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Influence of Project-Based Learning and Homogeneous Grouping on Gifted Students' Cognitive Abilities

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Walden University
2020

Abstract

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MA, Walden University, 2005

BS, Rutgers University, 1988

Project Study Submitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

The problem investigated in this study was the lack of an appropriate educational setting for gifted and talented students (GATSs) in New Jersey. Accordingly, the purpose of this study was to determine the differences in cognitive abilities between GATSs who participated in project-based learning (PBL), and if so, in homogeneous grouping (HG) or not, and GATSs who did not participate in PBL. The theoretical frameworks used in this study were the theories of learning, creativity, and critical thinking of Vygotsky and Piaget. The research questions addressed differences in GATSs' cognitive abilities as measured by score changes in the scaled verbal, quantitative, nonverbal, and composite cognitive abilities test (COGAT) scores of GATSs who participated in PBL, and if so, in HG, as compared with GATSs who did not participate. In this causal-comparative study, the changes in COGAT scaled scores from 77 GATSs who chose to participate in PBL and 77 GATSs who did not participate were compared. An additional comparison was made within the group of 77 GATSs who learned in homogeneous (n = 34) and heterogenous (n = 43) environments. Due to the small sample size and nonnormality, a Kruskal Wallis test was conducted for each grade level with most results showing a significant difference in COGAT change scores for PBL participants, but not for HG participants. This finding suggests that, from the examined instructional interventions, only PBL has a positive effect on GATSs' cognitive abilities. The results of this study led to the creation of a PBL curriculum plan. This study contributes to positive social change by providing a PBL plan that includes specific examples of what type of instruction might best be suited for GATSs and the fostering of their cognitive abilities.

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Dedication

This study is dedicated to my husband, Vincent Holman. I would not have been able to achieve this dream without you encouraging me to fulfill my wildest ambitions and helping me to fly.

I also dedicate this to my daughters, Melissa and Vanessa Holman. You are my inspiration. I hope my educational journey has shown you that there are no limits to what you can do in life.

Finally, this study is dedicated to Tamika Pierce, Randolph Dixon, Geneva Vanderveer and the many others who lost their lives during the pandemic. Although you are gone, you live on in the lives of the people you touched.

Acknowledgments

I acknowledge all those who encouraged me to strive to be more than I was. I thank God, who gave me the strength and patience to overcome the challenges that I faced to complete this degree. My sincere gratitude to my parents who showed me the value of an education. My thanks to my siblings who have always supported their baby sister‘s ambitions.

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Section 1: The Problem

Gifted and talented students (GATSs) are not always educationally challenged when attending regular schools, which can adversely affect their overall academic performances. Recent research has found that GATSs were challenged educationally when they were given real-life problem-solving and project-based instruction (Horak & Galluzzo, 2017; Schmitt & Goebel, 2015). Therefore, East Side Charter School (ESC; a pseudonym) started a pilot gifted and talented education program (GATP) in the 2010–2011 school year that included project-based learning (PBL) and homogeneous grouping (HG).

The Local Problem

The problem investigated in this study was the lack of an appropriate educational setting for GATSs at ESC located in New Jersey. Teachers discussed the lower than expected performance of GATSs during the weekly grade-level meetings led by grade-level lead teachers and supervisors during the 2008–2009 school year. In these meetings, the teachers at ESC reported that while they did provide enrichment activities to the higher-level students, such as higher-level worksheets or books, most of the classroom instructional activities were focused on the average student. The State of New Jersey requires that the educational needs of GATSs be addressed with a school board-approved educational program that adheres to the National Association for Gifted Children's Gifted Programming Standards, which were adopted in 2010 (National Association for Gifted Children, n.d.). As a result, ESC initiated a pilot GATP that included PBL and HG for students who had scored above grade level on the New Jersey standardized tests for the

2010–2011 school year. Due to a lack of funding, the pilot program was discontinued after 3 years.

Sisk (1990) claimed that during the 20th century, interest in special GATSs services and associated federal funding for such programs occurred in waves, which were followed by periods of disinterest. Following the release of the Marland Report in 1972, many GATP were created during the 1970s (Feldhusen, 1985). Additionally, Sisk stated that the report gave a federal definition for giftedness and outlined the challenges and needs for effective gifted education in the United States. As a result, there was also a significant increase in advocacy groups and research journals dedicated to working with GATSs (Sisk, 1990). Following these innovations, federal laws were passed during the 1980s that provided funding for gifted and talented education (Feldhusen, 1985; Greer, 1990; Stanley, 1976).

Since then, federal funding for and federal interest in gifted and talented education has been inconsistent, with annual spending being far below the $250 million annual allocations of the early 1960s (Jolly & Kettler, 2008; Jolly & Robins, 2016; Samuels, 2010). Although there has been ongoing research on the topic, implementation has not consistently followed. In the wake of the No Child Left Behind Act of 2001 (U.S. Department of Education, 2007), most states, including New Jersey, focused their spending on improving the performances of lower-performing students (Gallagher, 2015; Hodges, 2018; Kettler, Russell, & Puryear, 2015). Many educators believe that GATSs do not require special services to meet their educational needs, with the prevailing thought among general educators being that teachers in traditional classrooms are able to

meet the educational needs of their low, average, and high-achieving students by differentiating instruction and using cooperative learning methods (Archambault et al., 1993; Bernal, 2003; Colangelo, Assouline, & Gross, 2004; Duffett et al., 2008; Gentry, 2006; Grgich, 2009; Troxclair, 2013; Yuen et al., 2016). However, some other educators claimed that similar to lower-achieving students who require special services to meet their educational needs, such as smaller classrooms, instruction with similar students, different pacing, and resources teachers, different instructional strategies are needed to meet the educational needs of GATSs (Ecker-Lyster & Niileksela, 2017; Jolly & Hughes, 2015; Miedijensky, 2018; Yeung, 2014).

Rationale

ESC's annual report stated that the administration and teachers at the school review the standardized test scores of all students in Grades 1 to 4 during their grade-level meetings to identify students with achievement deficits and to determine the specific subjects or skill sets that are lacking. Like many educators, teachers at ESC use tests to examine their own practices and guide their classroom instruction (Christie, 2007). If available, extra resources, such as tutoring, are provided to increase student performances at ESC. The high-achieving students at ESC did not receive special support until the pilot GATP was inaugurated in 2010 offering PBL and HG for GATSs. However, the effectiveness of the program was not determined. Therefore, the purpose of this study was to determine the differences in cognitive abilities between GATSs who participated in PBL, and if so, in HG or not, and GATSs who did not participate in PBL at ESC.

Definition of Terms

Creativity: The process of generating a product using inventiveness (Lucas, 2016; Paul & Elder, 2006). Creativity can be expressed through several different modalities, including intellectual, artistic, or imaginative. Creative students generate new and useful products to meet a specific need. Critical thinking is an essential process in creativity because students are unable to generate new, innovative products or ideas without critically assessing what already exists; otherwise, the product would be derivative. Creativity requires students to evaluate and synthesize information to identify the deficit in existing intellectual, artistic, or imaginative structures (Handa, 2013).

Critical thinking: A meta-cognitive process that assesses the quality of thinking to achieve a challenging end product (Paul & Elder, 2006). Critical thinking is a continuous process that encompasses the higher-order thinking skills of analysis, evaluation, and synthesis. Critical thinkers are encouraged to synthesize information from different sources, usually in cooperative small groups, and evaluate it with the aim of refining their own thinking (Mehta & Al-Mahrooqi, 2014).

Differentiated instruction: An instructional method in which instructional tasks are completed in leveled groups to meet different student developmental. Students may be grouped homogeneously or heterogeneously depending on the task they need to complete or the skills they need to master. Because differentiated instruction ensures that all students become engaged in the learning process, the instruction is neither too difficult nor too simple. In addition, the student groupings are dynamic and, therefore, change with student needs (Tomlinson, 2005; Watts-Taffe et al., 2012).

Gifted and talented: While the Marland Report established a federal definition for giftedness, there has been no universally agreed-upon definition for what is considered gifted and talented. Unlike most theorists, Renzulli (2012) used the term to describe the behaviors that students exhibit rather than the inherent characteristics they possess. For this study, however, the definition for gifted and talented was based on the mastery model, which claims that a child can be recognized as gifted and talented when there is a marked difference between the child's developmental level and the educational program level available to that child. That is, the gifted and talented child has a subject level mastery that is exceptional for his/her age, which means that the child needs to receive different instruction if his/her educational needs are to be adequately met (Matthews & Foster, 2006).

High achieving: A level of student performance that is either at or above the 90th percentile or a performance level in the top 10% of the student population (Duffett et al., 2008). The mastery model claims that high achievement is a criterion for the identification of GATSs; however, despite their ability, because of underperformance, not all gifted, and especially those from non-White backgrounds, perform at this level (Olszewski-Kubilius & Steenbergen-Hu, 2017).

Homogenous grouping (HG): An educational strategy that seeks to advance the learning outcomes of students. Students are grouped with students of similar abilities, either part-time or full-time, which enables them to learn from each other. Enrichment clustering, the pull-out instruction that enables teachers to differentiate their instruction to

meet the educational needs of the GATSs, is the HG examined in this paper (see Kokotsaki, Menzies, & Wiggins, 2016; Matthews et al., 2013).

Project-based learning (PBL): An instructional method in which students use critical thinking and creativity to solve a problem, design a model, or make a decision. Innovation, synthesis, and evaluation are some of the skills observed in students participating in PBL, which employs authentic situations so that students can use their knowledge to reach conclusions and communicate their findings to others (Blumenfeld et al., 1991; David, 2008; Kokotsaki et al., 2016).

