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Teresa Ogden

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Communication, and Critical Thinking in a Fourth and Sixth Grade Math Class

The Impact of Personalized Learning on Learner Agency, Communication, and Critical
Thinking in a Fourth and Sixth Grade Math Class

Submitted on July 11, 2019

in fulfillment of final requirements for the MAED degree

Teresa Ogden and Erica Pierce

Saint Catherine University

St. Paul, Minnesota

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Communication, and Critical Thinking in a Fourth and Sixth Grade Math Class

Advisor Kristine Cook

Date _____

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Abstract

Agency, communication and critical thinking are skills that all students must develop in order to become effective life-long learners. The action research was designed to determine the impact of a Personalized Learning format on students' learner agency, and their communication and critical thinking skills. The research was conducted with fourth-grade students in a suburban elementary setting, and with sixth-grade students in a suburban middle school setting. The researchers collected before and after treatment data using an agency rubric, and using communication and critical thinking skills rubric. Researchers also collected data to determine student preference for working in a personalized learning format, and teacher-researchers' feelings, planning time, and number of redirections for students during the four week personalized learning unit. The research showed that students' exhibited growth in agency, communication and critical thinking skills. The data also showed an overall preference for the format by students, positive teacher-researcher feelings, low overall redirections, and less daily planning time once the unit was initially set up. The teacher-researchers suggest further study into how personalized learning effects different demographics of students such as age, and gender. As well as, investigating the impact of teaching mindset, agency, communication and critical thinking skills to students, teachers and parents.

Keywords: learner agency, communication, critical thinking, personalized learning

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One of the primary responsibilities of educators is to prepare students for their futures. This task has increased in difficulty due to the continually changing demands of the world around us. Teaching skills such as creativity, critical thinking, and collaboration are especially important. These skills can be taught in a variety of ways and the role of the teacher is to cultivate a desire for students to become lifelong learners. The driving force behind 21st Century learning is preparing students to be successful in today's world.

Intentional methods of instruction, curriculum, and learning environments are key components in meeting the individual student's needs and teaching 21st-century skills. Learning and understanding math is more than memorizing procedures and facts. Grasping math is about student's fundamental mathematical ideas. Comprehending math involves knowing why a mathematical idea is important and the contexts in which it is useful. It also includes being aware of the many connections between mathematical ideas. In the math classroom, there is diversity among student motivation, attitude, and response to the classroom environment and instructional practices.

In a direct instruction environment, students are not gaining collaboration, critical thinking, communication, and creativity skills. Change is required to not only improve students' cognitive abilities in math but to also develop learner agency. Future careers are looking for students with 21st Century skills. Teaching practices need to change to not only meet the needs of the learner but to also prepare them for their future.

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The research took place in a suburban, elementary fourth-grade classroom, and in a suburban, middle school sixth-grade classroom. The fourth graders were ages 9-10 and the sixth graders were ages 11-12. Teachers used the personalized learning model for a unit of instruction during January.

The need for teachers not only to foster a deep understanding of mathematical ideas, contexts, and connection but also to help students develop 21st-century skills to prepare them for their future in an ever-evolving workforce is critical. A personalized learning model is intended to help teachers meet the diverse range of skills, attitudes, and learner agencies that make up the classroom. There is a need to study the personalized learning model in the mathematics classroom, and its ability to facilitate a deep understanding of math, as well as facilitate the development of 21st-century skills. The purpose of this action research study is to investigate the effects of a personalized learning model (instruction that offers pedagogy, curriculum, and learning environments to meet the individual student's needs) on the development of learner agency, communication, and critical thinking skills in fourth and sixth-grade mathematics.

1. To what degree will the use of a personalized learning model in a fourth and sixth-grade mathematics class increase students' learner agency?
2. To what degree will the use of a personalized learning model in a fourth and sixth-grade mathematics class develop students' communication skills?
3. To what degree will the use of a personalized learning model in a fourth and sixth-grade mathematics class develop students' critical thinking skills?

Theoretical Framework

The Humanist's view on the purpose of education is the "development of self-actualized, autonomous people (David, 2015, para. 2). Huitt (2009) cites Gage and Berliner (1991) who described the five tenets of the humanist stance on education including the development of independence, creative and divergent thinking, exploration and creativity, ownership of learning, and the artist within. Humanism is a pedagogical belief that holds learning as a very personal quest to fulfill one's own potential (David, 2015). In Humanism, it is more important to know how to learn than what is learned (Gage and Berliner as cited in Huitt, 2009).

The current traditional classroom ignores the development of a child's regulatory and affective/emotional systems that are integral to how children synthesize the world around them (Huitt, 2009). The teacher's role is to facilitate a personalized, student-centered learning experience (David, 2015). Finally, Huitt writes that a teacher should be a facilitator in the classroom, allowing students' choices, teaching them to set attainable goals, and having students work in groups cooperatively (2009).

The research studied relates to the humanist theory because the structure focuses on a personal learning journey. Through this process students discover their own creative, intellectual and social potential. While developing learner agency, communication, and critical thinking skills within a personalized learning model the focus shifts from what is learned to how.

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Review of Literature

“Too often in the past, the prevailing attitude has been that in every class there are a few unreachable students -- students who are lazy, too emotionally disturbed, to ESL, too learning disabled, too inattentive, or too lacking of intelligence or self-control to learn” (Powell & Kusuma-Powell, 2011, p. 15).

The demands of the world are changing rapidly. Several researchers identify the importance of refocusing student’s skills in creativity, critical thinking, communication, and collaboration (4 C’s) (Goldberg, 2012; Snape, 2017; Soulé & Warrick, 2015). The digital market requires different workforce skills than those developed in the 20th Century teacher-centered classrooms. Mark Stevens, 2011 stresses that learning environments are not transformed into 21st-century classrooms with the addition of gadgets. The transformation occurs as educators “employ today’s technologies to make material accessible and engaging” (as cited in Tucker, 2012, p. 12). Although digital technology can be used to hook students’ interest and help them to develop relevant skills for success beyond school, the addition of technology alone does not create a transformative classroom. While technology can provide equity of voice and engage students in more complex tasks that require time, communication, and collaboration (Tucker, 2012) teachers can, perhaps more easily, use digital tools to simply replicate existing worksheets and lectures. Curriculum to develop the needed 21st century skills is student-driven in its approach and provides rich engagement in inquiry, project, and problem-based activities (Snape, 2017).

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According to Walkins (2010) and Haite, Biggs, & Purdie (1996), a focus on *learning* rather than *performance* has a powerful impact on test results (emphasis ours, as cited in Snape, 2017). Fahnoe and Mishra (2013) reported that students in a technology-rich environment were significantly more self-directed in their learning than their classmates in the traditional classroom, suggesting that technology may carry with it an inherent tendency towards increasing self-directed learning in K–12 students (as cited in Bartholomew et al., 2017).

