not know what to do. They did not try to find the answer nor ask others in the room for help first (Inkson & Smith, 2001). Contradicting Inkson and Smith, Watson (1990) found that self-paced learning seems to develop several positive characteristics, such as self-reliance and independence, in some students. These are characteristics instructors want to build in their students.

Brydges et al. (2010) completed a study that looked at various ways tasks were ordered in self-guided learning. The participants were nursing students who needed to learn how to perform intravenous catheterization. They broke the 60 participants into four groups of 15 each. One group worked through the tasks from low, to mid, and finally high by only moving on once they tested proficient in the current task, proficiency-based students. Another group, progressive students, worked through the tasks, low to high, determining on their own when they were ready to move on. The third group was a yoked control group that followed a progressive practice schedule that was determined for them. The final group was open-ended and allowed to move

freely between the tasks. Oddly, 11 of the 15 open-ended group participants wound up moving through the tasks in a progressive manor (Brydges et al., 2010).

Brydges et al. (2010) determined that the proficiency-based group scored highest in all three areas on the immediate post-test. However, on the delayed transfer test taken one week later, the proficiency-based group showed a significant decline. The progressive and open-ended groups stayed relatively the same or increased from immediate to delayed testing. The yoked control group scored low to begin with and then declined on the delayed transfer test. Brydges et al. (2010) inferred that "the optimal format for a progressive training regime is to let students decide when to progress from" (p. 1841) one skill to the next. The researchers found that when students do not have control over moving on to the next task, there is a decline in the retention of the skill. When students had control over their progress, there is no decline in retention (Brydges et al., 2010).

Based on previously discussed research, what would the most beneficial self-guided system in a classroom look like? Students would be allowed to determine when they move onto the next skill, as they will have a better skill retention rate (Brydges et al., 2010). They should not be required to master the skill based on criteria set by the teacher, instead based on criteria set by themselves (de Jonge et al., 2015; Tullis & Benjamin, 2011). There should be human instructors, which could be on videos (Hsieh & Cho, 2011), and face-to-face interactions among students and teachers (Inkson & Smith, 2001), because having a relationship with the instructor can accelerate student achievement (Hattie, 2018). Research supports using a self-paced approach to learning. However, there are other logistics to consider when using it in a middle or high school classroom.

Flexible Seating

When students are working at their own pace, they will need to be free to move around the room at different times focusing on different tasks. What could this look like? What seating arrangement does the research say is best for students? Where students are seated in a classroom can impact their social status (van den Burg & Cillessen, 2015). Does it also impact their performance in the class? What about when students are allowed to choose their seats? How does flexible seating play a role in learning and engagement? All questions that should be considered before implementing flexible seating in a self-guided classroom.

Van den Burg and Cillessen (2015) completed a study where they looked at the likeability and popularity of 336 fifth and sixth grade students based on where they were placed in a teacher-determined seating chart. They collected data in August/September (Time 1) then again in February/March (Time 2). A standard distance formula was used based on desk locations where, from desk to desk was considered one unit. They gave the students questionnaires to fill out that asked how much they liked each classmate and how popular they thought each classmate was. The results from van den Burg and Cillessen (2015) were interesting:

> Children with a larger distance to classmates at Time 1 received lower liking ratings at Time 1 and Time 2. Thus, students who sat more toward the boundaries of the classroom were less liked than students who sat more toward the center of the classroom.
>
> In addition, liking and popularity ratings received were significantly correlated with each other concurrently and over time; children who were liked were also seen as popular and

> vice versa. Liking and popularity ratings received also correlated positively over time, indicating stability. Children who were liked or popular at Time 1 were also liked or popular at Time 2. (p. 26)

Oddly enough, teachers can play a role in how liked and popular students are simply based on where they assign students seats to be at the beginning of the year (van den Burg & Cillessen, 2015). While relationships are developing, proximity has a huge impact. Students' likeability held from the first observation to the second. The first observation was what impacted the likeability of student relationships between each other. In the second observation, however, the proximity did not determine likeability. The first seating arrangement is what affected relationships and had a lasting effect (van den Burg & Cillessen, 2015). If teachers are aware of new-to-the-school students at the start of the year, they can impact the rest of that student's year by placing those students in the middle of the classroom or close to students they know will befriend them (van den Burg & Cillessen, 2015).

Van den Burg and Cillessen (2015) added a second section to the above study to see what would happen if students choose their own seats. In Study 2, they wondered if students would place themselves closer to classmates they liked or perceived as popular (van den Burg & Cillessen, 2015)? No participants from Study 1 were also a part of Study 2. However, they were still from fifth and sixth grade classrooms.

Van den Burg and Cillessen's (2015) Study 2 was completed during the second semester, so students were familiar with each other. Students were asked to create seating charts based on where they would like their classmates to sit. They were also asked to determine the likability and popularity of their classmates, as in Study 1. When the students created the seating charts,

they “placed well-liked or popular children closer to themselves” (van den Burg & Cillessen, 2015, p. 30).

In self-paced classrooms students have the opportunity to self-select seats when they are working independently on tasks. The research done by van den Burg and Cillessen (2015) suggests that students who mutually like each other, will most likely choose to work together on a task. Even if the student himself is not perceived as popular, he may choose to work close by a student who he perceives as popular. Popular students will most likely have many students who want to work near them (van den Burg & Cillessen, 2015, p. 30).

In addition to fostering relationships among specific students (van den Burg & Cillessen, 2015), seating charts can also calm the chaos in a new classroom and aid in remembering students’ names. However, in a self-guided classroom, students are moving around the room completing different tasks at different times (Brydges et al., 2010; Crouch & Mazur, 2001; Morgan & Wakefield, 2012; Muñoz-García et al., 2013; Tulles & Benjamin, 2011). Thus, students only stay in their assigned seat for the beginning of the class. While they are working independently or in pairs, students are choosing their own seats and partners. How does that affect their learning?

Seating placement during instruction definitely affects students’ learning, according to Blume et. al (2018). They found that students learn better when seated close to the instructor. Their study placed students in one of two seats, proximal to or distant from the instructor in a virtual classroom. There were 81 participants; 34 fifth graders and 47 sixth graders. The students were taught a math lesson in the virtual classroom on number bisection, a concept the students should have been unfamiliar with. Students seated in the seat distant from the instructor

experienced the instructor at a lower volume and other students in front of him/her, to simulate sitting in the back of a real classroom. After the lesson, the students were tested on number bisection via computer, but no longer in the virtual classroom (Blume et al., 2018).