Significance of the Study

Researchers in the field of gifted and talented education have proposed that GATSs can be better served educationally when put in more challenging learning environments than regular classrooms (Assouline et al., 2015; Brigandi, Weiner, Siegle, Gubbins, & Little, 2018; Colangelo et al., 2004; Delcort, Cornell, & Goldberg, 2007; Duffett et al., 2008; Mendoza, 2006). In the local setting, it was not only interesting to see if the pilot GATP raised the academic achievement of GATSs, but the results of this study also allow for some initial discussion of whether PBL and ability grouping benefitted the primarily African American and Hispanic student population of ECS. African American and Hispanic students have traditionally been underrepresented in GATPs (Grissom & Redding, 2016; Sparks, 2015). The lack of racial diversity in GATPs is a contributing factor to the growing excellence gap between White and non-White students in the United States (Sparks, 2015; Tomlinson & Jarvis, 2014).

Research Questions and Hypotheses

The purpose of this study was to determine the differences in cognitive abilities between GATSs who participated in PBL, and if so, in HG or not, and GATSs who did not participate in PBL at ESC. The following research questions guided this study:

RQ1: What are the differences in scaled verbal, quantitative, nonverbal, and combined composite Cognitive Abilities Test (COGAT) score changes of GATSs who participated in PBL and those who did not participate in PBL?

$H_0$1: There are no differences in the scaled verbal, quantitative, nonverbal, and combined composite COGAT score changes of GATSs who participated in PBL and those who did not participate in PBL.

H_a1: There are differences in the scaled verbal, quantitative, nonverbal, and combined composite COGAT score changes of GATSs who participated in PBL and GATSs who did not participate in PBL.

RQ2: What are the differences in the scaled verbal, quantitative, nonverbal, and combined composite COGAT score changes of GATSs who participated in HG and GATSs who did not participate in HG?

$H_0$2: There are no differences in the scaled verbal, quantitative, nonverbal, and combined composite COGAT score changes of GATSs who participated in HG and GATSs who did not participate in HG.

H_a2: There are no differences in the scaled verbal, quantitative, nonverbal, and combined composite COGAT score changes of GATSs who participated in HG and GATSs who did not participate in HG.

Review of the Literature

Because of the NCLB policy and the introduction of high-stakes testing, schools began focusing on ensuring that all students were meeting the required educational standards; however, while this was commendable, those students who were already meeting or exceeding these standards were often ignored, which could possibly have a negative effect on their long-term educational outcomes (Gentry, 2006; Siemer, 2009). Therefore, in this literature review, I examined the neglect of GATSs and their current educational settings as well as strategies that could alleviate this situation. The Walden University Library Education Research search engine was used to search the following key terms: *gifted and talented education (GATE), project-based learning (PBL), differentiated instruction (DI),* and *homogeneous grouping (HG).* While most seminal articles from peer-reviewed journals and handbooks were written in the 1960s and 1970s, using delimiters, I found a sufficient number of articles that were published in or after 2015.

Theoretical Foundation

I based this study on developmental psychology theories and the work of Piaget and Vygotsky. Piaget (2001) developed the theory of staged cognitive development in infants and children, and Vygotsky (2016) developed the theory of the effect of social interactions on cognitive development. For example, grouping and PBL are related to Vygotsky's zone of proximal development ((ZPD) and give students the space to perform at their highest level.

In the theory of cognitive development, Piaget outlined four discrete stages for the manner in which children construct knowledge through their interactions with their environment. Learning is an independent activity in which children attempt to make sense of unknowns in their environments (Piaget, 2001; Qayumi, 2001). As children interact with their environments, they organize the information into patterns or schemata; however, as children encounter information that does not fit their current schemata, they experience dissonance (i.e., a disconnect between what they know and what they are experiencing), which causes them to search for new explanations and construct new knowledge to dissipate the dissonance (Piaget, 2001; Qayumi, 2001). Children adapt to these disconnects using their prior knowledge to make changes to, refine, and create new schemata (Gordon, 2016; Tanner, 2016). Because cognitive development occurs in discrete stages, students need to have sufficient cognitive development for learning to take place, and for children to learn, they need to experience their environment through hands-on activities and play (Lourenço, 2012; Qayumi, 2001; Vygotsky, 2016)).

Vygotsky's (2016) theory of cognitive development is based on the relationship between social interaction and learning. Vygotsky theorized that children learned from those who knew more than they, such as adults and their peers, and that social interactions preceded cognitive growth and development. Learning takes place in the ZPD, which is the difference between what a child can do independently and what they can accomplish through interactions (i.e., instruction) with people who have a greater skillset (Clapper, 2015; Lourenco, 2012). A child knows the task she or he wants to accomplish, has the basic skill set, and requires only limited guidance from the expert to

complete the task, which the student can then repeat independently (Ardila, 2016; Lourenço, 2012). An expert provides the initial support and removes it when it is no longer needed, much like scaffolding provides a temporary support for construction.

At first glance it may appear that the theories of cognitive development of Piaget and Vygotsky are contradictory; however, they are in fact complementary and provided support for this study. The environment is not the sole contributing factor in a child's cognitive development (Ardila, 2016). Because children do not exist in a vacuum, most of their interactions occur in both a physical and social environment; therefore, collaboration and shared schemata enable children to learn from one another (Kaur, 2017; Lourenço, 2012). Students grow and learn through both Piaget's cognitive dissonance and Vygotsky's social interactions. PBL encompasses both these constructivist theorists because it is a hands-on educational approach in which the children collaborate and build knowledge through active problem-solving (Kaur, 2017; Webb, 1980).

Collaboration is essential for learning because children can experience the greatest success when they are able to work together. While diverse heterogeneous groups are the norm in most classrooms, students have been found to achieve the greatest gains when they are grouped with students who are slightly above or below them because they are able to move within their ZPD when the relative levels of understanding are similar (Clapper, 2015). However, when there are larger gaps in understanding students are often discouraged from interacting and questioning each other (Mouw, Saab, Janssen, & Vedder, 2019). In heterogeneous groups, students either take on the role of a student or

a teacher, which prevents the interactions necessary to move through their ZPD (Mouw et al., 2019).

Similarly, because most projects in PBL are designed to be just above students' levels of independent understanding, the students move through their ZPD to learn, increase their understanding, and develop skills (Clapper, 2015). When students are interacting with their peers and assisting each other to solve problems, they take on the roles of both teachers and learners and are working through their ZPD to further their understanding. This type of scaffolding is fostered through the students' interactions and the teacher's support, which leads to the project tasks being resolved and movement within students' ZPD (Kokotsaki et al., 2016). However, because this movement most often occurs most frequently when students are placed in similar ability groups, PBL in HG results in greater learning because students can more easily shift their ZPD (Clapper, 2015; Mouw et al., 2019).

Gifted and Talented Education

The United States has a long tradition of educating all its children, with average students usually being educated in traditional classrooms and other differently abled students being taught in settings that best suit their educational needs (Greer, 1990; VanTassel-Baska, 2018). To provide additional support, learning-disabled students are educated in inclusion classrooms with extra support as well as in traditional, self-contained classrooms (Greer, 1990). Theoretically, from kindergarten through high school, schools should provide students with the best educational settings for their individual learning; however, this has not been the usual case with GATSs. Merry (2008)

claimed that GATSs are placed in traditional classrooms under the assumption that these students can raise the performance levels of the lower-achieving students and will increase their own achievements without assistance.

GAT education in the United States has been discussed for decades. Beginning in the 20th century, GAT education proponents have argued that GATSs require different educational opportunities outside the traditional classroom (Coleman, 1999; Jolly, 2005). During the 1920s and 1930s, early researchers, such as Hollingsworth and Terman, studied high-achieving students and recognized that they possessed unique qualities, such as superior intelligence, creativity, and leadership (Coleman, 1999; Feldhusen, 1985). According to Feldhusen (1985), Terman's groundbreaking work in 1921 and the work of Hollingsworth from 1926, both determined that GATSs were not receiving the education they needed, with their subsequent studies finding that students who had received some form of academic acceleration performed better in college and were more motivated than their peers (Jolly, 2005; Jolly & Kettler, 2008).

Feldhusen (1985) noted that Terman studied the long-term effects of not meeting the needs of GATSs and claimed that "those who were held back languished in idleness throughout the grades and did not develop the habits or motivation necessary to succeed in high school or college" (p. 2). In addition, Feldhusen noted that Hollingsworth found that GATSs "wasted much of their time in elementary schools…and learned habits of getting by without effort" (p. 2). Feldhusen also noted that Hildreth had recommended GATSs should be educated with students of similar ability, and believed that elementary

students benefited most from enriched educational environments and older students benefited more from a combination of acceleration and enriched educational activities.

Interest in GAT education waxed and waned during the 20th century, and despite the research findings, implementation languished during the 1940s and 1950s Feldhusen, 1985However, the establishment of advocacy and support programs, such as the National Association for Gifted Children and the Association of the Gifted, during the 1960s brought national attention to the need for GAT education (Jolly & Robins, 2016). Consequently, after the Sputnik launch refocused attention on the needs of the future in the United States, interest in GAT education revived during the 1960s and 1970s (Coleman, 1999; Jolly & Robins, 2016; VanTassel-Baska, 2018). The release of the Marland Report in 1972, which stated that U.S. GATSs were not on par with those in other nations, included the first national definition for the gifted and talented and incited several state and federal governmental initiatives (Jolly & Robins, 2016). However, while the revival of an interest in GAT education was only made possible by the advocacy groups and the consequent Marland Report, the cycle of interest and disinterest continued for the remainder of the century (Coleman, 1999; Gallagher, 2015; Jolly & Kettler, 2008; Jolly & Robins, 2016).

Current support for GAT education is mixed, with just over half of all U.S. states having mandated GATP, but only four states fully funding these programs in 2014 (National Association for Gifted Children, 2015). In particular, after the introduction of high-stakes testing, the funding for GATP has fallen by the wayside (Gentry, 2006). For example, for every $100 spent on education, $34 is spent on the needs of exceptional

students with $33 of this devoted to students with disabilities and only $1 devoted to students with advanced abilities (DeNisco, 2014; Jolly & Hughes, 2015; Young et al., 2014). The consequences of not providing the best educational opportunities for students have been documented as have been the benefits to be gained by all students from the development of innovative GAT education practices (Yeung, 2014).