Self-directed learning has been identified as a key 21st-century skill required for students to succeed (Bartholomew et al., 2017). The skills and knowledge needed today are different than those needed 50, 20, or even ten years ago. As the marketplace and use of data to design our lives, our economy, our political outcomes, and our work rapidly evolves, so must the landscape of education. Learning the 4C's requires active student engagement. Students need to be able to communicate effectively and work collaboratively with their peers--while being challenged with real-world problems. The rapidly changing world requires them to think fast and use others as resources. It is easier to develop these skills when students are enthusiastic participants in their education (Tucker, 2012).

Self Direction and Student Agency

Personal integrity, respect, and appreciation for qualities of the individual are key components to student agency. Efficacy is the second vital element to a sense of agency. Students with efficacy can act--and will act--with effect (Williams, 2017). Johnson (2004)

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states that students have efficacy when they are empowered to take strategic steps to attain their goals (as cited in Williams, 2017). Freire (1970) states “agentic learners are human beings acting upon their full potential to change their world” (as cited in Vaughn, 2014, p. 4). Learning based on student agency stems from natural curiosity within each student. Mitchell (2014) indicates that self-directed learning is becoming increasingly relevant in today’s educational landscape (as cited in Bartholomew et al., 2017). Student agency is a pedagogical approach that elicits and values student choice and voice.

Students become the experts when the locus of power shifts from the teacher to the student (Williams, 2017). Research has demonstrated students with agency in learning are more motivated, experience greater satisfaction in learning, and are more likely to achieve academic success (Lin-Siegler, Dweck, & Cohen, 2016, p. 297). Views on respect for student perspective trusted educators, and ability to be themselves dramatically affects investment and motivation in student learning (Lin-Siegler, Dweck, and Cohen, 2016). Student agents are independent thinkers who reveal their thinking through reflection and observation. Feedback develops a metacognitive awareness with an emphasis on the individual identities of capable thinkers who build their understandings (Williams, 2017).

STEM Curriculum and Instruction

According to National Council for Teacher of Mathematics (2014), ideal math learning is not a passive process of practicing procedures, memorizing formulas, and using standard algorithms (as cited in Martin & Rimm-Kaufman, 2014). Rather, students

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develop an understanding of math procedures and concepts by making sense of the mathematical task, participating in reasoning, problem-solving, communicating with teachers and other students, and investigating mathematical problems to determine a solution.

The end goal of the education system is for students to maximize their potential and to participate civically in a vibrant democracy (Horn, 2017). Humans crave autonomy, competence in their chosen field, and a purpose that will make the world better (Wormeli, 2012). Wormeli believes that teachers must provide students with choices in their learning, feedback to help them set their own competency goals, and help them to make meaning of their learning--to transform their lives and the world (2012).

The curriculum must embrace a holistic approach to educating the whole child (Powell & Kusuma-Powell, 2011). Woodley (2017) writes that it is key to design online environments for students that support their diverse backgrounds to ensure their future success as adults. Woodley cites Gay's (2010) guidelines for developing culturally responsive teaching practices to point out that lessons should be validating, culturally comprehensive, multidimensional, empowering, transformative, and emancipating (2017). When students have the opportunity to construct and validate their meaning and regulate their behavior they develop a positive disposition towards math, leading to deeper engagement and motivation (Hunter & Anthony, 2011). When students become reflective and self-managed in their learning, they own their learning goals and will make assessment strategies to guide their learning (Hooker, 2016).

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Blended-Learning

Blended learning is an approach to instruction that has been implemented in a variety of ways in multiple educational settings. Blended learning is defined as student learning in a hybrid experience of in class and online instruction, where they are given choices in their path, pace, and space (Smith & Basham, 2014; Taminiau, Kester, Corbalan, Spector, Kirschner, & Van Merriënboer, 2015; Zezula, 2011).

This approach to teaching matured out of necessity and increased access to technology (Tucker, 2012). A lack of agreement on the definition of blended learning has led to difficulties in the research of its effectiveness. Blended learning through its use of technology requires a degree of personalization. Therefore, it offers a means by which to effectively personalize learning.

Personalized Learning

Personalized learning is transformative in how students are instructed and how learning is organized (Domenech, Sherman, & Brown, 2016). Every student is a respected and valued part of the learning environment in personalized learning classrooms (Zumba & Kallick, 2016). Students are empowered to recognize the power of their own and other's ideas (Zumba & Kallick, 2016). The goal of personalized learning is to entice students with different readiness levels, interests, cultural backgrounds, intelligence preferences, and learning styles. It aims to keep students engaged while maximizing their understanding and achievement (Powell & Kusuma-Powell, 2011).

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Costs

There are several noteworthy potential and actual costs to consider when implementing a personalized learning model. In terms of actual financial impacts, Cross (2016) explains that the cost-savings of reclaiming textbook expense are about 0.5 percent of the per-pupil expense, and the cost savings of implementing blended learning would not be significantly different. A personalized learning environment has a heavy dependence on technology. Online tools need to be reliable—so depending on the existing system—there may be additional costs to ensure technical issues (wifi bandwidth, device consistency, lms functionality, teacher professional development to facilitate personalized learning) (Patterson, 2016). The demands of blended learning can be unrealistic for teachers and students to solve technical issues, and a lack of support for redesigning courses and learning new technology skills (Poon, 2013). Teachers report that there was a huge learning curve and a great amount of time necessary to create successful blended learning experiences (Phillips, Schumacher, & Arif, 2016).

The requirements for developing student efficacy in the personalized learning model is also a potential cost consideration. While the lack of choice in learning can be harmful, when students have too much autonomy in learning a task, this can cause more problems if the high demands of the learning tasks exceed students' abilities (Wielenga-Meijer, Taris, Kompier & Wigboldus, 2011).

Benefits

One of the many benefits of blended learning is flexibility and convenience

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(Zezula, 2011). Blended learning provides flexibility in delivering content. Content that benefits from direct teaching can be taught in the classroom, while other learning can be presented online, offering students choices in when and where they learn (Patterson, 2016). Students whose needs make attending a brick and mortar building difficult daily are still able to continue their learning (Zezula, 2011). Blended learning can take students beyond the walls of the school to provide real-world experiences (Armes, 2012).

Teachers and students can access high-quality content, take virtual field trips, and connect in real time with subject-matter experts online, with little to no cost (Patterson, 2016). Students may also access their teachers outside of school via online tools (Messier, 2016). Blended learning creates the possibility of learning spaces that can foster the development of the 21st-century skills of critical, creative, and complex thinking (Garrison & Kanuka, 2004).