Blume et al.'s (2018) research determined that students "sitting proximally to the teacher in the virtual reality classroom learned significantly better than the group sitting further away" (p. 5). In most classrooms, there are not enough seats for all students to sit close to the teacher. However, in a self-guided classroom, with the option of watching a video for instruction, all students can be in the front row. Creating videos as instructional tools is something to consider when deciding to move to a self-guided classroom. If students are allowed to choose their own seats, they can sit in the back of the room, but still have the learning benefits of sitting in the front. Having videos can also open up the front seats for students who choose to listen to the instruction live.

Students choosing where in the room to sit is only one way to give students seating options. Another way students can have options is with flexible seating. Flexible seating is having multiple types of seating options for students such as bean bags, camp chairs, stools, stability balls, benches, couches, recliners, floor cushions, rockers, standing tables, and of course, the tradition desks or tables and chairs. Published research on the effects of seating types in primary and secondary schools is rare, but there are a lot of proclaimed benefits online from current teachers who moved from traditional seating to flexible seating ("16 Awesome," 2018). "16 Awesome Flexible-Seating Classrooms That'll Blow Your Mind" (2018) is one of many sites that claim flexible seating creates happier, healthier, and more engaged students. This site

also claims flexible seating gives students a sense of responsibility and encourages collaboration ("16 Awesome," 2018).

Although there was no research on how the more extreme flexible seating options (bean bags, rockers, floor cushions, etc.) affected primary and secondary students, Adedokun et. al (2017) looked at how flexible learning spaces affected post-secondary student learning and engagement from a student's perspective. Their study offered students couches or different types of commercial chairs to sit on during class. Through surveys and a focus group, Adedokun et al. (2017) found that students believed there were multiple benefits to flexible seating in a post-secondary setting. The seating options were adaptable for different classroom activities, specifically they liked how easy it was to reconfigure the furniture. The students liked how there were a variety of seating options and that the options were comfortable. In addition, they felt the seating options increased instructor-student interactions (Adedokun et al., 2017).

Not all comments from the participants in the study completed by Adedokun et al. (2017) were benefits. There were also challenges that came up. Some students felt there was too much furniture in the room and that once it was moved around, it looked cluttered or disorganized. Although there were students who liked the comfortable furniture, there were others who said it was too comfortable and caused them to doze off. Additionally, a few students wished there would have been more tables available (Adedokun et al., 2017). There are benefits and challenges to most practices in a classroom. Teachers have to be ready to face and overcome the challenges, if they want the benefits of flexible seating.

A study completed by Kutnick and Kington (2005) looked beyond the seats themselves at whether friends paired together would perform better on cognitive tasks than acquaintances

paired together. There were 72 participants equally divided into three groups, approximately ages five-, eight-, and ten-years old. They were asked who their best friend was in their classroom and who their acquaintances were. In groups of three pairs each, children were paired into the following categories: male friends, female friends, male acquaintances, and female acquaintances. Within each group of three pairs, there were low, mid, and high ability levels based on their teacher's rating. Each pair was assigned to complete a science reasoning task (SRT).

Kutnick and Kington's (2005) research found that "girls partnered with (female) friends provided the highest levels of performance, followed by boys in acquaintance pairings, then girls in acquaintance pairs" (p. 534). The pairing that performed the worst was when two male friends worked together. Although the data shows otherwise, when interviewed, both male and female students would rather collaborate with friends over acquaintances (Kutnick & Kington, 2005).

There are many opportunities where students pair up or work collaboratively in a self-guided classroom model. They might play a game together, check each other's homework, or keep each other on pace. Perhaps there could be assigned "study buddies". Based on the research by Kutnick and Kington (2005), it seems like the most productive and learning-focused way to create pairs is to have females choose their best friend in the class and have males work with acquaintances. Of course, this gender-specific way of creating pairings would not be presented to the students. The instructor would gather friend information from all students and create the pairings based on research, females would be partnered with friends and males would not be (Kutnick & Kington, 2005).

During Independent work time, an instructor can allow the students to move freely about the room or expect students to work quietly in their seats. Independent work time is when students have choice and are working on what they need in order to grasp, practice, and retain the concept being taught (Children's literacy initiative.). In a self-guided classroom, the students will all be going different directions to complete the tasks they personally need to finish. Although students with choice are often more on-task (Dyer, Dunlap, & Winterling, 1990), without proper direction and guidance, independent work time can get chaotic and some students can lose focus (Children's literacy initiative.). In turn, disruptive behavior can start to build. With students choosing their seats during independent seatwork, Bicard et al. (2012) found that there was more disruptive behavior than when the teacher assigned students' seats. They also found that individual seating in rows caused less disruptions than when students were seated in groups or pods (Bicard et al., 2012).

Bicard et al. (2012) looked at one private school fifth-grade classroom with 21 students, 10 boys and 11 girls. The students were given assigned seats at the beginning of each week. The assignments were given one of four ways - teacher assigned in rows, teacher assigned in groups, student assigned in rows, or student assigned in groups. The groups were groups of four with one group of five. An observer came in once a day just before lunch to record disruptive behavior.

Bicard et al.'s (2012) study should be taken into consideration when determining how to handle the independent work time in a self-guided classroom. The study considered disruptions to be anytime a student talked without raising his/her hand or touched another student that caused the other student to stop working. Thus, if during independent work time students should be silently working, then individual seats in rows assigned by the teacher causes the least

disruptive behaviors (Bicard et al., 2012). However, Crouch and Mazur (2001) found that when students work in groups, a deeper understanding is gained. The result being that there should be time given in a self-guided classroom to both working individually and with other students. This freedom will turn into the students choosing their own seats and being situated in self-selected groups. The teacher will have to decide what type of work time, individual or group, works best for each situation.

Partner and Group Work

Although self-guided requires a lot of individual time, partner or group work can add an enjoyable change to the routine. In addition, there are proven benefits to students talking with each other about newly learned content (Morgan & Wakefield, 2012). Morgan and Wakefield (2012) created a study where students were asked the same multiple-choice question twice during a lecture-formatted university physics class. A portion of the lecture was given. Then a question was asked for the first time and the results were shown to the students. After that, students were asked to find a peer, who answered differently, to talk with regarding the questioned information. The cycle ended with students being asked the same question again to see if their answer had changed after talking with a classmate. The results showed that almost a fourth of students changed from an incorrect to a correct response after having a conversation with a peer who answered correctly (Morgan & Wakefield, 2012). A little over a third of students answered correctly both times, meaning that an incorrect peer was not able to persuade them to answer differently. However, a third of students who were incorrect the first time were also incorrect the second time. The remaining 8% of students changed from correct to incorrect,

showing that sometimes peers can persuade students in the wrong direction with misinformation (Morgan & Wakefield, 2012).