Prior to the pilot PBL program begun at ESC in the 2010–2011 school year, several factors were identified as impacting the GATSs at the school. ESC intended to develop differentiated instruction to challenge these students; however, teacher reports noted that this was not being done consistently. According to Gagné (2007), differentiation has been determined to be an effective strategy for GAT education. In addition, the lack of a definitive setting for GAT education contributed to the problem of the lack of appropriate educational setting for the GATSs at ECS because those students were not able to be educated with their peers (Ecker-Lyster & Niileksela, 2017; Olszewski-Kubilius & Steenbergen-Hu, 2017; Sparks, 2015). The school addressed these issues by implementing a pilot PBL curriculum program to meet their educational needs.

Differentiated Instruction

In most classrooms, teaching is geared toward the average student, which means that the educational needs of the students who are above and below this average are not being met; however, when teachers group students homogeneously, greater learning and achievement can take place (Brighton, Moon, & Huang, 2015; Connor & Morrison, 2016; Matthews, Ritchotte, & McBee, 2013). When differentiated instruction is offered, the education is provided in smaller instructional units geared to the level of the student

group, and when done correctly, these groupings ensure that the classroom instruction is relevant to a greater proportion of the students (Adelson & Carpenter, 2011; Park & Datnow, 2017; Van Tassel-Baska, 2017).

The assumption is that differentiation will meet the education needs of GATSs in a different way. Partly because of cost, separate classrooms and schools for differently abled students are being replaced by inclusive classrooms for both students requiring remediation and those requiring acceleration; however, the educational dollars that, in the past, were spent on GATP are frequently being shifted to remediation programs (Bernal, 2003; Colangelo et al., 2004). In differentiated classrooms, students learn at their own pace and from other students. George (2005) claimed that because the differentiated classroom replicated real cultural settings in which people and students of all levels work together and interact regardless of ability, there are opportunities for all students to achieve to their highest potential. Ideally, this is how differentiation is supposed to work; however, the differentiated classrooms of today are far from ideal.

Previously, differentiation was possible based on teacher expertise, with lesser experienced teachers focusing their instruction on the average student (Park & Datnow, 2017; Parks, 2019). Today, however, because of the wide-spread institutionalization of differentiation, both expert and novice teachers need to be able to deliver differentiated programs because school administrators require teachers to demonstrate greater flexibility and ensure that low-performing students achieve passing scores on the high-stakes tests (Connor & Morrison, 2016; George, 2005; Valli & Buese, 2007).

Although this differentiation trend is laudable, the goals of differentiation are frequently unmet because most teachers lack adequate training in the process (Archambault et al., 1993; Bogen, Schlendorf, Nicolino, & Morote, 2019;). Generally, because most teachers are unable to educationally accommodate their learning needs, GATSs require separate instruction (Brighton et al., 2015; Matthews et al., 2013; Moon, 2009; Young & Balli, 2014). Matthews et al. (2013) found that differentiated instruction in many classrooms consisted of individual options for projects and other assignments rather than by the employment of instructional groupings. Because of the requirements of high-stakes testing for NCLB and its successor the Every Student Succeeds Act (n.d.), rather than targeting instruction to raise the passing scores of the high-achieving students, the differentiation focus has been on ensuring that all students meet the minimum standards (Bernal, 2003; Duffett et al., 2008; Latz, Speirs Nuemeister, Adams, & Pierce, 2009); therefore, true differentiation has been put aside.

Several delivery options have been developed for successful targeted gifted and talented instruction (Bernal, 1993; Colangelo et al., 2004; Delcort et al., 2007; Van Tassel-Baska, 2017; Van Tassel-Baska & Brown, 2007). In their book, *A Nation Deceived: How School's Hold Back America's Brightest Students*, Colangelo et al. (2004) outlined 18 GAT education instruction methods, such as admitting students to school earlier than their same-age counterparts, extracurricular instruction (either before or after school), compacted the curriculum (decreasing the time spent), small group mentoring, and grade acceleration (Swan et al., 2015), with the best acceleration depending on both the students and the program goals.

Homogeneous Ability Grouping

HG is based on theories of fixed intelligence is the practice of grouping students based on their perceived intellectual abilities. While this practice of static grouping was commonplace in previous eras, it has fallen by the wayside (Park & Datnow, 2017). Ability grouping has been and remains a controversial subject because it has frequently been associated with tracking, which involves students permanently placed in an educational instruction sequence. Student tracking has been found to lead to educational inequities, particularly for students on the lower level tracks, because they receive levels of instruction and therefore have lower educational expectations. Tracking has also been associated with social, racial, and economic bias (Chmielewski, Dumont, & Trautwein, 2013; Matthews et al., 2013). Ability grouping, however, allows teachers to meet the educational needs of all students. Because all students in the class receive the same instruction, grouping facilitates instructional differentiation as teachers are able to provide remediation or enrichment to small groups of students. Because ability level groups are smaller, this also assists in developing student self-esteem as they are able to experience greater success within the group (Chmielewski et al., 2013; Yuen et al., 2016) and the students are periodically assessed rather than being permanently tracked. Pull-out GATSs grouping is a form of part-time between-class ability grouping, in which students within the school are grouped together based on ability. Because teachers frequently have fewer students performing at the highest levels in one classroom, grouping the highest performing students with others from different classes can provide these students with a differentiated curriculum that benefits them the most and it allows them to be educated

with their peers, which facilitates learning. GATSs report less boredom and greater engagement when grouped with comparable peers (Assouline et al., 2015; Lee, Olszewski-Kubilius, Makel, & Putallaz, 2015). It has been demonstrated that older GATSs benefit from these educational practices, therefore, the possibility exists that younger GATSs could also benefit (Horak & Galluzzo, 2017; Schmitt & Goebel, 2015).

Project-Based Learning

Grounded in the progressive education movement of the late 19th and early 20th centuries, PBL is an approach to learning that allows students to use their own knowledge bases to solve problems and construct new knowledge (Kokotsaki et al., 2016). Modern PBL is based on the educational theories of Dewey, Kilpatrick, and Piaget. Dewey believed that education was experiential and occurred through problem-solving and Kilpatrick believed learning occurred through social projects focused on student goals. While these two ideas appear similar, Dewey believed learning was teacher driven while Kilpatrick believed it was student focused (Gordon, 2016; Soutine, 2013). Building on these ideas, Piaget theorized that learning occurred because children constructed knowledge through their own experiences (Gordon, 2016; Tanner, 2016). Therefore, these cognitive theories have formed the foundation of modern PBL programs for the teaching of critical thinking skills, problem-solving, and creativity – the basic GAT education skillset. Students are given a problem that relates to them and motivates them to think creatively about the causes of the problem and the possible solutions (Grant & Branch, 2005; Harada, Kirio, & Yamamoto, 2008).

At the elementary school level, in particular, this is a multidisciplinary curricular approach, in which math, science, reading, and language are integrated to allow the students to form and articulate their solutions, analytically and reflectively (Duke, 2016; Grant & Branch, 2005; Hanney, 2018; Harada et al., 2008). Because the teacher does not predetermine the solution, the students are also encouraged to use their preferred learning styles and modes of intelligence to determine the solutions, with the teacher functioning more as a facilitator than an instructor. Therefore, PBL builds on the students' inherent skills and encourages student independence (David, 2008; Grant & Branch, 2005; Schalk, Schumacher, Barth, & Stern, 2018). Because there are no quick solutions to the problems, students are forced to demonstrate an in-depth knowledge of the subject matter rather than the cursory knowledge required for typical tests. Students engaged in PBL have been found to report a higher level of satisfaction with how the learning is presented and the educational gains they achieve (Gulbahar & Tinmaz, 2006).

This multidisciplinary approach is quite different from traditional education methods. Rather than the teacher expert transferring knowledge to students, teachers become guides students to construct their own knowledge. Despite the stated benefits, because of their changing roles teachers can be reluctant to implement PBL due to being uncomfortable with not being in control of students' learning. In addition, PBL works best in an open classroom structure which some teachers can be reluctant to implement. (Cook & Weaver, 2015; Revelle, 2019). Despite these barriers, as the skills, strategies, and dispositions that it promotes are the desired goals for GAT education, GATSs should

be given leave to deviate from slower-paced lessons, that cover material they already know or can easily master, to focus on faster-paced multidisciplinary curriculum.

Implications

Based on this research, it is clear that GATSs have different educational needs than other students and that sometimes these needs are not being met. In addition, the literature suggests that students who participate in PBL programs perform better than those who do not. It is also expected that homogeneously grouped GATSs would have increased academic performance compared to the nongrouped GATSs.

Summary

Most school districts have programs such as acceleration, or separate instruction that are designed to meet the needs of GATSs, and 94% of states have some type of legislation regarding GAT education (Sisk, 1990). The National Association for Gifted Children reported that 54% of states mandate the identification of GATSs and 48% mandate services for GATSs (National Association for Gifted Children, n.d.), with most programs usually being implemented at the upper elementary level. However, providing instruction in an appropriate setting is key to the success of the young GATSs because students who are not challenged in their classroom are frequently bored and often act out, which is particularly true in the early grades.

Because educational practices should be ability appropriate and developmentally appropriate, advancing children to the next grade or giving them advanced work is not always a viable option to meeting the educational needs of GATSs in a regular classroom. An effective alternative would be to provide separate targeted instruction, to

groups of GATSs that includes problem-solving and decision-making through inquiry, key components of GAT education.

The lack of such GAT education was and remains the main issue at the ESC, which means the educational needs of GATSs are not being met. The purpose of this study was to determine the differences in cognitive abilities between GATSs who participated in PBL and if so, in HG or not, and GATSs who did not participate in PBL at ESC. Section two of this doctoral research study contains details of the research study methodology including the rationale for performing this type of study and the chosen quantitative research design. The participant selection; the measures taken to confidentiality, before, during, and after the study; data description and its means of collection; the analysis framework; and the validity and quality are also given.