Schools implementing blended learning classrooms believe that students are more engaged, and have seen improvements in student achievement (Armes, 2012). Multiple reviews give evidence that there is a positive correlation between autonomy and task performance. (Wielenga et al., 2011). Blended learning allows students to move at their own pace, allowing for interventions and enrichment (Armes, 2012). Armes adds that the blended learning model allows teachers to group students effectively, providing learning opportunities across grade levels, and subjects (2012). Blended learning can allow for personalization of learning specific to the student's interests, and learning styles (Patterson, 2012).

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One of the biggest challenges for teachers is addressing the diversity of learner needs within one classroom (or five or six classrooms at the secondary level). Blended learning can differentiate and personalize the learning as all students work towards a learning targets with the content they find useful and the time they need to master it before moving on (Tucker, 2016). Teachers can collect more accurate and timely data and evidence of learning from students in a blended learning model, allowing teachers to provide timely, personal, and targeted feedback (Tucker, 2016). When students learn both online and in the classroom, they not only can move at their own pace, they take more responsibility for their learning outcomes, and this can aid them in learning to organize their materials (Tucker, 2016). Teachers can spend more one-on-one time with students in a blended learning classroom (Tucker, 2016).

Heterick & Twigg (2003) found evidence in a higher learning setting that students scored as well or higher on tests in a blended learning environment, compared to those in a face-to-face more traditional classroom, and the students were content with the blended learning format (as cited in Garrison et al., 2004). Garrison et al., continue to explain that other benefits of a blended learning instructional design included higher course completion rates, increased retention of learning, ability to create a community of inquiry and more positive attitudes about the subject matter (2004). Blended learning is efficient with the ability to deliver a wide range of online content and digital videos, recordings, eBooks quickly (Patterson, 2016). Tucker reports that a blended learning environment

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frees up time for teachers in their planning, as they do not need to plan and prepare copies (2016). Some reported that blended learning can save districts money by using online texts, resources, and software taking the place of costly texts, videos, and other content (Messier, 2016).

Perhaps most importantly, blended learning encourages 21st-century skill development. Using online collaboration tools to connect with experts, authors, STEM professionals, and even other students around the world create connected learning experiences for students in a blended learning classroom (Arnes, 2012). Connected learning combines personal interest, supportive relationships, opportunities.

Finally, the Common Core State Standards goal of creating learners with digital fluency is met by implementing the blended learning model; students learn to use digital technology in many different academic subjects naturally (Messier, 2016).

Methodology

This study used a personalized learning model. A variety of instruction from online and teacher led sources were used. Students received practice in both formats, and participated in group activities. Daily teacher observations were used to gather both quantitative and qualitative data and notes. Teachers completed a pre and post-assessment rubric for each student to assess growth in their learner agency. Students completed a daily exit slip to gauge their preference of working using a personalized learning format, along with their goals and daily work. Weekly, students recorded themselves demonstrating their communication and critical thinking skills by explaining

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their solution to a given math problem. The video was scored by the teacher using a rubric. The data collected from the fourth grade and sixth-grade students were used to determine if the Personalized Learning unit increased learner agency, communication, and critical thinking skills.

The research was conducted in two different math classrooms in Minnesota. This study included fourth graders and sixth graders attending suburban elementary and middle schools. Students ages ranged from nine to twelve years old. The fourth-grade class consisted of 23 students, 13 female, and 10 male. The sixth-grade class was made up of 39 students, 20 male, and 19 female. The device ratio for both groups was 1:1. The fourth graders used Chromebooks and the sixth graders used iPads.

The qualitative instrument used in this study was in the form of a Daily Teacher Journal. Data was collected on how the personalized learning unit is going along with notes on the benefits and challenges. This data allowed for daily reflection on student agency, communication, and critical thinking skills.

The teacher-researchers used three quantitative instruments in this study. First, the students rated their preference for the Personalized Learning format in the Student Daily Reflection Exit Slips. The teacher-researchers used the Learner Agency Rubric to determine learner agency developed over the course of the personalized learning unit. Finally, the teacher-researchers used a Communication and Critical Thinking Rubric, to indicate communication and critical thinking skills ranging from emerging to advanced in relation to the learning occurring during the personalized learning unit.

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The participants in this study included 23 fourth grade students, nine to ten years old and 39 sixth grade students, eleven and twelve years old. With permission from their parents, the students in the two classes participated in a Personalized Learning math unit lessons during the four week study period. The personalized learning math unit was structured using a “playlist” that guided the students’ daily work time. Students chose from different activities chosen by the teacher-researcher: online practice and games using their devices, paper pencil traditional practice, instructional videos, and hands-on games. Students were able to work at their own pace, using feedback from the activities and the teacher-researcher to guide their next steps in mastering the learning target. The teacher scored each student using the NTN Agency Rubric (see Appendix A). The teacher compared pre and post rubric scores to determine if the students increased in their growth mindset and ownership over learning based on the teacher's professional observations.

Once the personalized learning unit began, students completed an online survey to gauge how much they enjoyed working in the personalized format. The teacher-researcher gathered the data from the survey to determine students’ preference for the personalized learning format. The teacher-researcher also completed an online survey daily to determine the amount of time spent planning for the day’s lessons, the number of times students’ needed redirection, and qualitative reflections to determine how the teacher felt about the day. The teacher analyzed the daily survey data to determine the amount of time spent planning personalized learning lessons daily, and the number of

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times students needed redirection during the lessons. The qualitative observations were analyzed for trends and comparisons between the two teachers and their classrooms.

At the end of each of the four weeks, students were presented with a math problem. They were directed to first complete the problem to the best of their ability, and then record a video of themselves explaining what strategies they used to solve the problem using Flipgrid. Flipgrid is a social learning platform that allows educators to ask a question, then the students respond in a video. Teachers then watched the student videos and used a rubric to score each student's communication and critical thinking skills. The data was analyzed to determine if the personalized learning format improved the students' critical thinking and communication skills.

Data Analysis

The purpose of this study was to investigate the effects of a personalized learning model on the development of learner agency, communication, and critical thinking skills. The research studied relates to the Humanist theory because the structure focuses on a personal learning journey. Through this process, students discover their own creative, intellectual, and social potential. Personalized learning shifts the focus from what is being learned to how while developing learner agency, communication, and critical thinking skills. The students completed the unit at their own pace while making choices about how they would work on meeting the specified math standards. The study included an analysis of common challenges of using a personalized learning format, student preference for

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working in a personalized format, and the impact that the personalized learning unit had on student agency, and communication and critical thinking skills. The research design was both qualitative and quantitative. The researchers observed and investigated the impact of this learning model on student's learner agency development as well as communication and critical thinking skills.

The selected participants in this study were from two different schools: a fourth-grade mathematics class in a suburban Midwestern elementary school and a sixth-grade class at a suburban Midwestern middle school. Students ages ranged from nine to twelve years old. There were 57 total participants in the study, with 23 fourth grade students and 34 sixth grade students. Table 1 shows the breakdown of gender, race, English language learners, and special education students.