As some of the results from the Morgan and Wakefield (2012) study show, peer conversations can be detrimental to learning the correct information, if perhaps the student who is incorrect is very persuasive. On the other hand, being able to move a fourth of students from incorrect to correct with little work from the instructor is powerful. It is important that instructors pull everyone together to correct any misconceptions that may have been talked about during peer conversations (Morgan & Wakefield, 2012).

If peer pairings are random, misconceptions can happen (Morgan & Wakefield, 2012). However, to avoid peers teaching misconceptions, instructors can be more intentional with their pairings. They can use peer coaches that have displayed mastery of the content as a reference for those students that are struggling (Muñoz-García, Moreda, Hernández-Sánchez, & Valiño, 2013). Muñoz-García et al. (2013) determined which students to use as peer coaches based on high pretest scores. Their study showed students paid more attention to the peer coach than a teacher and the students with peer coaches performed better on the assessment (Muñoz-García et al., 2013).

Random or self-selected peer pairings are not all detrimental. Peer conversations can happen organically by having students work with partners to answer questions or play student-directed games related to the content. Students will also be working on their decision-making and communication skills (Persky, Stegall-Zanation, & Dupuis, 2007). The students will not even know that learning is happening in the midst of the game. Having peers

conversing with each other about the content can add a beneficial piece to self-guided classrooms (Morgan & Wakefield, 2012).

Putting partner or group work into work time is something that would benefit students more than direct instruction, according to Crouch and Mazur (2001). Their research from 10 years of teaching showed that peer conversations improved students' correct responses on conceptual questions. In addition, students "performed better on quantitative problem solving, as measured on the mechanics baseline test, after a semester of Peer Instruction than after a semester of traditional lectures" (Flosason, McGee, & Diener-Ludwig, 2015, p. 319). Although a self-guided classroom does not remove the lecture portion of instruction, it does allow for many other strategies of teaching, like Peer Instruction, to take place within its structure.

Similar to the Morgan and Wakefield (2012) study, the Crouch and Mazur (2001) study's Peer Instruction model starts with a short presentation focused on only one point. Then students are given a minute or two to answer a conceptual question relating to the presented material. With their peers around them, students have discussions and are encouraged to persuade their classmates that their answer is correct and to explain their reasoning. Then students answer the same question again, changing their answer, if desired. Finally, the instructor explains the correct answer and the cycle starts over (Crouch & Mazur, 2001).

The results show, almost a third of students, 32%, changed their incorrect answers to correct answers after talking with their peers (Crouch & Mazur, 2001). Forty percent of students were correct the first time and were not persuaded by their peers to change their answer. However, 6% of the students were convinced by their peers to change from a correct answer to an incorrect answer. The remaining 22% of the students were wrong the first time around and

were not persuaded by their peers to change their response. This research shows that 72% of the students had the correct answer after discussing the content with their peers compared to the 46% that had the correct answer before talking to their peers (Crouch & Mazur, 2001). Although some students changed from correct to incorrect, a larger percentage of students understood the concept after talking to their peers than before, which makes peer conversations aid in the understanding of content (Crouch & Mazur, 2001).

Knowing that peers discussing content can help students to have a better understanding of the content (Crouch & Mazur, 2001; Morgan & Wakefield, 2012), makes peer conversations an important piece to include in a self-guided classroom. One way for discussions to happen organically is to include group work activities or games. During games, students will naturally challenge their opponent, if they think their opponent's answer is incorrect. Alternatively, students whose answer has been challenged will naturally think through their own answer and then either change to their opponents response or defend their answer. In addition, if they cannot come to an agreement, the students will approach the instructor for the correct answer before moving on in the game. This creates students wanting to learn, which is what all instructors want (Crouch & Mazur, 2001; Morgan & Wakefield, 2012).

Group work can naturally create peer conversations when students are working together and disagree on an answer (Crouch & Mazur, 2001; Morgan & Wakefield, 2012). The students will have similar conversations to the game situation, but in the game situation there will be a greater desire to seek out the correct answer from the instructor. Thus, slipping in time for them to converse about the content, even when it is spontaneously happening, will help them have a deeper understanding of the content (Crouch & Mazur, 2001; Morgan & Wakefield, 2012).

Play Games for Learning

Through games, students not only are provided with organic ways to have content related conversations, but games enhance learning and motivation (Cagiltay et. al., 2015; Chang et. al., 2015). Researchers recommend game designers incorporate competition into the games they create to facilitate learning. This provides another research-based reason to incorporate games into a self-guided classroom.

Although the research done by Cagiltay et. al., (2015) was done with digital serious games, "games having purposes other than entertainment" (p. 35), the fact that they focused on the competition these games provided means we can transfer their findings to other games with competition. They found that "when a competition environment is created in a serious game, motivation and post-test scores of learners improve significantly" (Cagiltay et. al., 2015, p. 35).

Cagiltay et. al. (2015) looked at 142 university students in computer engineering, software engineering, and information systems engineering. They took a prior knowledge test to make sure the competition and control groups did not start with differing levels of knowledge of the game. All participants were new to the game (Cagiltay et. al, 2015).

The goal of the game was to collect as many points as possible (Cagiltay et. al., 2015). Points were given based on a correct response and the sum of two rolled dice. If the participant answered incorrectly, then the sum of the dice is subtracted from the total points. Rolling dice gave the game an element of chance. Participants were asked true and false questions with immediate feedback and explanations after each response (Cagiltay et. al., 2015).

Each participant could see their own points adjusted after each response (Cagiltay et. at., 2015). They were also able to see all other participants' points in real-time, in the first version of the game. This was removed in the second version. Collaboration was not allowed among participants. Points were the only motivation piece of the game (Cagiltay et. al., 2015). To determine if participants learned through playing the game, they were given a post-test of questions related to the game. Participants in the competition group performed better on the post-test than the participants in the control group (Cagiltay et. al, 2015). Other results revealed were that there was not a difference in the total amount of time each group spent reading explanations nor their accuracy in the game. Results where the two groups differed were that the control group spent more time responding to the questions and the competition group was more motivated than the control group. In addition, the more motivated the participants were, the more accurate they were in the game (Cagiltay et. al., 2015).