Section 2: The Methodology

During the initial year, 2010–2011, the full battery of the COGAT was administered, both in the fall and in the spring, to all ESC students from the first to the fourth grade. The students identified as GATSs were then grouped to receive PBL instruction. One year later, based on the preferences of the students and their parents, some students learned in HG, while other learned in a heterogeneous classroom setting.

Research Design and Approach

I designed this quantitative, quasi-experimental study to determine the differences in cognitive abilities, operationalized as the changes of the scaled verbal, quantitative, nonverbal, and composite COGAT scores, between GATSs who participated in PBL, and if so, in HG or not, and GATSs who did not participate in PBL at ESC. A quasi-experimental design was used because the data were retrieved from the school archive and random assignment was not possible. A 2x2 factorial design that included the possible interaction effects between the two treatments PBL and HG would have been more appropriate (see Cook & Cook, 2008; Creswell, 2003; Walker, 2005); however, due to the participant distribution, a 2x2 factorial design was not applicable. As a result, I examined the two research questions separately.

Setting and Sample

The study site, ESC, is a small charter school in a city. Established in 1999 with an enrollment of 200 students in two grades, the ESC has grown to encompass 500 students in five grades. In the spring of 2010, teachers identified a total of 154 GATSs for possible inclusion in the pilot GATP.

For RQ1, I used the COGAT scores of the first through fourth grade GATSs (N = 77) who were grouped for PBL instruction. These students had the following grade-level breakdown: first grade (n = 18), second grade (n = 20), third grade (n = 20), and fourth grade (n = 19). The control group consisted of 77 GATSs whose parents chose that their children not participate in PBL. These students had the following grade-level breakdown: first grade (n = 18), second grade (n = 20), third grade (n = 20), and fourth grade (n = 19).

For RQ2, the 77 GATSs were split into two groups: One group continued learning in their heterogenous classrooms (n = 43), whereas the remaining GATSs (n = 34) were pulled out of the classroom and received the same instruction in a HG group. The 43 GATSs who learned in a heterogenous classroom setting had the following grade-level breakdown: first grade (n = 11), second grade (n = 11), third grade (n = 11), and fourth grade (n = 10). The 34 GATSs who learned in HG had the following grade- level breakdown: first grade (n = 7), second grade (n = 9), third grade (n = 9), and fourth grade (n = 9). Given the small sample sizes, I analyzed the data using nonparametric tests for which no a priori power analysis could be calculated.

Instrumentation and Materials

The dependent variable of this study comprised the verbal, quantitative, nonverbal, and composite scores from the COGAT (see Cognitive Abilities Test Form 6, n.d.; Loman & Gambrell, 2011; Warne, 2014). Developed in 2000 by Riverside Publishing, a leading publisher of researched-based educational and clinical tests who has partnered with the University of Iowa in creating tests, the COGAT measures students' reasoning ability in three skill areas (i.e., quantitative, verbal, and nonverbal) and is

suitable for as a criterion for entrance into GATPs (Loman & Gambrell, 2011; Warne, 2014). Scaled scores on the verbal battery of the COGAT range from 11–223 for first grade and 24–239 for second grade. Scaled scores on the quantitative battery of the COGAT range from 25–229 for first grade and 42–242 for second grade. Scaled scores on the nonverbal battery of the COGAT range from 49–229 for first grade and 66–249 for second grade. Composite scores on the COGAT range from 28-227 for first grade and 44–240 for second grade (Cognitive Abilities Test Form 6, n.d.). The three COGAT batteries were found to be valid and have a $r = .76$ when correlated with the IQ score of the Wechsler Intelligence Scale for Children, demonstrating that it is an appropriate measure to use with gifted and talented students (Loman & Gambrell, 2011; Warne, 2014).

Data Collection and Analysis

The COGAT was administered during the fall and the spring of the 2010–2011 school year. I contacted the principal from ECS to obtain permission to access the archival data. I received archival data from the 2010–2011 school year were retrieved, which noted the students' participation (or nonparticipation) in PBL and HG. COGAT scaled scores on the verbal, quantitative, and nonverbal batteries as well as the composite scores for first through fourth grade are listed in Table 1. The raw data are in Appendix B.

I analyzed the data set to determine what, if any, significant differences in the universal scaled battery scores and composite scores existed.

Table 1

Scaled Score Ranges for Batteries of the COGAT

Level	Verbal	Quantitative	Nonverbal	Composite
First grade	11–223	25–229	49–229	28–227
Second grade	24–239	42–242	66–249	44–243
Third grade	65–244	65–252	82–259	71–252
Fourth grade	77–259	77–259	89–264	81–259

Table 2

Normality Scores for Skewness of the Scaled Score of COGAT Batteries

Level		Verbal	Quantitative	Nonverbal	Composite
First grade					
	Fall	0.967	1.517	0.416	0.521
	Spring	2.327	3.475	1.201	3.101
Second grade					
	Fall	2.268	0.072	2.060	3.581
	Spring	1.653	0.443	1.239	2.356
Third grade					
	Fall	4.349	1.254	-1.079	1.182
	Spring	-0.376	0.750	-0.662	-0.652
Fourth grade					
	Fall	-0.551	0.057	0.582	0.012
	Spring	-0.032	2.012	1.805	1.680

The data analysis involved calculating the descriptive statistics for the examined variables. I used the Statistical Package for Social Sciences (SPSS), Version 25 by IBM for all statistical calculations. The assumption of normality for the distributions was not met. The results of the normality tests revealed that less than one half of the distributions of scaled scores were within the normal range. Normal skewness scores are between ± 1.96 and are listed in Table 2 (see Doane & Seward, 2013). For this reason and due to the small sample sizes, I conducted a Kruskal-Wallis test, also known as a one-way ANOVA on ranks, to analyze the data.

Assumptions, Limitations, Scope, and Delimitations

As with any research study, there are certain factors that are beyond the researcher's control that could affect the results of the study. One assumption I made was that no selection bias exists, which can occur in a quasi-experimental design such as this one. In this study, students were not randomized and were selected based on their prior school performance. This selection bias was lessened because I used all GATSs who matched the criterion.

Another assumption was that the archival data are accurate. Because the same test level of COGAT was administered to the same group of students in both the fall and the spring, it is possible that the students remembered questions. The same testing instrument with the same questions was used in the repeated test administration, which could be a possible weakness.

There are several factors that limit the generalization of this study. First, there could have been other factors not measured that contributed to the possible score change, such as teacher effectiveness and parental support. The conclusions are also limited to the administration methods for this particular program. In addition, because the student population at the ESC is primarily African American, the results are not applicable to diverse student populations of GATSs.

The study was delimited to the first through fourth grade students who took the COGAT in the fall and spring of the 2010–2011 school year at ESC.

Protection of Participant's Rights

Before collecting data for this study, I received approval from Walden University's Institutional Research Board (Approval Number 12-06-19-0020785). I then contacted the principal of the ECS seeking permission to retrieve and analyze the students' data. To protect the student identities, the archival data that existed in the school's records was stripped of all identifiers by the school principal, and each student was assigned a number. Because the participating students and some of the classroom teachers were no longer at the school, the students were not affected by this study.

Data Analysis Results

I divided the data set into four groups representing the GATSs in first through fourth grades because each grade level had a different range of universal scaled scores on the COGAT. The full battery of the COGAT is comprised of three subtests: verbal, quantitative, and nonverbal. The scores of the subtests are averaged to result in the composite score. For these reasons, I determined that the Kruskal-Wallis test was the best means of analyzing the data (see Meyer & Seaman, 2013). For each dependent variable, (i.e., the verbal, quantitative, nonverbal, and composite scores), a Kruskal-Wallis test disseminates three numbers as follows: the test statistic, represented by "H"; the degree of freedom, notated by a number in parentheses; and the asymptotic significance, represented by *p* (see Meyer & Seaman, 2013). In order for the Kruskal-Wallis statistics to be considered statistically significant in this study, *p* must be less than .05 (see Meyer & Seaman, 2013). This indicates that there is a 95% probability that the differences in score changes resulted from the students' participation in either PBL or HG.

PBL and COGAT Score Changes

I sorted the data by the independent variable, PBL, to answer the first research question. Table 3 shows the differences in the median COGAT subtest scores of first grade GATSs at the beginning and end of the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in PBL medians for the first grade subtests and the composite are greater than the differences in non-PBL medians. The scaled score changes of first graders had the following H scores and significance levels: verbal - $H(1) = 22.019$, $p < .001$; quantitative - $H(1) = 13.695$, $p < .001$; nonverbal - $H(1) = 6.218$, $p = .013$; and composite - $H(1) = 17.601$, $p < .001$. The distributions of first grade COGAT score changes are statistically significant where $p < .05$. As a result of the significance levels, I rejected the null hypothesis for all subtests and the composite for first grade students.

Table 3

Differences Between First Grade PBL and non-PBL Participants

		Verbal	Quantitative	Nonverbal	Composite
PBL	*N*	18	18	18	18
	Mdn	179.5	185.5	199	188
No PBL	*N*	18	18	18	18
	Mdn	152	163.5	183	166.5
Total	*N*	36	36	36	36
	Mdn	162	172	191	179
Kruskal-Wallis H		22.019	13.695	6.218	17.601
df		1	1	1	1
p		.000	.000	.013	.000

Note. *p* values of .000 are interpreted as $p < .001$.

Table 4 shows the differences in median COGAT subtest scores of second grade GATSs at the beginning and end of the pilot program for GATSs as well as the results of

the Kruskal-Wallis test analyses. The differences in PBL medians for the second grade subtests and the composite are greater than differences in the non-PBL medians. The scaled score changes of second graders had the following H scores and significance levels: verbal - $H(1) = 16.208$, $p < .001$; quantitative - $H(1) = 19.270$, $p < .001$; nonverbal - $H(1) = 2.489$, $p = .013$; and composite - $H(1) = 18.540$, $p < .001$. The distributions of second grade COGAT score changes are statistically significant where $p < .05$. As a result of the significance levels, I rejected the null hypothesis for the verbal and quantitative subtests as well and the overall composite score changes in second grade students. However, there was no statistically significant difference in the medians of the second grade nonverbal test. While the difference in the median is greater in the nonverbal tests, 6 of 20 students experienced a score decrease rendering the difference statistically insignificant.