Table 1
Demographics of Students

<i>School/Grade Level</i>	<i>Male</i>	<i>Female</i>	<i>Native</i>					<i>English</i>	<i>Special</i>
			<i>American</i>	<i>White</i>	<i>Black</i>	<i>Asian</i>	<i>Hispanic</i>	<i>Language Learner</i>	<i>Education IEP</i>
<i>Elementary/4th Grade</i>	<i>10</i>	<i>13</i>	<i>0</i>	<i>18</i>	<i>2</i>	<i>0</i>	<i>3</i>	<i>0</i>	<i>1</i>
<i>Middle/6th Grade</i>	<i>20</i>	<i>14</i>	<i>3</i>	<i>16</i>	<i>9</i>	<i>3</i>	<i>3</i>	<i>3</i>	<i>0</i>
<i>Total</i>	<i>30</i>	<i>27</i>	<i>3</i>	<i>34</i>	<i>11</i>	<i>3</i>	<i>6</i>	<i>3</i>	<i>1</i>

Personalized Learning as a Method to Develop Learner Agency

The first research question that this study addressed was learning through activities that are meaningful and relevant to learners, driven by their interest, and self-initiation with teacher guidance. *To what degree will the use of a personalized*

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learning model in a fourth and sixth-grade mathematics class increase students' learner agency? To answer this question, the teacher- researchers completed a rubric addressing mindset and ownership of learning for each student before and after the math unit.

According to Figure 1, the fourth grader learner agency mindset proficiency scores were higher than those of the sixth graders before beginning the unit. Before beginning the personalized learning unit none of the fourth or sixth graders scored at an advanced level. The data shows that 13% of the fourth graders and 6% of the sixth graders were proficient, 87% of the fourth-grade students scored at the emerging or developing level, and 95% of the sixth graders fell within this range. The combined data regarding learner agency mindset indicates that 9% of the students were proficient according to the Learner Agency Rubric. The other 91% were developing or emerging.

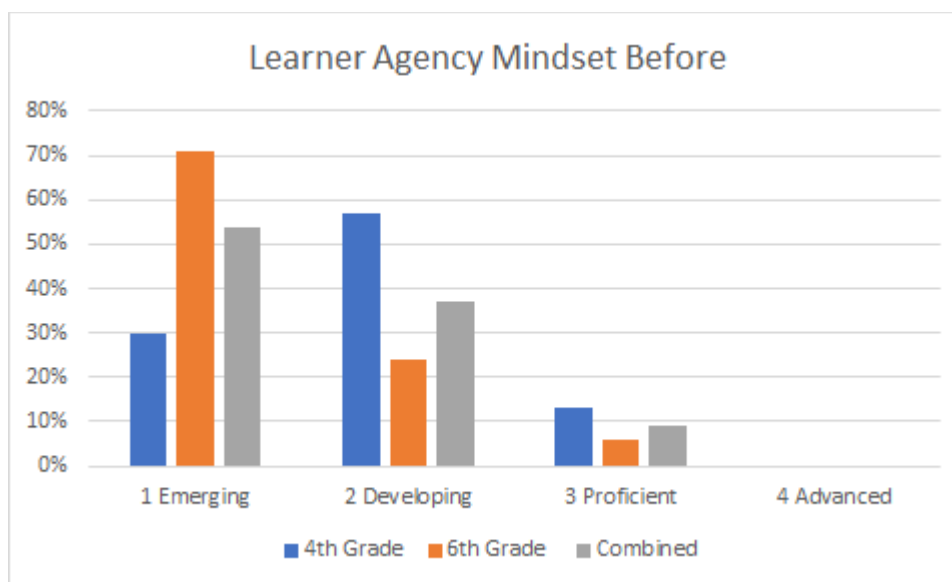


Figure 1. Fourth grade, sixth grade, and combined students' learner agency mindset scores. This shows students' mindset development before beginning the Personalized Learning unit.

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According to Figure 2, the fourth-grade and sixth-grade mindset proficiency scores were more comparable after the unit. 4% of the fourth-grade students and 18% of the sixth-grade students had advanced scores. 43% of the fourth-grade scores and 32% of the sixth graders were proficient. 52% of the fourth-grade and 50% of the sixth-grade students scored within the emerging and developing range. The combined data displayed indicates that 37% of the students were proficient, and 12% had advanced mindsets according to the Learner Agency Rubric. The other 51% were developing or emerging.

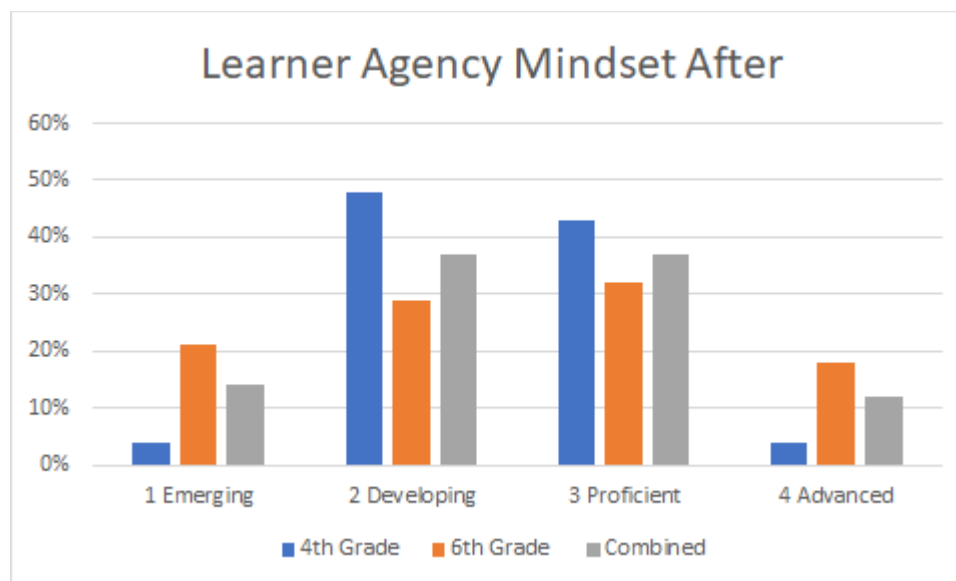


Figure 2. Fourth grade, sixth grade, and combined students' learner agency mindset scores. This shows students' mindset development after completing the Personalized Learning unit.

The data indicates mindset growth in both the fourth and sixth-grade students. A t-test - paired difference was used to compare the before and after learner agency mindset

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scores. The derived t-statistics (see Appendix B) of -8.94 for the sixth grade and -6.42 for the fourth-grade students mindset development scores showed statistical significance.