It is nice to have games to help motivate students to learn (Cagiltay et. al., 2015). Within self-guided classrooms, games provide an opportunity for students to compete with the knowledge they just learned. There are both person-to-person competition opportunities and person-to-computer competition opportunities. However, the person-to-person competition seems to create more motivation among students than when they are competing against a computer (Cagiltay et. al., 2015). Instructors can provide games as a choice for a means of practicing the newly learned skills.

Games can be an important piece in a self-guided classroom to help motivate students to want to learn (Cagiltay et. al., 2015). However, the game has to be at the right level for the students to feel success (Van Eck & Dempsey, 2002). Either the game has to be below the

student's maximum level of performance or the game needs to offer assistance to the player, when needed (Van Eck & Dempsey, 2002).

Van Eck and Dempsey's (2002) study looked at computer-based games that had help available to participants in a contextualized manner to see if students' knowledge learned in a computer game would transfer to similar situations outside of the game. Half of the 112 participants received help from contextualized characters, an aunt and an uncle, the other half did not. Also, a cross-sectioned half of the participants were competing against a computer character. In the noncompetitive group, participants were encouraged to move quickly and accurately, but no penalty existed for moving slowly. Thus, there were four groups and a control group: contextualized advisement, no competition; contextualized advisement, competition; no contextualized advisement, no competition; and no contextualized advisement, competition. The control group was given similar questions on a computer without any type of competition nor did they have access to advisement (Van Eck & Dempsey, 2002).

The results of the Van Eck and Dempsey (2002) study found that the contextualized advisement without competition group had the highest transfer rate at 0.82. Followed by the non-contextualized advisement with competition group (0.78) and the contextualized advisement with competition group (0.47). The lowest transfer rate was found in the group that did not receive contextualized advisement, nor did they have any competition element (0.25). This research supports the idea that perhaps learning a skill in a competitive environment is not the best option (Van Eck & Dempsey, 2002). However, having competition as a form of practicing the skill can increase student's motivation to become more efficient at the skill (Cagiltay et. al., 2015).

In another study, Chang, Evans, Kim, Norton, and Samur (2015) found that games were a good option for mathematical intervention of students in middle school. Chang et al. (2015) created a learning game, [The Math App], for students to learn fraction concepts in a game situation. A pretest was administered to determine a baseline of students' mathematical abilities. There were 306 total participants in sixth, seventh, and eighth grade with 171 using [The Math App] as a medium and 153 using paper and pencil. Students worked on fractions for 20 minutes per day for the 18-day study. Then students took a posttest to see if there were any improvement in their abilities. The results showed that all levels of "students who played [The Math App] demonstrated improved mathematics performance compared with those who used paper-and-pencil drills" (Chang et al., 2015, p. 54).

Based on the research, games benefit self-guided classrooms. Chang et al.'s (2015) research supports using learning games to help teachers differentiate by using them as an intervention method to improve student achievement. However, Van Eck and Dempsey's (2002) results suggest that students will lose motivation, if the games do not meet students where they are at because they need to feel success. Then again, research completed by Cagiltay et. al. (2015) pushes teachers to include student-to-student competition. When students compete against each other, students are motivated to keep doing math problems (Cagiltay et. al., 2015). Of course, the ultimate benefit to having games in a self-guided classroom...fun.

Immediate Feedback/Self-Assessment

Receiving immediate feedback, whether it be through self-assessment or playing games, is the basis of how a self-guided classroom is able to function. Students need to grade formative

assignments to get immediate feedback that drives their next steps. The teacher is not able to correct all work done by students, manage classroom behaviors, and answer questions all during one class period (Andrade & Valtcheva, 2009). Thus, in order for students to receive immediate feedback, which is influential to learning (Hattie & Timperley, 2007), there will have to be alternative methods of feedback. One of which is to have students grade formative assessments, homework, and quizzes on their own (Griffin, 1989).

Feedback alone is not enough to make changes in student learning, students must be willing to accept it and determine what their next step should be (Hattie & Timperley, 2007). In a study done by Hattie, he found that different types of feedback are more influential than others (as cited in Hattie & Timperley, 2007, p. 83). Feedback that provides students with cues or reinforcement; assisted instructional feedback via video, audio, or computer; and/or feedback tied to goals are the most effective forms of feedback, according to Hattie's other study (as cited in Hattie & Timperley, 2007, p. 84). Inserting these three types of feedback into a self-guided classroom will enhance the effectiveness of students' learning experiences.

Providing students with cues and assisted instructional feedback through videos and computers can be gained through the use of computer programs such as Khan Academy (2019) or iXL (2019). These types of online practice programs tell the student if his or her answer is right or wrong. If wrong, they offer hints, or cues, to point the learner in the right direction. Learners can also read or watch videos of similar problems being solved ("IXL Learning", 2019; "Khan Academy", 2019). Khan Academy (2019) and iXL (2019) also offer students positive reinforcement by awarding the learner with points and/or badges as they complete a certain amount of problems correctly. With effective forms of feedback being included, online practice

programs are an efficient addition to self-guided classrooms. Students receive necessary feedback without needing the teacher.

As mentioned previously, tying feedback to goals in a self-guided classroom can improve the effectiveness of student learning (as cited in Hattie & Timperley, 2007, p.84). All tasks in a self-guided classroom should be tied to a goal to keep students driven to complete tasks (Boekaerts, et al., 1999, p.479). Students can keep a record of their standards (goals) and track their progress in small increments throughout the year by month, trimester, semester, or other division. Keep the goal timely, so the students see progress throughout and do not have to wait until the end of the year to reach the goal.

Achieving a goal has different meanings for each individual. Even the motivation behind pursuing a goal can be different for each person. Urdan and Mestas (2006) looked into why 53 urban, high school seniors were driven to pursue performance goals. These students were also part of a survey completed when they were sophomores that looked at "their desire to achieve in school for the purposes of making parents proud and providing for family members later in life" (Urdan & Mestas, 2006, p.356). One of the criteria to be a part of the 2006 study was based on the students' answers as sophomores. The results ended up gender lopsided with 28% of the participants being boys.