Table 4

Differences Between Second Grade PBL and non-PBL Participants

		Verbal	Quantitative	Nonverbal	Composite
PBL	*N*	20	20	20	20
	Mdn	174	189	193	186.5
No PBL	*N*	20	20	20	20
	Mdn	156	166	183	170
Total	*N*	40	40	40	40
	Mdn	169	177	190	178.5
Kruskal-Wallis H		16.208	19.27	2.489	18.54
df		1	1	1	1
p		.000	.000	.115	.000

Note. *p* values of .000 are interpreted as $p < .001$.

Table 5 shows the differences in median COGAT subtest scores of third grade GATSs at the beginning and end of the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in PBL medians for the third grade subtests and the composite are greater than the differences in non-PBL medians. The scaled score changes of third graders had the following H scores and significance levels: verbal - $H(1) = 21.336$, $p < .001$; quantitative - $H(1) = 19.732$, $p < .001$; nonverbal - $H(1) = 9.825$, $p = .002$; and composite - $H(1) = 21.688$, $p < .001$. The distributions of third grade COGAT score changes are statistically significant where $p < .05$. As a result of the significance levels, I rejected the null hypothesis for all subtests and the composite for third grade students.

Table 5

Differences Between Third Grade PBL and non-PBL Participants

		Verbal	Quantitative	Nonverbal	Composite
PBL	*N*	20	20	20	20
	Mdn	196	204	208.5	204.5
No PBL	*N*	20	20	20	20
	Mdn	186	176	199	186.5
Total	*N*	40	40	40	40
	Mdn	191	184	203	192.5
Kruskal-Wallis H		21.336	19.732	9.825	21.688
df		1	1	1	1
p		.000	.000	0.002	.000

Note. *p* values of .000 are interpreted as $p < .001$.

Table 6 shows the differences in median COGAT subtest scores of fourth grade GATSs at the beginning and end of the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in PBL medians for the fourth grade subtests and the composite are greater than differences in the non-PBL medians. The

scaled score changes of fourth graders had the following H scores and significance levels: verbal - H(1) = 9.091, $p = .003$; quantitative - $H(1) = 12.523$, $p < .001$; nonverbal - H(1) = 3.895, $p = .048$; composite - H(1) = 14.765, $p < .001$. The distributions of fourth-grade COGAT score changes are statistically significant where $p < .05$. As a result of the significance levels, I rejected the null hypothesis for all subtests and the composite for fourth grade students.

Table 6

Differences Between Fourth Grade PBL and non-PBL Participants

		Verbal	Quantitative	Nonverbal	Composite
PBL	*N*	19	19	19	19
	Mdn	208	207	216	212
No PBL	*N*	19	19	19	19
	Mdn	194	180	199	192
Total	*N*	38	38	38	38
	-	203	196	202	195.5
Kruskal-Wallis H		9.091	12.523	3.895	14.765
df		1	1	1	1
p		0.003	.000	0.048	.000

Note. *p*-values of .000 are interpreted as p < .001

To conclude the analysis of the relationship between PBL and COGAT scores, the data, in Tables 3-6, demonstrate that apart from one subtest in second grade, the null hypotheses were rejected throughout the grades in all the subtests and composite score changes of the COGAT. Thus, it can be concluded that participation in PBL did have a significant effect on GATSs academic achievement at ESC as measured by changes in COGAT scores. In addition, as every PBL median score was greater than every non-PBL median score across the board, it can be further stated that the effect PBL had on the academic achievement of GATSs was positive. It is not possible to determine the factors

that contributed to the decrease in nonverbal scores for second grade students. It is possible that a larger sample size would have yielded different results.

HG and COGAT Score Changes

For the remainder of the data analysis, I sorted the data by the independent variable, HG, to answer the second research question. Each grade level group of students was divided by the type of instructional grouping that was used for the PBL instruction, which was either HG or non-HG. Because the data were sorted by a different independent variable, HG, the number of elements, medians, and descriptors listed in Tables 7-10 are dissimilar to those in Tables 3-6.

Table 7 shows the differences in median COGAT subtest scores of first grade GATSs who were grouped or not grouped that participated in the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in HG medians remain unchanged or decreased when compared to the differences in non-HG medians. The scaled score changes of first graders had the following H scores and significance levels: verbal - $H(1) = .002$, $p = .964$; quantitative - $H(1) < .001$, $p = 1.000$;n verbal - $H(1) < .001$, $p = 1.00$; composite - $H(1) = .75$, $p = .785$. The distributions of first grade COGAT score changes are not statistically significant; all $p > .05$. As a result of the significance levels, I could not reject the null hypothesis for any subtests or the composite in first grade students.

Table 7

Differences Between First grade HG and non-HG Participants

		Verbal	Quantitative	Nonverbal	Composite
HG	*N*	7	7	7	7
	Mdn	177	189	199	188
No HG	*N*	11	11	11	11
	Mdn	182	182	199	188
Total	*N*	18	18	18	18
	Mdn	179.5	185.5	199	188
Kruskal-Wallis H		0.002	0	0	0.075
df		1	1	1	1
p		0.964	1.000	1.000	0.785

Note. *p*-values of .000 are interpreted as $p < .001$

Table 8 shows the differences in median COGAT subtest scores of second grade GATSs who were grouped or not grouped that participated in the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in HG medians are greater than the differences in non-HG medians. The scaled score changes of second graders had the following H scores and significance levels: verbal - $H(1) = 1.647$, $p = .199$; quantitative - $H(1) = .013$, $p = .909$; nonverbal - $H(1) = 1.313$, $p = .252$; Composite - $H(1) = 2.699$, $p = .100$. The distributions of second grade COGAT score changes are not statistically significant; all $p > .05$. As a result of the significance levels, I could not reject the null hypothesis for any subtests or the composite in second grade students.

Table 9 shows the differences in median COGAT subtest scores of third grade GATSs who were grouped or not grouped that participated in the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in HG

medians are greater than the differences in non-HG medians. The scaled score changes of third graders had the following H scores and significance levels: verbal - H(1) = 1.913, p = .167; quantitative - H(1) = .2.940, p = .086; nonverbal - H(1) = .330, p = .566; composite - H(1) = 3.063, p = .080. The distributions of third grade COGAT score changes are not statistically significant; all p > .05. As a result of the significance levels, I could not reject the null hypothesis for any subtests or the composite for third grade students.

Table 8

Differences Between Second grade HG and non-HG Participants

		Verbal	Quantitative	Nonverbal	Composite
HG	*N*	9	9	9	9
	Mdn	187	193	196	187
No HG	*N*	11	11	11	11
	Mdn	174	189	190	184
Total	*N*	20	20	20	20
	Mdn	174	189	193	186.5
Kruskal-Wallis H		1.647	0.013	1.313	2.699
df		1	1	1	1
p		0.199	0.909	0.252	0.100

Note. p values of .000 are interpreted as p < .001

Table 10 shows the differences in median COGAT subtest scores of fourth grade GATSs who were grouped or not grouped that participated in the pilot program for GATSs as well as the results of the Kruskal-Wallis test analyses. The differences in HG medians are greater than the differences in non-HG medians. The scaled score changes of fourth graders had the following H scores and significance levels: verbal - H(1) = 5.487, p = .019; quantitative - H(1) = 1.228, p = .268; nonverbal - H(1) = .813, p = .367;

composite - H(1) = 3.695, p = .055. As a result of the significance levels of quantitative, nonverbal, and composite score changes, which are all greater than .05, I could not reject the corresponding null hypotheses for fourth grade students. I only rejected the null hypothesis for the verbal subtest because p =.019.

Table 8

Differences Between Third grade HG and non-HG Participants

		Verbal	Quantitative	Nonverbal	Composite
HG	*N*	9	9	9	9
	Mdn	203	213	213	209
No HG	*N*	11	11	11	11
	Mdn	196	195	207	200
Total	*N*	20	20	20	20
	Mdn	196	204	208.5	204.5
Kruskal-Wallis H		1.913	2.94	0.33	3.063
df		1	1	1	1
p		0.167	0.086	0.566	0.080

Note. p-values of .000 are interpreted as $p < .001$

Table 9

Differences Between Fourth grade HG and non-HG Participants

		Verbal	Quantitative	Nonverbal	Composite
HG	*N*	9	9	9	9
	Mdn	213	207	217	219
No HG	*N*	10	10	10	10
	Mdn	201.5	204	207.5	197.5
Total	*N*	19	19	19	19
	Mdn	208	207	216	212
Kruskal-Wallis H		5.487	1.228	0.813	3.695
df		1	1	1	1
p		0.019	0.268	0.367	0.055

Note. p values of .000 are interpreted as $p < .001$

To conclude the analysis of the relationship between HG and COGAT score changes, the data, in Tables 7-10, demonstrate that apart from one subtest in fourth grade, I could not reject the null hypotheses throughout the grades in all the subtests and composite score changes of the COGAT. Thus, it can be concluded that the grouping of students did not have a significant effect on GATSs academic achievement as measured by COGAT score changes at the ESC. Although the differences in median score changes of the students who received HG increased at all levels, when compared to the students who did not receive HG, the increases were not enough to be considered significant. The small sample size could be a contributing factor to these results. Additional students might have yielded increases of that showed greater significance.

Conclusion

The lack of an appropriate educational setting for the GATSs at this urban charter school was the problem addressed in this study. While teachers provided enrichment activities for GATSs, students did not participate in PBL nor were they grouped homogeneously. Both active participation in PBL and homogeneous grouping have been demonstrated to provide education benefits for GATSs. By exploring the relationship between PBL, HG, and GATSs achievement, the results of this study have the potential to affect positive social change.