According to Figure 3, the fourth grader learner agency ownership of learning proficiency scores were higher than those of the sixth graders before beginning the unit. Before beginning the personalized learning unit, none of the fourth or sixth graders scored at an advanced level. 28% of the fourth graders and 3% of the sixth graders were proficient. The data show that 78% of the fourth grade students scored at the emerging or developing level, and 97% of the sixth graders fell within this range. The combined data shown regarding learner agency ownership of learning indicates that 11% of the students were proficient according to the Learner Agency Rubric. The other 89% were developing or emerging.

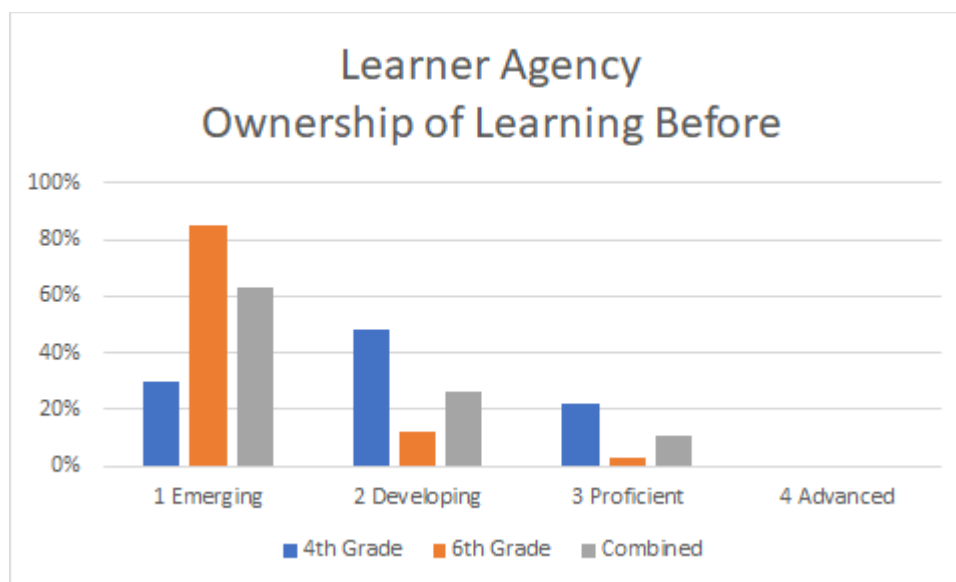


Figure 3. Fourth grade, sixth grade, and combined students' learner agency ownership of learning scores. This shows students' ownership of learning development before beginning the Personalized Learning unit.

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According to Figure 4, the fourth grade and sixth grade ownership of learning proficiency scores were more comparable after the unit. 4% of the fourth grade students and 15% of the sixth grade students had advanced scores. 35% of the fourth grade scores and 38% of the sixth graders were proficient. 47% of the fourth grade and 61% of the sixth grade students scored within the emerging and developing range. The combined data displayed indicates that 37% of the students were proficient and 11% had advanced ownership of learning according to the Learner Agency Rubric. The other 52% were developing or emerging.

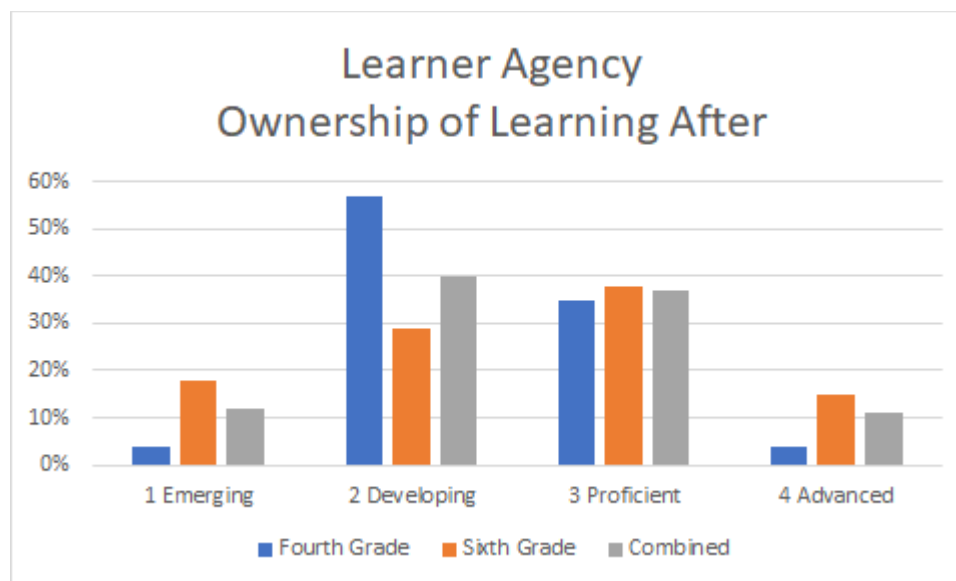


Figure 4. Fourth grade, sixth grade, and combined students' learner agency ownership of learning scores. This shows students' ownership of learning development after completing the Personalized Learning unit.

A t-test - paired difference was used to compare the before and after learner agency ownership of learning scores. The data indicates ownership of learning growth in

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both the fourth and sixth grade students. The derived t-statistics (see Appendix C) of -9.57 for the sixth grade and -4.49 for the fourth grade students' ownership of learning development scores showed statistical significance.

Personalized Learning as a Method to Promote Communication and Critical Thinking

The second and third questions were: *To what degree will the use of a personalized learning model in a fourth and sixth-grade mathematics class develop students' communication skills? To what degree will the use of a personalized learning model in a fourth and sixth-grade mathematics class develop students' critical thinking skills?* The teacher-researchers wanted to know if personalized learning had an impact on communication and critical thinking skills. Students were given a math problem to solve once a week. They recorded themselves, using Flipgrid. Flipgrid is a digital tool that is available both online and as an app on the students' devices. It allows a teacher to pose a question, and students to respond to that question by making creating a video and then submitting it to the class set. Students were asked a question that they solved and then used Flipgrid to explain their process used to solve the problem and their solution. To address these questions the recordings were scored using the Communication and Critical Thinking Rubric each week. Students first week's scores were interpreted by the teacher-researchers and compared to the fourth week's scores to determine growth in the areas of communication and critical thinking

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Using the data seen in Figure 5, the elementary 4th-grade students' scores for communication for the first week had a mean of 2.72. The scores for those students when assessing week four in the area of communication had a mean of 2.28. From week one to week four the 4th-grade students showed negative growth. The sixth-grade students scores in the area of communication skills for the first week had a mean of 1.13. The fourth-week assessment had a mean of 2.28 for the communication skills category. A t-test paired difference was used to compare the before and after communication rubric scores. The data indicates growth in the area of communication skills for sixth-grade students but not for fourth-grade students. The derived t-statistics (Appendix ?) for the sixth grade was -9.12 and 1.74 for the fourth-grade students'. The communication scores showed statistical significance for the sixth graders (p-value 0.00007), but not for the fourth-grade students (p-value 0.099).