The participants of the Urdan and Mestas (2006) study were interviewed using questions similar to their sophomore survey. However, using an interview-style approach allowed researchers to dig deeper into the students' responses. Urdan and Mestas (2006) wanted to have a deeper understanding of the students' thoughts and beliefs in regards to the goal, not just a numerical rating. The three types of questions asked of the participants were

performance-avoidance ("It is important to me that I do not do worse than other students in this class" (Urdan & Mestas, 2006, p.356)), performance-approach ("I want to do better than other students in this class" (Urdan & Mestas, 2006, p.357)), and family orientation ("An important reason that I try to do well in school is to please my parents/ guardians" (Urdan & Mestas, 2006, p.357)). After each answer the interviewer would ask follow-up questions to gain a thorough insight into the students' rationale behind their responses.

The participants' responses were classified into four categories - appearance–avoidance, appearance–approach, competition–avoidance, and competition–approach (Urdan & Mestas, 2006). Urdan and Mestas (2006) determined the types of statements that went into each category as follows:

> The appearance–avoidance category contained statements that reflected a desire to avoid appearing academically unable or incompetent to others. Statements in the appearance–approach category involved concerns with appearing academically able, or competent, to others. The two competition categories included statements regarding the desire to do better than, or outperform, others (competition–approach) or avoid doing worse than others (competition–avoid). (p.358)

From the 53 participants, there were 297 statements analyzed and categorized. Overall, the responses were mainly appearance-avoidance (31%) and competition-approach (36%). Competition-avoidance had the least number of statements with 13% (Urdan & Mestas, 2006). Even though the questions asked in the Urdan and Mestas (2006) study were categorized to hopefully elicit responses specific to the question's category, not all participants responded within the category. A performance-avoidance question asking "whether they wanted to avoid

doing worse than others" was responded to with "Yes, I want to do better than others", which would be performance-approach (Urdan & Mestas, 2006, p. 363).

Urdan and Mestas (2006) also found that based on participants' responses, it was difficult to pinpoint the students' exact reasoning for pursuing their goal. Some participants had multiple reasons. However, they all tied into one or more of the following areas: "culture, achievement history, self-perceptions, and idiosyncratic concerns and prior experiences" (Urdan & Mestas, 2006, p. 364). This study helps to understand that each student in a self-guided classroom may have a variety of reasons for pursuing their goals. In addition, the drive behind accomplishing a goal will be different for all students. It is up to the instructor to help the student figure out what drives them and to keep reminding them of why they want to pursue and achieve the goal.

With goals established, students in a self-guided classroom will need to assess themselves on their progress towards the goals. As stated earlier, the teacher does not have time to look at all assessments (Andrade & Valtcheva, 2009), the students have to perform self-assessments. Andrade and Du (2007) completed a study that looked at how students felt when they had to perform self-assessments in class. There were fourteen participants in the study's focus group. They were selected because of their enrollment in a specific post-secondary class where they were very forthcoming with their opinions. The small sample size was for the purpose of improving self-assessments, not to represent the larger population. The class required self-assessment, but it did not count towards their grade (Andrade & Du, 2007).

The focus group interviews by Andrade and Du (2007) revealed eight discoveries. The first was that students' attitudes towards self-assessments gained more positivity the more self-assessments they completed. The participants admitted that at first they thought

self-assessment was pointless, as how could they evaluate their own work when they are the learners. Now, after training and practice, they see the value in self-assessments and recommend the process (Andrade & Du, 2007). For a self-guided classroom, keep this focus group in mind. Students may struggle and resent having to self-assess at the beginning of the course, but will most likely come around in the end to seeing the benefits (Andrade & Du, 2007).

The second and third discoveries that came out of Andrade and Du's (2007) focus groups pointed out that without clear expectations and/or standards from the instructor, self-assessment is difficult. The participants identified that transferring the ability to self-assess to other classes is difficult when the instructor does not give students a rubric or specific criteria for the assignment. After successfully self-assessing, the students were frustrated when other instructors gave more ambiguous assignments (Andrade & Du, 2007). Remember to have clear expectations and rubrics when implementing self-assessment into a self-guided classroom.

Another discovery by Andrade and Du's (2007) focus groups was that " students self-assess by checking, revising and reflecting" (p.165). These students were writing papers and found themselves using the rubric throughout the writing process. The rubric helped them read, assess, and rewrite before turning the paper into the instructor (Andrade & Du, 2007). For a self-guided math class, this process might mean students assess their work after each problem and not just at the end of the assignment to prevent from practicing multiple problems incorrectly.

An additional finding from these focus groups was students believed there were benefits to self-assessing their work (Andrade & Du, 2007). The students knew what was expected and were able to reach the standards, which increased their grades and academic work. They could

objectively look at their work as though they were the teacher. Thus, the students had a better idea of what their grade would be when they turned the paper in, reducing anxiety (Andrade & Du, 2007). To transfer this discovery to the mathematics world, as long as the students have the criteria of what the instructor is looking for and students put those into practice, their learning will show on a summative assessment.

Finding number seven was that there could be a discrepancy between students' own expected quality of work and what the teacher wants (Andrade & Du, 2007). This was an issue that came up more in the layout of work and not the actual content. Teachers had specific expectations regarding how they wanted the assignment to look and flow, but the students felt that was not how they would want to present their work (Andrade & Du, 2007). This issue could arise in a math class when teachers have a specific way they want the work of a problem organized. However, if specified before the work is done, students can follow the guidelines and their grade will not be affected.

The final finding of Andrade and Du's (2007) focus groups was that there was no evidence supporting a difference of opinion between male and female participants. Previous research suggested that responses would vary based on the group members' gender. However, Andrade and Du (2007) specifically looked for this variance and did not find any.

Andrade and Du's (2007) work can help direct teachers on how to implement self-assessments into the self-guided mathematics classroom. The instructor's criteria must be clearly defined and explained to the students through a rubric. Students need to use the rubric to assess themselves throughout the learning process, not just at the end. The self-assessment process, specific to mathematics and the instructor, needs to be explicitly taught and practiced in

order for the process to be beneficial to the students. Getting the right answer in math is not always the only thing that matters. Thus, any specific way that the teacher is looking for students' work to be organized should be taught and the reasoning behind it explained (Andrade & Du, 2007).