The results of the data analysis suggest that GATSs can be best supported educationally by learning in an educational environment that encourages and offers in PBL activities. These results led to two possible project options: a position paper that recommended that GATSs be grouped homogeneously as they engaged in PBL or a PBL

curricular unit. However, I decided to do the curricular unit, because it would provide an exemplar for teachers seeking to replicate that type of curricular unit.

In the next section, I delineate the project specifics, which will provide an example of the type of educational activities that provide the best educational challenge for GATSs. In addition to discussing the purpose and rationale, I include a review of the literature to provide a background context for the project. Finally, I include detailed project specifics and a discussion of the project evaluation.

Section 3: The Project

Introduction

As schools work to meet the educational needs of diverse learners, it behooves them to expand their instructional practices. By sharing the results of the study in the previous section, I demonstrated that a positive relationship between PBL and the COGAT scores of GATSs exists. HG was also shown to have a slight, but not significant, influence on their scores. Based on the results of the study, I decided that a curriculum plan in the form of a PBL unit was the most appropriate deliverable artifact to develop as a project. The findings indicate that the creation of a sample project-based curriculum unit would be beneficial for teachers of GATSs.

In this section, I explain the project that provides teachers with activities and other resources to better help their GATSs achieve their academic goals. The project could serve as an example that teachers could emulate in creating their own projects. In addition to discussing the purpose and rationale for the project, I present a review of the literature to provide background context for the project and its design. The section concludes with a description of the method of evaluation for the delivered project.

Rationale

As noted in Section 1, the GATSs at ESC lacked an appropriate educational setting to meet their special needs. While the teachers at the school would like to provide appropriate instruction to the GATSs, they lack the curricular materials that could facilitate this instruction. In order for instructional change to occur at ESC, the staff would need access to a curriculum that would fulfill the lack (see Boyce, Van Tassel-

Baska, Burruss, Sher, & Johnson, 1997). Therefore, the audience for this curriculum plan was the school's administration who are responsible for curriculum, instruction, and assessment at ESC. Researchers have noted that while PBL is beneficial to students, teachers can be reluctant to use it in their educational practice because it is a distinct departure from traditional instruction (Revelle, 2019). Therefore, an explicit, well-researched PBL curriculum plan will provide a guide that the school's administration can disseminate to curriculum committees and teachers. The hope is that this project will provide an exemplar that can be used to create future PBL curriculum units.

A well-designed curriculum facilitates teacher instruction and student growth (Boyce et al., 1997). Rationalizing that the ESC administration and teachers would need to create their own PBL units, I believed that a PBL unit was the ideal project that would best benefit the administration and teachers at ESC. Because they may not be versed in writing curriculum, especially when using the backward design method, both the teachers and the students could benefit from instruction in curriculum design. Providing the staff with a curriculum exemplar could provide a solution to the problem of the lack of appropriate instruction for the GATSs at the school. In the literature review, I center on the importance of standards-based curriculum and backward design, a method of curriculum design in which the instruction content is determined by its assessment (see Wiggins & McTighe, 2006; Ziegenfuss & LeMire, 2019). In the following subsection, I also discuss topics relevant to the curriculum plan.

Review of the Literature

In this literature review, I cover the curriculum and its importance in education as well as backward design. The Walden University Library Education Research search engine was employed to search the following key terms: *curriculum, curriculum theory, curriculum design, educational standard,* and *backward design. John Dewey* was also used as a search term because he is considered the father of inquiry curriculum, from which PBL has developed. Finally, the terms *coronavirus* and *health education* were searched to find background information to support the selection of the topic of the curriculum unit. Because the project is a PBL unit on the causes of epidemics, I searched these terms to provide a content basis for the curriculum project. Using delimiters, I found sufficient articles that were published in or after 2015.

John Dewey

Prior to Dewey, education in the United States focused on rote memorization and learning (Beard, 2018). This traditional view of education was contrary to that of the progressive educational reformer, Dewey (Beard, 2018; Williams, 2017). Dewey transformed the U.S. education system and believed that education was an interactive process and that students learned best when they were able to actively participate in their education (Holt, 2020; Rocco & McGill, 2018). Dewey's philosophy about education and learning, based upon experiential learning, has impacted educators and is incorporated into progressive education theories (Beard, 2018; Holt, 2020; Williams, 2017; Wraga, 2019).

A belief in problem-solving was fundamental to Dewey's theory of education, which was grounded in the thought that the purpose of education was to encourage the natural interests of students through real-life experiences (Beard, 2018; Holt, 2020). According to the theory, students could build on the knowledge and skills gained from authentic problem-solving experiences by transferring it to new situations (Beard, 2018; Dewey, 1913; Holt, 2020).

In Dewey's (1913) view, the purpose of education was not the attainment of a set of teacher-mandated skills but rather the ability to use those skills in authentic situations. According to Dewey, in order for education to be its most effective, students must be able to relate the information to past experiences and build on those past experiences to deepen and acquire new knowledge (Beard, 2018; Williams, 2017). This emphasis on experiential learning differs from the student experience in many classroom settings.

The idea of isolating instruction from purpose was anathema to Dewey (1913), and when this occurred, students exhibited disinterest and boredom (Wraga, 2019). The traditional approach of learning through rote memorization did not foster true learning; however, when students had a purpose or goal for education, they developed an interest in the educational activity (Dewey, 1913; Rocco & McGill, 2018). In other words, whenever students were solving problems, they became more engaged and actively sought out the information needed to solve problems (Rocco & McGill, 2018). In Dewey's child-centered classroom, students could solve problems as a community through a curriculum based on inquiry (Beard, 2018; Williams, 2017; Wraga, 2019).

At the end of the 19th century, Dewey began an experimental lab school to put theories into practice (Holt, 2020). Through the students at the lab school, Dewey was able to test and refine an inquiry curriculum. At the school, students were able to explore and learn through experience; however, this was not a random experience (Dewey, 1913). Dewey believed that it was the school's responsibility to provide an inquiry-based curriculum that included activities, such as projects and experiences, that would guide students to the desired understanding (Beard, 2018; Rocco, 2018).

In an inquiry-based curriculum, students are never told how to make sense of their experiences or what to think (Dewey, 1913). Although they are guided, students remain in control of their learning. The curriculum Dewey designed allowed for the implementation of the concept of experiential learning through problems or projects and promote the study of pedagogy (Holt, 2020). It is for these reasons that Dewey's educational theories are fundamental to PBL.

Curriculum

The term *curriculum* can refer specifically to a planned sequence of instruction in the educational process (Livingstone, 2019). The type of curriculum an educational system has in place is a guiding force in the delivery of students' instruction (Clark, 2015). For much of the 20th century, the traditional curriculum of learning, which focused on rote memorization and the acquisition, rather than the application, was the norm in most schools (Lipsky, 1992; Miller, 1986). This type of curriculum was opposed by Dewey and other adherents of the progressive school of thought; reform in this school of thought was based upon democratic principles and included educators as agents of

change (Wraga, 2019). In the 1960s and again in the 1980s, attempts were made to reform the curriculum to become more progressive; however, they were short lived and largely unsuccessful (Greer, 2018; Lipsky, 1992; Tirozzi & Uro, 1997).

However, over the past few decades, the curriculum in the United States has undergone change. In the past, local education authorities decided what students should learn (Tyler, 1981). There has been a shift toward an outcome- or standard-based curriculum reform that has concentrated on setting challenging academic standards that describe the specific content that students should know as they build the skills necessary to eventually become part of the workforce (Greer, 2018; Ozar et al., 2019; Petrilli, 2020; Tirozzi & Uro, 1997). Rather than just a set of fact-based, teacher-decided, essential learnings, the reform movement called for instructional content with measurable standards that were achievable for all school students, and as such, standards are crafted to be challenging but not unachievable for students (Tirozzi & Uro, 1997).

As curriculum was reformed, an effective standards-based curriculum framework came to encompass four elements: objectives, content, learning experiences, and evaluation (Livingstone, 2019). The curriculum framework serves to gradually build students' understanding of requisite skills by having students partake in activities that access their prior knowledge (Cook & Weaver, 2015, Smith et al., 2017). The goal of a curriculum framework is to lay the cornerstone for a lifetime of education and learning by dispensing high-quality instruction to students through the four components (Clark, 2015; Tyler, 1981). Objectives are the skills that students demonstrate to indicate mastery (Gamson, Eckert, & Anderson, 2019). In standards-based instruction, the teacher plans

learning experiences to disseminate the subject area content to students (Livingstone, 2019). Because curriculums are living documents, they must be regularly evaluated to determine how well they are meeting the objectives and if they will need to be revised (Gamson et al., 2019; Lang & Collins, 2019; Livingstone, 2019; Smith et al., 2017).

A key aim of standards-based curriculums is to provide differentiated instruction to students so that all students may succeed. Differentiation allows teachers to modify the level of instructional difficulty without changing the instructional content (Archambault et al., 1993). Although differentiation helps to meet the needs of diverse students, this vital teacher practice is infrequently used (Bogen et al., 2019). One way to achieve this differentiation is through the use of PBL, a type of inquiry instruction. The purpose of inquiry-based instruction is to spark students' curiosity so that they desire to seek out the answers to their questions (Goldenberg, 2019). During the experiences that students have and the process of finding answers, students learn the subject matter content.

Twenty-first-century students require 21st-century tools to achieve 21st-century learning goals. No discussion of a curriculum can be complete without the inclusion of technology. In order to have an effective curriculum, technology should be fully integrated into it (Sardone, 2019). Learning experiences that are designed within an effective curriculum give the student time to practice with a repertoire of electronic tools and resources (Bond, 2020). With technology, students are better able to engage in self-directed inquiry learning and become autonomously independent (Livingstone, 2019; Sardone, 2019). Students learn to integrate technology in their inquiry, so that they may develop the ability to fully integrate these skills as lifelong learners.