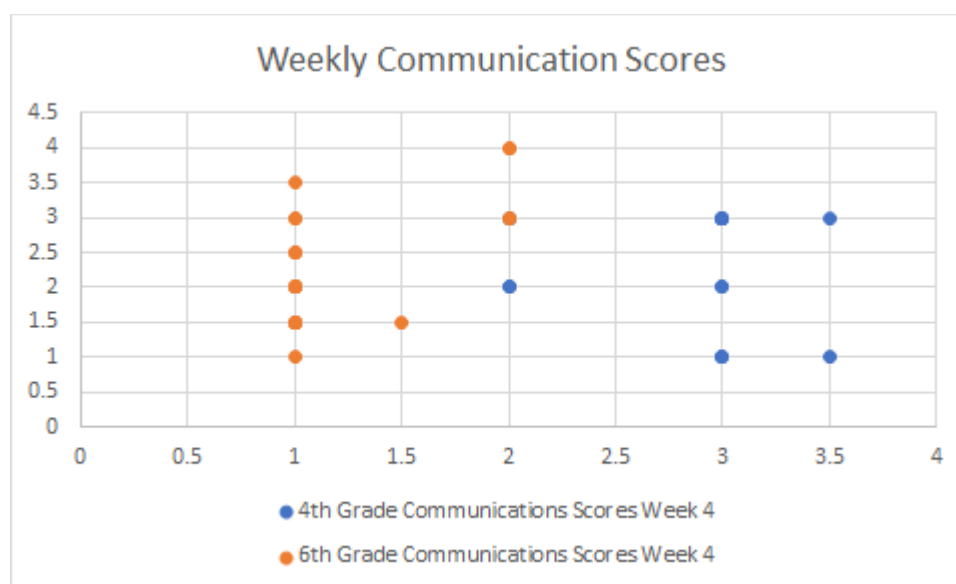


Figure 5. Fourth and sixth-grade students' raw data scores for the communication skills rubric for week 1 and week 4.

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Analysis of the data in Figure 6, the elementary fourth-grade students' scores for critical thinking for the first week had a mean of 2.53. The scores for those students when assessing week four in the area of critical thinking had a mean of 2.28. From week one to week four the 4th-grade students showed negative growth. The middle school 6th graders had a mean score after week one of 1.0 in the area of critical thinking. The week four assessment showed a mean score of 2.0. The paired t-test for the week one to week four in the area of critical thinking yielded a value of 0.89 with a p-value of 0.39 for fourth-grade students. The middle school sixth-grade students scores gave a value for the paired t-test for weeks one to four, of -5.88 for, with a p-value of 0.003. This data indicates that there was a slightly significant decrease in growth in the area of critical thinking for fourth-grade students. There was a significant increase in critical thinking skills scores for the sixth-grade students.

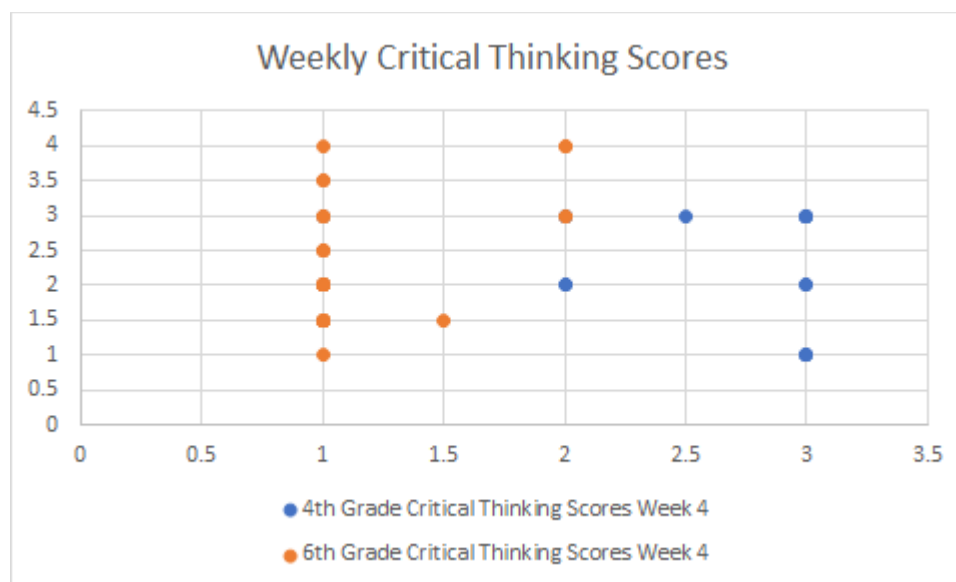


Figure 6. Fourth and sixth-grade students' raw data scores for the critical thinking skills rubric for week 1 and week 4.

Teacher Reflection on Personalized Learning

Teacher-researchers wrote in a Daily Teacher Journal. It addressed the time it took to plan the lessons, how the learning went, the redirecting needed of students, as well as notes on questions students had. The teacher notes were another source used to answer the three questions about the impact of personalized learning on learner agency, communication, and critical thinking.

The first question in the teacher’s daily journal asked the teacher-researchers to describe the day in one word. For the elementary teacher-researcher, the proportion of positive responses was 71%. The proportion positive responses for the middle school teacher-researcher was 64%. The combined proportion of responses that were coded as “positive” was 68%, compared to the proportion of negative and neutral coded responses as 20% and 12% respectively.

Table 2:

Proportional Responses for Question 1: In one word, how do you feel about math class today?

<i>School/Grade Level</i>	<i>Negative</i>	<i>Neutral</i>	<i>Positive</i>
<i>Elementary/4th Grade</i>	2 (14%)	2 (14%)	10 (71%)
<i>Middle/6th Grade</i>	3 (27%)	1(9%)	7 (64%)
<i>Total</i>	5 (20%)	3 (12%)	17 (68%)

The second question in the teacher’s daily journal asked the teacher-researchers to report the amount of time they spent preparing for the lesson for that day. 79% of the responses from the elementary teacher-researcher were in the 0-30 minute range, while

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the middle school teacher-researcher reported spending 0-30 minutes planning 64% of the time. The elementary teacher-researcher reported spending 31-60 minutes planning in 21% of the responses, the middle school teacher-researcher reported 31-60 minutes planning in 27% of the responses. The elementary teacher-researcher had 0% of the responses as spending more than 60 minutes planning, and the middle school teacher researcher reported spending more than 60 minutes planning just one time, or 9%. In total, 72% of the responses were planning for 0-30 minutes, 31-60 minutes planning was reported in 24% of the responses, and 4% of the responses were for 60 minutes or more time spent planning.