The students in Andrade and Du's (2007) focus groups felt like self-assessment was beneficial, but would they have gotten the same grades regardless? Griffin (1989) completed a study using two seventh grade classes taught by the same teacher, in the same way. One seventh grade class used an Immediate Feedback System of students grading their own papers and keeping a record of their grades. The other class turned their papers in to the teacher to correct and record. Students grading their own work and keeping their own grades had one-third of the students increase their letter grades by one or more letters (Griffin, 1989). In addition, the self-grading class had one-fourth fewer failures than the teacher-graded class (Griffin, 1989). After the six-week trial period, the teacher-graded class was introduced to the Immediate Feedback System and similar results occurred within six weeks.

Not only did allowing students to check their own work give them immediate feedback on how they did, but students were also focused on what happened that made their answer incorrect (Griffin, 1989). Being able to recognize their own errors can help students avoid making the same mistake on a similar problem in the future (Griffin, 1989). Another benefit that Griffin (1989) found from his research is that:

> By constant reinforcement and helping students to see academic progress as a result of effort, it may be possible to cause externally controlled students to recognize that they

> have power over what happens and consequently, that they must assume some responsibility for what happens. (p. 23)

Students who know they have the power to change the outcome of their grades, will put forth more effort in learning (Griffin, 1989). There are multiple benefits to using an Immediate Feedback System.

Sanchez, Atkinson, Koenka, Moshontz, and Cooper (2017) found similar benefits to Griffin (1989) in a meta-analysis of self-grading and peer-grading in primary schools through high schools. Sanchez et al. (2017) determined the benefits of self-grading to include metacognition, motivation, and transferable skills. Metacognition being when students think about their thinking (Sanchez et al., 2017), looking back at their own work to analyze and grade it. Motivation comes from the autonomy students feel when grading their own work (Sanchez et al., 2017), they know the criteria and there is no mystery to the grading process. According to Sanchez et al. (2017), transferable skills will come about with "increased communication and collaboration skills, as well as the ability to evaluate future work in professional or academic contexts" (p. 1050). All three advantages come together to support self-grading in a mathematics classroom.

Sanchez et al.'s (2017) meta-analysis specifically asked three questions about self-grading and peer-grading. What effects does self-grading and peer-grading have on later tests graded by the teacher? What is the average difference between self- or peer-graded and teacher-graded scores on the same test? To what degree do the teachers and students agree on scores? For the purpose of this paper, we will focus only on the results Sanchez et al. gathered in regards to the first question.

Within the studies that met Sanchez et al.'s (2017) criteria, there were 44 effect sizes analyzed to see what affect self-grading had on subsequent teacher-graded tests. A little over 72% of the effect sizes were positive, meaning students performed better than the control group on subsequent tests, if they had previously self-graded (Sanchez et al., 2017). Peer-grading also made a positive impact on subsequent tests, although not as great as self-grading (Sanchez et al., 2017). Some research, 27%, showed that self-grading students did worse on subsequent tests than control groups (Sanchez et al., 2017). However, overall, the meta-analysis done by Sanchez et al. (2017) established that more studies support using self-grading as a way to improve student achievement performance, than not. The caveat is that teachers must provide students with training on and a clear understanding of the grading system and what is important when analyzing their own work (Sanchez et al., 2017).

What do students do once they have completed a self-assessment and understand what areas they need to improve upon? According to Koriat and Bjork (2006), students need to work in a study-test cycle. This cycle is where students study or practice the material and then take a mock test to see where they are at. Then, knowing what they need to work on, they repeat the cycle studying or practicing the needed knowledge, and then retesting (Koriat & Bjork, 2006). In the self-guided classroom, the "test" part of the cycle would be a self-assessment until the final test, which would be assessed by the teacher.

A study-test cycle helps students see what material they are missing and still need to learn or practice (Koriat & Bjork, 2006). In addition, students will have an accurate judgement of learning and not think that they have full comprehension of a topic when they do not. Sometimes students stop studying because they falsely believe they know the material (Koriat & Bjork,

2006). The study-test cycle shows the student what they need to work on to successfully master the skill or topic.

Koriat and Bjork (2006) completed a study with multiple experiments pertaining to the study-test cycle. The experimental procedures were to show participants paired words and test their recall. In the first experiment, after viewing each pair, the participants were asked how likely they would be to remember the target word when given the cue word, on a scale of 0% to 100%. The test took place immediately after viewing all pairs. Koriat and Bjork (2006) were looking for how accurate the participants were at determining their recall rate. As expected, recall improved with practice, specifically when the participants were given the word pairs backwards - the target word was given instead of the cue word (Koriat & Bjork, 2006).

The second experiment by Koriat and Bjork (2006) had the control group estimate how well they learned the word pairs after one study session, then studied three more times and asked for their estimate again. After that, they took the test. The other participants were asked to estimate their learning after the first study session, but then took a test, studied, took a test, studied with a request for the participants estimate of their learning, and then ended with a test. This experiment's results showed that when students have experience taking tests, it will help make their estimate of how well they know the material more accurate. Koriat and Bjork (2006) explain that knowing how well students know the material they just learned is important because

> illusions of competence may have serious consequences. A student who falls prey to a foresight bias in preparing for an exam, for example, is likely to stop studying prematurely, expecting to do better on the exam than he/she ends up doing. (p. 960)

Koriat and Bjork's (2006) third experiment was similar to the second experiment. The difference was in the parts of the cycle. The control group had a study session with estimates of learning, a study session without, a study session with, and then a test. The other participants had a study session with an estimate, a test, a study session with an estimate, and a test. Koriat and Bjork (2006) found through this experiment that " test experience was more effective than study experience in alleviating the inflated [estimates of learning] associated with the backward-associated pairs" (p. 967).

The fourth experiment performed in this study by Koriat and Bjork (2006) focused on the timing of the estimate of learning. This time all the participants studied word pairs forward, backward, and unrelated. However, for half the word pairs, the participants were asked for their estimate of learning right after each pair and the other half the participants were asked for their estimate of learning after a time delay. Koriat and Bjork (2006) found that delaying the estimate of learning almost eliminated the foresight bias, or the illusion of competence.

Koriat and Bjork's (2006) final experiment allows students to reallocate study time to the areas of need specific to the participant. Similar to de Jonge et al.'s (2015) research, the results of this experiment show that when using the study-test cycle and students are allowed to determine how much time they spend studying a concept or skill, students are more likely to accurately predict their scores on the test (Koriat & Bjork, 2006). Having a self-guided classroom will allow students to spend time on the topics or skills they struggle with instead of keeping pace with the teacher. Adding in practice tests, or quizzes, for students to take and self-assess completes the study-test cycle that Koriat and Bjork's (2006) research results support.