Backwards Design

Several models for curriculum design have emerged as a result of the focus on subject content standards. Frequently, curriculum is designed to be implemented by examining the content standards, then creating learning activities to disseminate the content (Kumpas-Lenk, Eisenschmidt, & Veispak, 2018). Once the content is shared with students, assessments are designed and given to students in order that students may demonstrate the acquisition of the knowledge (Kelting-Gibson, 2005). However, a more intentional curriculum design is backward design, which begins with assessment (Cohen, 2015; Mills, Wiley, & Williams, 2019; Ziegenfuss & LeMire, 2019). Like a driver using a road map to plot the route to their destination, backward curriculum design begins with the desired knowledge that students are expected to acquire from instruction (Mills, et al., 2019; Ziegenfuss & LeMire, 2019). This directly contrasts with traditional curriculum design, which is like the driver who starts the journey but has no clear destination in mind.

Coined by Wiggins and McTighe (2006) in their book of the same name, the phrase “understanding by design” builds on the work of Tyler. Tyler stressed the importance of assessment in a curriculum, and understanding by design accordingly starts with assessment (Baker, 2013). Using backward design ensures that the instruction for the subject content is focused and organized, thereby fostering a more thorough understanding of the content. Because teachers can use a backward designed curriculum as a framework for developing teaching modules, the possibility exists that with curriculum, students may learn faster and with a deeper level of understanding. By

focusing on what students need to learn, teachers can design learning experiences that guide students towards the desired instructional goal.

According to Wiggins and McTighe (2006), there are three discrete stages of backward curriculum design. The tasks in the stages are to (a) identify the learning objectives from the standards, (b) determine the assessments practices that provide evidence meeting the learning objectives, and (c) implement instructional activities that enable students to achieve the learning objectives (Boozer & Carlson, 2015; Paesani, 2017). In backward design, curriculum designers unpack content standards to determine the essential questions. As designers unpack the standards, they generate the big concepts that can be turned into the higher-order questions, that form the basis for assessment and planning. Once the curriculum endpoint is known, then assessments can be designed that align with the learning objectives. Finally, the designer determines the instructional components that will guide students to reaching the assessment destination, paying close attention to ensure that instructional activities are relevant to the learning outcomes (Black & Allen, 2019). Because the focus is on essential questions, students comprehend the enduring understandings that form the bedrock of lifelong learning (Alenezi, 2016; McFadden & Roehrig, 2017; Mills et al., 2019; Ziegenfuss & LeMire, 2019)

Differentiated instruction is inherent in backward design. Because the focus of backward design is learning outcomes rather than teaching, it is rooted in learning principles that engage students (Kumpas-Lenk, et al., 2018; Ziegenfuss & LeMire, 2019). Both the instructional activities and the assessment product can be varied to reflect students' interests or learning styles. Students have a selection of instructional activities

that address their various learning styles. They also have a choice in how to demonstrate subject content mastery (Taylor, 2015). Because backward design is student-centered, students can build upon prior knowledge and construct content meaning. This type of curriculum planning allows students to reflect upon their own learning. The inherent choice motivates students, who are then inspired to master the subject content (Butler, Heslup & Kurth, 2015). For these reasons, backward design is suitable for all types of inquiry learning, including PBL.

Epidemics

The world is currently fighting a global pandemic caused by the novel coronavirus, COVID-19. Schools worldwide have been shut down leaving millions of students at home (Kennedy, 2020). Around the world, students have questions about this virus that has affected their lives. Being a new virus, students have little to no factual knowledge of it (Mian & Khan, 2020). Because the virus is a hot topic in social media, students' perceptions and beliefs may be are shaped by the juxtaposition of factual and false social content (Al-Hazmi, Gosadi, Somily, Alsubaie, & Bin Saeed, 2018; Lugemwa, (2020).

Across the world, basic health information is taught in school to most students. However, while students may be familiar with the word *virus*, they frequently have misconceptions regarding the transmission and prevention of viruses. Simon, Enzinger, and Fink (2017) surveyed European children and discovered that their knowledge related to viruses was fragmented. Specifically, over one half of the students did not know the correct relationship between viruses, vaccines, and antibiotics. Likewise, in a study of

Philippine students, Gregorio et al. (2019) discovered that students exhibited misconceptions about how another virus, Zika, was spread.

Schools are required to provide science-based health education to students, but frequently that instruction lacks depth. Based on this evidence, students lack knowledge regarding viruses. Teaching students about viruses at school is important. The smaller the world becomes globally, the more likely it is that students will require this knowledge. While this is the first epidemic to affect the United States, it is likely it will not be the last one (Doornekamp et al., 2017; Koralek, Runnerstrom, Brown, Uchegbu, & Basta, 2016). As a result, students lack science based, health relevant knowledge that may contribute to the continued spread of viral disease.

The scientific study of viruses and epidemics is one that could be readily be taught using PBL. Science and social studies standards lend themselves to multidisciplinary units of study (Sumrall & Schillinger, 2004). In addition, it is a real-world problem that students can relate to and think critically about as they attempt to find a solution.

Summary

Based on the analysis of the COGAT scores in Section 2 of this study, engaging in PBL would benefit the GATSs academically; it follows that the project for the study should be a PBL curriculum plan. Never having written a curriculum plan, it was essential that I understood the foundational background for writing one, as well as what constitutes an effective plan. It was also necessary to develop knowledge of using Wiggins and Tighe's (2006) curriculum templates.

A standards-based curriculum is a document that teachers can use to guide their instruction and raise the level of academic performance of their GATSs at ESC. Providing a standards-based, PBL curriculum sets the level of excellence for a PBL curriculum at ESC. Additionally, it will furnish the necessary support teachers as they move through their own PBL curriculum development process (see McFadden & Roehrig, 2017).

Project Description

The project is a PBL curriculum plan for the third and fourth grade GATSs at the ESC that is written using backward design. The Understanding by Design templates created by Wiggins and Tighe would be used to guide the curriculum plan structure. The needed resources to present the project would be a meeting with the administration at ESC. This meeting would include the president of the principal and department supervisors at ESC, as well as the chairman of the board of directors because the chair has final approval for curriculum recommendations. The ESC already has some supports to aid in the project implementation. The available supports would be classroom space to conduct the pilot and presence of the testing materials used to select students because this would be a curriculum designed for GATSs.

There was a need for an alternative method of instruction for the GATSs at ECS. The project would assist teachers in creating PBL curricular units for the GATSs in their classrooms. Based upon a current event of which students have some basic knowledge – the COVID-19 pandemic – the curriculum plan will provide an exemplar of a PBL curriculum plan. Using the project as a model, teachers will then be able to replicate the

curriculum using topics of their choosing. As a result, the only barriers would be teachers who would be unwilling to take the time to research and to create a differentiated PBL curriculum for the GATSs at the school. However, since the administration is supportive of the project, it is conceivable that implementation could be a school mandate, which would, therefore, remove the barriers.

To ensure a smooth implementation and cooperation of all teachers, professional development is needed before teachers can create their own curricular units. This training can be completed prior to the official start of the 2021-2022 school year. ESC has 2 weeks of professional development before the beginning of the year. The teachers would have all of the fall to research and write their plans. The proposal for the implementation of this project recommends that the administrators use the curriculum plans at the beginning of 2022. The teachers should receive notice of the new expectation as soon as possible. The professional development should include a detailed walkthrough of the process of creating the curriculum.

Project Evaluation Plan

This project was developed to solve the problem of the GATSs at ESC. I created the curriculum plan to serve as an exemplar for the teachers' creation and use of PBL. To assess the implementation of the project, school leaders require a means of evaluation. In order to ascertain to what extent, the project achieves its aims, a goal-based evaluation can be used. Teachers can submit their curricular units to provide evidence that the stated aims have been met (Youker, Zielinski, Hunter, & Bayer, 2016).

The project evaluation period could be the 2021-2022 school year. The key stakeholders are the evaluators and those who are evaluated – school administration and classroom teachers. The school administration can review the curricular plans to document the degree of implementation of the project guidelines. Administrators regularly review teachers' plans to ensure that they meet curriculum standards and adhere to the school guidelines. It is appropriate for teachers to develop a curriculum for their students because the teachers have distinctive knowledge of their students enabling them to differentiate. If teachers are provided professional development in curriculum mapping, planning, and design, they can create their own curriculums, because teachers have expertise in the knowledge, skills, and experiences that are necessary to meet curricular needs (Butler et al, 2015; McFadden & Roehrig, 2017).

Project Implications

As stated in Section 1, GATSs are not always educationally challenged in traditional classrooms. Instead, GATSs benefitted when they had special services, such as smaller classrooms, instruction with similar students, different pacing and resources, or trained teachers. Also, the research demonstrated that when they were given real-life problem-solving and project-based instruction, GATSs achieved academic success. The purpose of the project was to rectify that situation, by providing an alternative instructional strategy for GATSs. The implication was that with specially designed curriculum materials, the students would be rewarded with a higher level of academic performance and higher interest in schooling which would follow them throughout their educational career.

This project could help the administrators at the ESC prevent the GATSs at the school from becoming underachievers. If students are not challenged, it is possible that they will only achieve at the level of the class, which might be below their potential. Providing the GATSs with a challenging curriculum at an early age has the possibility of ensuring that they will work to achieve their highest potential. This is important because the student population is overwhelmingly African American and Hispanic, and traditionally these students have been underrepresented in GATPs. Nationally, an achievement gap exists between minorities and white students. For this reason, this project could help close the achievement gap.

Section 4: Reflections and Conclusions

In this section, I share my reflections and conclusions about the task of writing this project study. This section includes the strengths and limitations of the project as well as possible alternatives. I also discuss scholarship, implications, and directions for future studies. Finally, this section ends with a reflection on my personal growth during this process.

Project Strengths and Limitations

The strengths and weaknesses of this project lie in its use. Creating a curriculum is a challenging task for teachers, one that adds another layer to their professional responsibilities. When teachers create a curriculum, they can bring to it both their strengths and weaknesses as professionals. The effectiveness of the curriculum is determined by whether the teacher allows their strengths or their weaknesses to be dominant and inform the project. Teachers have an intimate knowledge of their students, so this strength can add to the curriculum they create; however, because teachers may have no experience with curriculum design, this weakness can detract from the curriculum development.