Table 3

Proportional response for Question 2: How much time was spent preparing for today's lesson?

<i>School/Grade Level</i>	<i>0-30 Minutes</i>	<i>31-60 Minutes</i>	<i>More than 60 minutes</i>
<i>Elementary/4th Grade</i>	<i>11 (79%)</i>	<i>3(21%)</i>	<i>0 (0%)</i>
<i>Middle/6th Grade</i>	<i>7 (64%)</i>	<i>3 (27%)</i>	<i>1 (9%)</i>
<i>Total</i>	<i>18 (72%)</i>	<i>6 (24%)</i>	<i>1 (4%)</i>

The final question in the teacher's daily journal asked the teacher-researchers to select the range for the total number of times that the teacher-researcher had to redirect students, either individual students, small groups, or the entire class were included in the total count.

In the elementary classroom, 64% of the responses were in the category of 0-5 redirections, 21% in the 6-10 redirections category, 14% in the 11-15 times category, and 0% of the responses were in the more than 15times category. In the middle school setting

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27% of the responses were in the 0-5 times category, 73% of the responses were in the 6-10 times category, 1% in the 11-15 times category and 18% of the responses were in the more than 15 times category. A total of 80% of the responses were in the 0-5 and 6-10 times categories combined, with 20% of the responses in categories over 11 redirections required in the class period.

Table 4

Proportional response for Question 3: Student Agency: How often did you need to redirect students today?

<i>School/Grade Level</i>	<i>0-5 Times</i>	<i>6-10 Times</i>	<i>11-15 Times</i>	<i>More than 15 Times</i>
<i>Elementary/4th Grade</i>	<i>9 (64%)</i>	<i>3 (21%)</i>	<i>2 (14%)</i>	<i>0 (0%)</i>
<i>Middle/6th Grade</i>	<i>3 (27%)</i>	<i>5 (73%)</i>	<i>1 (9%)</i>	<i>2 (18%)</i>
<i>Total</i>	<i>12 (48%)</i>	<i>8 (32%)</i>	<i>3 (12%)</i>	<i>2 (8%)</i>

Student Reflection on Personalized Learning

Student-subjects wrote in a Daily Digital Exit Slip. It asked students to use a Likert scale from 1-5 to gauge their preference for working in the personalized learning format for each class period. A selection of 1 meant that the student did not at all prefer working in the personalized learning format, and a selection of 5 meant that the student completely preferred working in the personalized learning format that day.

The mean and mode response for the middle school students' responses was 3.1 and 3 respectively. The mean of elementary responses was 4.1, and the mode was 5. Overall, the mean response was 3.5, and the mode response was 3 (see Appendix D). The proportional responses for elementary students were that 95% of the responses were

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a score of 3 or higher. The proportion of middle school student responses that were 3 or higher was 68%.

Table 5

Proportional Likert scale responses for the question: I prefer to work in a personalized learning classroom.

<i>School/Grade Level</i>	<i>I Not At</i>				
	<i>All</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5 Completely</i>
<i>Elementary/4th Grade</i>	<i>7 (2%)</i>	<i>9 (3%)</i>	<i>60 (21%)</i>	<i>97 (34%)</i>	<i>114 (40%)</i>
<i>Middle/6th Grade</i>	<i>26 (8%)</i>	<i>84 (15%)</i>	<i>114 (34%)</i>	<i>59 (17%)</i>	<i>56 (17%)</i>
<i>Total</i>	<i>33 (5%)</i>	<i>93 (15%)</i>	<i>174 (28%)</i>	<i>156 (25%)</i>	<i>170 (27%)</i>

The findings of this action research project show that after four week personalized learning unit students exhibited growth in the area of mindset and learner agency. Sixth-grade students showed growth in communication, and critical thinking skills. Teacher-researchers used positive words to describe most of the days during the four week unit, mostly spent 0-30 minutes on planning for each day during the unit, and on most days, redirected students 0-5 times. Students in both fourth and sixth-grade responded mostly from 3-5 on the Likert scale that they preferred to work in the personalized learning format. The findings of this action research project support using personalized learning in the classroom to increase student agency, communication, and critical thinking skills.

Conclusion

The objective of this action research was to increase student agency, communication, and critical thinking skills in students by employing a personalized learning format. The intended outcome was that students would take more responsibility for their own learning while engaging in personalized learning math units. Teacher-directed activities offered various choices. Learners set their own pace and made decisions about which type of activities to complete to achieve the learning targets. Teacher-researchers also hoped to see growth in the communication and critical thinking skills of students.

Based on the findings of our Action Research, we drew several conclusions. Learner agency mindsets and ownership of learning grew over the four week personalized learning unit. Sixth-grade students' communication and critical thinking skills increased. The fourth-grade group did not exhibit growth in communication or critical thinking. Reflecting on the question asked in week four of the study, it is believed that the question was more challenging than the question in week one. The week one question was a review concept that was scaffolding to the more difficult new to fourth-graders concept of long division. Teacher-researchers felt as though the personalized learning days went well. The middle school students required more redirections than elementary school students. The teacher-researchers believe that this is within the "normal" range for redirections required in their classrooms. Overall

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personalized learning was viewed positively by students. The learning format was received more favorably by the fourth graders than the sixth-grade students.

Although the research results indicate that personalized learning daily prep was comparable to typical lesson planning there are a few other factors to consider regarding time. Both teacher-researchers took a great deal of time locating and organizing materials to support each standard before beginning the unit. Once this is done, it can be used in the future. Before reusing the unit materials, online resources would need to be checked to be sure they are still accessible and available for use.

After reviewing our data, our research team considered how different student demographics, such as age, gender, race, and special education qualifications, might affect learner agency, critical thinking, and communication. With further study, we may have been interested in the opportunity to look for significance in those factors and the students' growth in agency, critical thinking, and communication as well as learning preferences.

More research specific to teaching students, teachers, and parents about mindset, learner agency, communication, and critical thinking may be necessary. It would also be helpful to provide professional development where teachers can plan, collaborate, and develop personalized learning units. Additional research could determine best practices in personalized learning for different student demographics such as age, gender, race, and special education qualifications, Future research may help us further understand how to best implement personalized learning.

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A great amount of emphasis is placed on standards and academic achievement yet one of the primary responsibilities of educators is to prepare students for their futures. The driving force behind 21st Century learning is preparing students to be successful in today's world. To achieve, students need to have learner agency, critical thinking, and communication skills. Students are provided opportunities to persevere, think abstractly, engage in productive struggle, and work to improve within the structure of a personalized learning format.

We hope the findings of our research encourages other teachers to consider the intentional methods of instruction, curriculum, and learning environments which are key components in meeting individual student's needs and teaching 21st-century skills. Educators have the power and responsibility to cultivate a desire for students to become lifelong learners.