On a broader spectrum, Koriat and Bjork (2006) suggest that understanding one's own competence is a life skill. If a person believes their skills are greater than they actually are, there are real-world jobs that can cause serious harm (Koriat & Bjork, 2006). Students using the study-test cycle will hopefully transfer that way of mastering a skill onward into their future jobs and hobbies to eliminate an illusion of competence.

In this chapter, the research relating to methods of creating an effective self-guided mathematics classroom was considered. As long as students receive the proper training on how all aspects of the self-guided system works, each component suggested by Edwards (2013) was found to be more valuable to learning than the alternative (Andrade & Du, 2007; Inkson & Smith, 2001). Students' learning will benefit from both individual and group work as students proceed through the material when they feel ready to move on (Brydges et al., 2010; Cagiltay et. al., 2015; Chang et al., 2015; Crouch & Mazur, 2001; de Jonge et al., 2015; Hsieh & Cho, 2011; Morgan & Wakefield, 2012; Muñoz-García et al., 2013; Tullis & Benjamin, 2011). A system of immediate feedback needs to be implemented so that students can reflect and improve upon their knowledge of the content (Griffin, 1989; Hattie & Timperley, 2007; Koriat & Bjork, 2006; Sanchez et al., 2017). A self-guided classroom and Edwards (2013) article on self-paced mathematical instruction are supported by research when the main components are looked at separately.

CHAPTER III: DISCUSSION AND CONCLUSION

Summary of Literature

Self-guided classrooms, or some form of them, have interested educators since the late 1800s (Januszewski, 2001). There has not been a widespread appeal for trying a self-guided system until the help of technology came along (Kerr, 2017). Technology reduces the cost, aids in the management, and adds to the individualization through unlimited resources. The literature review sought to find what methods would create an effective and research-based, self-guided, mathematical classroom.

Self-guided learning research was approached from two directions. The first, are students able to determine their own pacing for what aspects of the content to study, how much time to spend on each topic, and in what order to master the content? Brydges et al. (2010), de Jonge et al. (2015), and Tullis and Benjamin (2011) all found that students will perform better when they regulate whether or not they have mastered the content, are ready to move on, and what to work on next. The second, does the delivery method of self-guided learning matter? Research by Hsieh and Cho (2011) discovered that students prefer to have some form of person-to-person interactions. This was supported by later research from Hattie (2018) and Inkson and Smith (2001). Overall, an individualized plan like self-guided learning is what is best for the learner.

Flexible seating research was sought out because little time is spent just sitting up, taking notes, and listening to an instructor in a self-guided classroom. A lot of freedom is given to students to choose who to work with and where to work. Social status and friendships within

the class, along with task success, are found to be influenced by students' choices in where they sit and who they work with (Dyer et. al, 1990; Kutnick & Kington, 2005; van den Burg & Cillessen, 2015). Students were more likely to gather in groups and felt more comfortable when the furniture was less traditional (Adedokun et al., 2017; "16 Awesome," 2018). For individual work, videos would be used to introduce students to new concepts. This would allow all students to sit anywhere in the room and still view the instructor from the front seat, which Blume et al.'s (2018) research determined as a benefit to student learning. There was research that showed there are more disruptions in a classroom without assigned seats in rows (Bicard et al., 2012). However, the researchers considered a disruption anytime a student talked without permission or interrupted another student working. Don't instructors want their students to be engaging with each other?

Whether it be working with a partner, in a group or playing games, engaging with other students proved to be a value to student learning (Cagiltay et. al., 2015; Chang et. al., 2015; Crouch & Mazur, 2001; Morgan & Wakefield, 2012; Muñoz-García et al., 2013). Peer interactions regarding content, along with immediate feedback have been found to be important parts of a self-guided classroom. In order to get feedback immediately when a student is finished, students have to be taught how to check their own work on formative assessments, to self-assess (Andrade & Valtcheva, 2009). As long as students are taught how to self-assess, the immediate feedback through self-assessment is the way to go (Griffin, 1989; Hattie & Timperley, 2007; Sanchez et al., 2017). A digital form of immediate feedback can be accessed through online programs such as Khan Academy (2019) and iXL (2019). These types of programs offer immediate feedback, video assistance, and extrinsic rewards, which is good for

practicing the newly learned skills. However, students also need the self-assessment piece to analyze and reflect on their own work (Griffin, 1989; Hattie & Timperley, 2007; Sanchez et al., 2017). Thus, using solely the online programs for immediate feedback would eliminate that benefit.

When students are self-assessing, they need to know what they are trying to achieve (Urdan & Mestas, 2006). Setting and tracking goals is another important part of a self-guided classroom. This piece will help students continue to strive for mastery of the content. Although the goal of mastery is the same for every student, each one will have a different reason for pursuing their goals (Urdan & Mestas, 2006).

Professional Application

The goal of a teacher is to help students learn. That is a tough job since every student is at a different level of knowledge and learns in a different way. Similarly, every teacher has a different style of teaching. This research compiled together can help teachers who want to move to a style of teaching that is more student-focused. The student has choices on how they gain the knowledge and when to move on. A self-guided classroom customizes the learning experience for the student.

Setting up a system within a classroom to allow for students to be self-guided requires a lot of components - a way for students to move through the content at their own pace; games that promote learning, conversations, and competition; planned activities for students to do where they have to collaborate; a way for students to self-assess their work for immediate

feedback; a means for setting up and tracking student goals; and places within the room where students can comfortably learn individually and with peers. Most of the components teachers already use in their classroom, it is just a matter of organizing them in such a way that allows for self-guided learning.

De Jonge et al. (2015) and Tullis and Benjamin's (2011) research tells us that we need to allow students to progress at their own pace. This means students need to be able to access lectures, practice, activities, and formative assessments at all times. Lectures, or a way to gain the new information, can be in the form of videos found online or of the actual teacher. Students do better when they have a person-to-person relationship with the instructor (Hsieh & Cho, 2011; Hattie, 2018), so based on research, it is best that the teacher creates the videos. Teachers can also do small group instruction for those students who struggle to learn from the video or need reteaching. Although this method cannot be accessible at all times, the teacher can have a small group that is moving along at the same pace. Some students can also learn the new content from reading the steps in a textbook. The student can choose the way to gain knowledge that works best for him/her, differentiated instruction.

Practicing the skill to be attained can come in various forms. One way is with paper and pencil. In the classroom this means instructors need to have future materials ready to go for the students who progress faster than most. There also needs to be a place to keep the materials around longer for the current unit, so that students who move slower can still have access to them, when most of the class has moved on. Practice can also be done through online programs like Khan Academy (2019) and iXL (2019). These programs allow for the teacher to see each student's progress and areas of struggle. They are also a great way to cycle back around when

students need more practice on past skills. Online practice programs have helped in the management aspect of self-guided learning, which was one of the challenges from the past.

Another form of practice can come from games. These can be both online and with peers in the classroom. The benefit to online games is that students receive immediate feedback on right or wrong answers (Cagiltay et. al., 2015). The drawback is that there is not any reflecting (Andrade & Du, 2007), if an answer is wrong. An in-class game is beneficial for having conversations regarding the content (Morgan & Wakefield, 2012). Students will naturally contest their classmates answer, if they think it is wrong. Then they will both have to defend their position, creating an organic dialogue about content. The downfall is that answers could be wrong and the game will move on. There is not always a natural check within the game for correct answers, just agreed upon answers. Both types of games should be played once students have a good understanding of the skill to get the most gain in regards to the skill (Van Eck & Dempsey, 2002).

Other activities, besides games, that promote collaboration can, and should, still happen in a self-guided classroom (Morgan & Wakefield, 2012; Crouch & Mazur, 2001). The challenge is to find a way for students to be able to do these at their own pace. This is another organizational challenge, the materials will need to be available for various activities at the same time.

The final piece to students progressing at their own pace is the assessments. Formative assessments, such as quizzes, can be handled in a similar way to the paper and pencil practice sheets. Students self-assess by checking their work against an answer key. They are trained on

what to look for and what to do next depending on their results (Andrade & Du, 2007). Then a cycle of studying and testing (Koriat & Bjork, 2006) begins until they reach their goal. The summative assessments are graded by the teacher. It could be in the form of a traditional test or a project to show they have mastered the skills being learned. At this point, the student should have a good grasp on their ability level of the skill. They should be confident they can at least show mastery of the basic aspects of the skill. If not, they should go back to the study-test cycle (Koriat & Bjork, 2006).

Goals have to be set so that students know where they are trying to get to (Boekaerts, et al., 1999). A way of tracking these goals also needs to be considered, another organizational challenge for a self-guided classroom teacher. According to Urdan and Mestas (2006) a teacher should take some time to figure out what motivates their students to achieve goals. That way the teacher will know how to inspire their students to forge onward when they are struggling with a skill.

Because it takes each student a different amount of time to accomplish his/her goals, each student is at a different point in the list of tasks to complete. Some might be more comfortable watching a video lying on the floor or propped up against the wall. While others may want to stand and work in a group. This is where flexible seating is beneficial in a self-guided classroom. Although it can be chaotic with students moving in all different directions, Dyer et. al (1990) discovered that students are more likely to be on-task when they have been given options. Where to sit can be one of those options. When there were nontraditional furniture options, students are more likely to collaborate (“16 Awesome,” 2018; Adedokun et. al., 2017). When given the option during collaboration, students will choose to

work with peers they like (van den Burg & Cillessen, 2015). That is beneficial when it comes to females, but detrimental for males (Kutnick and Kington, 2005). Therefore, varying whether or not students get to choose a partner will aid in the male students' on-task abilities.

What methods create an effective self-guided mathematics classroom? Most of the methods I already used in my self-guided classroom, however, now I have research to back them up. This past year, I moved away from students taking self-assessed quizzes to save time. By looking at the research, that was a poor choice. I will be putting the quizzes back into my self-guided classroom system so that my students can experience the study-test cycle to make sure they have mastered the skill. I will also be able to implement the new methods that I discovered during my research, such as pairing students based on gender and whether or not they viewed others as their best friend in the class or just an acquaintance. I tried that in one of my classes this past year. I took a survey and used the results to create study buddies. Students were more on-task when sorted due to the survey than when I allowed them to choose their own partners. I am hoping this literature review will help other teachers who either need research to support what they are already doing, or are looking for research-based methods to make changes in their classrooms.

Limitations of the Research

No research studies were found explicitly talking about the components of a self-guided classroom. Therefore, I came up with the components based on what I used in my own self-guided classroom - a means to individual pacing, flexible seating, partner and group work, playing games, and immediate feedback through self-assessments. Separately, the search for

studies regarding each topic was successful. Within these searches, articles were selected based on their relevance to a self-guided system. In the end, a magazine article in Mathematics Teaching in the Middle School was the only resource found that specifically stated the components necessary to create a self-guided system in a classroom (Edwards, 2013). As stated by Edwards (2013), the benefits are individual pacing, collaboration, immediate feedback, differentiation, and continuous assessments. Since differentiation and continuous assessments are embedded in the other three, the previous research found supported Edwards' (2013) claims.

I was expecting to find more research on flexible seating. There are numerous claims online that flexible seating has transformed elementary and secondary classrooms for the better. However, there are not any actual studies for flexible seating in those settings. In fact, I only found the one completed by Adedokun et. al. (2017) for a post secondary setting. Thus the term flexible seating also encompassed whether there should be assigned seats and/or students should be allowed to move freely around the room.

Implications for Future Research

There are new ideas coming out regarding education almost daily. Therefore, there is always something else that can be researched. I believe more research needs to be done on flexible seating, such as bean bags, exercise balls, cushions, and standing tables. Do students really learn better when they are more comfortable? How many options are too many options? Does the nontraditional seating ever negatively influence learning? I am hoping there are

already studies in the works for flexible seating, specifically in elementary and secondary settings.

How does self-guided learning affect the classroom community? This question came about because of a training that I attended on using circles to teach and build community in a secondary classroom. Is there a way to combine the two or do they contradict each other?

Conclusion

Is the education pendulum swinging back to the one-room schoolhouse approach with students of all knowledge levels in one room? The modern difference being each student is learning at his/her own pace. This literature review is a resource to support teachers who are ready to jump on the pendulum.

A self-guided system in a classroom can be scary, so start small. Begin by having students correct their own practice and/or quizzes. Be specific when instructing the students on what to look for in their work. Then find alternative resources for students to learn from - self-recorded videos, online videos, or text. Remember to teach the students how to gain the necessary knowledge from each form. Finally, create one, self-paced unit as practice for both you and the students. After the “test unit”, you will know if using a self-guided system in your classroom will work for you, or not.

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