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Appendix A
New Tech Network Agency Rubric

Figure 1:

NTN Agency Rubric, Grade 5

The ability to develop and reflect on growth mindset and demonstrate ownership over one's learning.



New Tech Network

	EMERGING	E/D	DEVELOPING	D/P	PROFICIENT	P/A	ADVANCED
GROWTH MINDSET	<ul style="list-style-type: none"> Is often hesitant to practice skills, even with encouragement Is often hesitant to take risks in their learning, even with encouragement Struggles to work through challenges without help or easily gives up Struggles to identify strengths Struggles to see failures and challenges as an opportunity for growth 		<ul style="list-style-type: none"> Shows a limited willingness to practice skills in order to get better at something Takes limited risks in their learning or takes risks only with encouragement Attempts to work through challenges but may easily give up Struggles to build confidence from their strengths Is beginning to see failures and challenges as an opportunity for growth 		<ul style="list-style-type: none"> Understands how practice and effort helps them to improve Often takes risks in their learning (takes on challenges, goes beyond, etc.) Works through challenges before asking for help Builds confidence from their strengths Sees failures and challenges as an opportunity for growth 		<p>In addition...</p> <ul style="list-style-type: none"> Actively works to improve skills through practice and effort Independently reflects on their actions, decision-making, and learning (strengths, areas for growth, needs, etc.)
OWNERSHIP OVER LEARNING	<ul style="list-style-type: none"> Is unable to complete tasks in a reasonable timeline Struggles to see value in feedback offered Struggles to complete tasks Is often distracted and does not often participate in class discussions Has not developed strategies for staying focused and on task Is hesitant to begin work on tasks even after teacher or peer prompting Struggles to build or maintain relationships and feels uncomfortable asking others for help 		<ul style="list-style-type: none"> Completes assignments at slower pace or alternative timeline Understands the purpose of feedback and receives it courteously Is able to complete tasks Participates somewhat in class discussions Has a limited number of strategies for staying focused and on task Gets started fairly quickly on tasks after teacher prompt or direction Maintains some relationships with others and asks a limited number of individuals for help 		<ul style="list-style-type: none"> Completes assignments and benchmarks on time Accepts feedback and uses that feedback to improve their work Is able to use a variety of strategies for tackling a task Actively participates in class discussions and activities Has developed a set of strategies for remaining focused and on task during work time Gets started on tasks without prompting from the teacher Builds positive relationships with others and feels comfortable asking others for help. 		<p>In addition...</p> <ul style="list-style-type: none"> Confidently seeks out resources and supports when needed in order to create higher quality work Actively seeks feedback from others in order to revise their work Monitors the effectiveness of strategies used for tackling a task and is able to adjust as needed

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Appendix B
Derived t-Statistics for Learner Agency Mindset

<i>Growth Mindset</i>	<i>4th Grade Before</i>	<i>4th Grade After</i>	<i>6th Grade Before</i>	<i>6th Grade After</i>
Mean	1.83	2.48	1.35	2.47
Standard Error	0.14	0.14	0.1	0.18
Median	2.00	2.00	1	2.5
Mode	2.00	2.00	1	3
Standard Deviation	0.65	0.67	0.6	1.02
Sample Variance	0.42	0.44	0.36	1.04
Kurtosis	-0.46	0.03	1.42	-1.06
Skewness	0.18	0.09	1.52	-0.01
Range	2.00	3.00	2	3
Minimum	1.00	1.00	1	1
Maximum	3.00	4.00	3	4
Sum	42.00	57.00	46	84
Count	23.00	23.00	34	34
Largest(1)	3.00	4.00	3	4
Smallest(1)	1.00	1.00	1	1
Confidence Level(95.0%)	0.28	0.29	0.21	0.36
Observations	23.00	23	34	34
Pearson Correlation	0.73		0.712732	
Hypothesized Mean Difference	0.00		0	
df	22.00		33	
t Stat	-6.42		-8.94165	
P(T<=t) one-tail	0.00		1.23E-10	
t Critical one-tail	1.72		1.69236	
P(T<=t) two-tail	0.00		2.47E-10	
t Critical two-tail	2.07		2.034515	

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Appendix C
Derived t-Statistics for Learner Agency Ownership Over Learning

<i>Ownership of Learning</i>	<i>4th Grade Before</i>	<i>4th Grade After</i>	<i>6th Grade Before</i>	<i>6th Grade After</i>
Mean	1.91	2.39	1.18	2.50
Standard Error	0.15	0.14	0.08	0.16
Median	2.00	2.00	1.00	3.00
Mode	2.00	2.00	1.00	3.00
Standard Deviation	0.73	0.66	0.46	0.96
Sample Variance	0.54	0.43	0.21	0.92
Kurtosis	-1.01	0.36	7.33	-0.86
Skewness	0.14	0.44	2.72	-0.11
Range	2.00	3.00	2.00	3.00
Minimum	1.00	1.00	1.00	1.00
Maximum	3.00	4.00	3.00	4.00
Sum	44.00	55.00	40.00	85.00
Count	23.00	23.00	34.00	34.00
Largest(1)	3.00	4.00	3.00	4.00
Smallest(1)	1.00	1.00	1.00	1.00
Confidence Level(95.0%)	0.32	0.28	0.16	0.34
Observations	23	23	34	34
Pearson Correlation	0.73509		0.549824	
Hypothesized Mean Difference	0		0	
df	22		33	
t Stat	-4.49073		-9.57427	
P(T<=t) one-tail	9.10E-05		2.38E-11	
t Critical one-tail	1.717144		1.69236	
P(T<=t) two-tail	0.000182		4.76E-11	
t Critical two-tail	2.073873		2.034515	

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Appendix D

Derived Statistics for Student Preference for Working in a Personalized Learning Format

Student reflection question: *I prefer to work in a personalized learning classroom.*
 Rated 1-5 with 1 being "Not at all" and 5 being "Completely".

<i>Student Preference for PL</i>	<i>4th Grade</i>	<i>6th Grade</i>	<i>All Responses</i>
Mean	4.05	3.10	3.54
Standard Error	0.06	0.06	0.05
Median	4.00	3.00	4
Mode	5.00	3.00	3
Standard Deviation	0.98	1.18	1.19
Sample Variance	0.95	1.38	1.41
Kurtosis	0.64	-0.83	-0.82
Skewness	-0.95	0.13	-0.35
Range	4.00	4.00	4
Minimum	1.00	1.00	1
Maximum	5.00	5.00	5
Sum	1,163.00	1,052.00	2215
Count	287.00	339.00	626
Largest(1)	5.00	5.00	5
Smallest(1)	1.00	1.00	1
Confidence Level(95.0%)	0.11	0.13	0.09