One strength of this project was that the curriculum plan was designed to solve the problem at ESC, and as a result, it met the needs of the school's administration. In the analysis of the data in Section 2, I provided evidence that a curriculum plan could be the desired output. In addition, the literature demonstrated that curriculum should be well researched and structured using backward design (Black & Allen, 2019; Boozer & Carlson, 2015). These precepts informed the writing of the project. Frequently, mass-

produced curriculum resources do not always meet the needs of teachers (Butler et al., 2015). The goals of the curriculum and the needs of teachers and students may be misaligned in a one-size-fits-all curriculum. One way to alleviate this mismatch is for teachers to create their own curriculum resources. The fact that this project was written for a specific student population was an additional strength.

I designed this project to improve the learning opportunities of GATSs at ESC by creating a sample curriculum plan that teachers could use to inform their own curriculum writing. However, creating curriculum forces teachers to become designers and not just users of the curriculum. Their discomfort can cause them to be reluctant creators, which would cause a limitation for the project. In addition, the administration has control over the implementation of the project, which also limits the project. Finally, assuming that the administration approves the implementation of the project, there is also no guarantee that teachers will use the curriculum model with fidelity even though they have written it themselves. This could happen because teachers at the school may not want to step out of their traditional roles (see McFadden & Roehrig, 2017).

Recommendations for Alternative Approaches

At one time I thought that the excellence gap (i.e., the gap in achievement that exists between comparable populations African Americans and White students) was another way to frame the issue at ESC; however, the school is predominantly African American and had no data that can be analyzed along racial lines. A second alternative would have been to compare the data of students of one grade with students of another grade rather than aggregate the data. However, because the sample size for each grade

level was small, this would have limited the data analysis and resulted in a greater margin of error because there would have been fewer data points.

The results of the data analysis determined the form of the project. While I chose a curriculum plan as the project, it was not the only approach that I could have taken. An alternative project could have been a position paper. The purpose of a position paper is to present a convincing argument in support of a particular action (Powell, 2012). Rather than creating an actionable exemplar for the teachers to model, in a position paper I would have addressed the school policy for a GATP. The difference in the project is the scope of the audience and whether the focus is on teachers and administration or simply the administration. Because the school previously had a GATP, there was not a need to convince the administration of the efficacy of GATPs. Since support for GATSs was not in question, I made the decision that the project should have the widest audience possible and targeted it toward the administration and teachers making the PBL curriculum the most useful actionable project.

Scholarship, Project Development and Evaluation, and Leadership and Change

It is important to have teacher leaders, educators who are reflective scholars working to improve the schools in which they work. During this doctoral journey, I have had to experience the education system in a new manner with an eye toward social change. The process of defining the problem of GATSs and looking for answers on a deeper level guided my scholarly direction. This process of identifying a thesis and looking for evidence to support it is one that I have frequently directed for my students, albeit on a much smaller level. As a teacher, when I looked at the classrooms around

mine, the issue of GATSs has always stood out to me. Just as I have guided my students to find support for their beliefs, I have had to search through literature to provide evidence, on a much greater scale, that my topic was worthy of scholarly study.

The principle that guided the project development was improving the education of students. The process forced me to focus on a single aspect of the issue of GATSs and refine my theories lest I produce a tome. At the same time, I had to examine my own assumptions and beliefs as a practicing educator. As change is the system by which growth occurs, this process has altered me and guided my growth as a teacher leader, with the goal of improving the education of my students and the students who come after them. The goal of teaching is to positively affect students. Becoming a teacher leader allows educational change to affect more than just the students in my classroom. Ultimately, while I am the one earning a doctoral degree, it is my students who will benefit.

Reflection on Importance of the Work

The job of a teacher is to assist students in reaching their full potential. As my research has demonstrated, there is a need for all students to have quality instruction to help them meet those goals. No student should be held back due to a lack of instruction. All teachers should have the materials they need to assist their students. The stakeholders in the education system (i.e., parents, teachers, and administrators) are accountable for ensuring that all students receive the education they deserve. This study helps to achieve that goal by identifying a deficiency and providing a means of alleviating it.

The process of completing this project study has helped me grow as a writer, teacher, researcher, and advocate for social change for students. The doctoral process is the greatest venture I have ever undertaken, and it has forced me to grow as no other educational endeavor has. As I moved along this research journey, I performed the tasks of analyzing text, interpreting data, and creating a project. Practicing these thinking skills has honed my ability to think critically. I now realize that critical thinking is a circular process of self-reflection that leads to analysis, which leads to interpretation, which leads to creation, which causes self-reflection. Developing self-reflective critical thinkers is the desired aim of the education process.

Implications, Applications, and Directions for Future Research

The results of this study have the potential to affect students on an individual level at the school and a societal level through the teachers. Using the students' COGAT scores, I was able to provide empirical evidence that GATSs' academic achievement, as measured using COGAT scores, was raised when they participated in PBL. It is through societal change that true change in education occurs. By providing the teachers with an exemplar, the possible educational changes are magnified.

The empirical evidence found in this study adds to the body of knowledge regarding the education of GATSs, which can be a controversial topic because it is sometimes depicted as elitist. Through analysis of the data, I confirmed the need for quality PBL, which guided the creation of the project. Because the project is a curriculum plan that is a model exemplar, it has the possibility of affecting change on a classroom level as well as on teachers. Teachers can use it to inform instruction in their class now

and in the future and, thus, affect the entire school population. Once the curriculum is made more challenging for one group of students, it follows that all students will benefit, for in the words of John F. Kennedy, “a rising tide lifts all boats” (Kennedy, 1962, paragraph 11). In other words, advancing the curriculum for one group of students will, over time, advance all students.

Conclusion

As researchers study students and instruction, they continually strive to make education relevant and accessible to 21st-century scholars. Pedagogy is not static. Like student learning standards that are revisited regularly to ensure they are meeting desired goals, educational pedagogy is constantly changing to seek out research-based, best instructional practices so that students achieve at their highest levels. PBL is a proven strategy to increase student achievement and deepen student understanding (Blumenfeld et al., 1991; Kokotsaki et al., 2016). In addition, it has been proven that GATSs benefit from a different type of instruction than is usually encountered in the traditional classroom setting (Brigandi et al., 2018; Miedijensky, 2018). Curriculum should be based upon the needs of students. The findings of this study helped to define a need for students, and I then used them to create a research-based solution to satisfy that need. Providing research-based curriculum plans that incorporate PBL can only benefit GATSs and, in turn, benefit other student populations as well. It is the responsibility of educators to grow to meet the needs of all students. The future of students is the future of our country.

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Appendix A: The Project

Unit Cover Page

Unit Title: Epidemic Grade: 3 & 4
Subject: Science
Key Words: microbes, bacteria, virus, immune system, disease prevention

Brief Summary of Unit (including curricular context and unit goals):
In this science unit, students will learn about different microbes – viruses and bacteria - as well as the role they play in human health. They will learn about the history of immunology and explore the immune system, a major system in the body. Students will create a comic strip illustrating the immune system's three lines of defense. They will also learn about historical diseases and the epidemics they caused. In addition, they will create a brochure identifying the factors that affect the immune system. Finally, in the culminating performance task, students create a PSA on epidemic prevention, that they will share with the school.

Unit design status:

- ☑ Completed blueprint for performance task
- ☑ Completed rubrics
- ☑ Directions to teachers & students
- ☑ Materials and resources listed
- ☑ Suggested accommodations
- ☑ Suggested extensions

Stage 1 – Identify Desired Results

Established Goals

Standards:

4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.

Science and Engineering Practices:

Use a model to test interactions concerning the functioning of a natural system

Construct an argument with evidence, data, and/or a model.

Crosscutting Concepts Systems and System Models

A system can be described in terms of its components and their interactions

What essential questions will be considered?

- What makes people sick?
- Why do people need to take care of their immune systems?
- Why should people get vaccinated?
- Why should people work to prevent the spread of disease?

What understandings are desired?

- Microbes – viruses and bacteria – cause diseases.
- The immune system is the body's defense against microbes and works to prevent illness.
- Vaccines are the only way to prevent viruses.
- When diseases spread unchecked, it can cause an epidemic.

What key knowledge and skills will students acquire as a result of this unit?

- Key terms – bacteria, virus, antibiotic, vaccine, immune system, epidemic
- Types of microbes
- Human body's 3 lines of defense
- Factors affecting the immune system
- Analyze transmission rates

State 2 – Determine Acceptable Evidence

What evidence will show that students understand?

Performance Tasks:

- *What's My Disease* – Students will make up a disease and create a profile for the disease.
- *Fighting a Disease* – Students will create a 6-8 panel comic strip to show the 3 lines of defense a microbe must cross to make a person sick.
- *Maintain a Healthy Immune System* – Students will create a 3-panel brochure describing the 4 outside factors that affect the immune system.
- *Prevent the Epidemic* – Students will create a PSA to describe the steps one should take to prevent the spread of disease in the school. Students will write school officials explaining why the school should follow the students' plan.

What other evidence needs to be collected in light of Stage 1 Desired Results?
Other Evidence:

- Vocabulary Quizzes
- Venn Diagrams
- Science Journals

Student Self-Assessment and Reflection:

- Self-asses the disease profile, *What's My Disease*
- Self-assess the comic strip, *Fighting a Disease*
- Self-assess brochure, *Maintain a Healthy Immune System*
- Self-assess PSA, *Prevent the Epidemic*

Stage 2 – Determine Acceptable Evidence (continued)

Assessment Task Blueprint

What understandings or goals will be assessed through this task?
Students will identify ways to prevent the transmission of infectious diseases

What criteria are implied in the standards and understanding regardless of the task specifics? What qualities must student work demonstrate to signify that standards were met?

- Type of pathogen
- Type of transmission
- Rate of infection

Through what authentic performance task will students demonstrate understanding?
Task Overview:
Students will create a PSA to inform the public about their disease. The PSA can be a brochure, Google presentation w/6 slides or 30 second commercial

What student products and performances will provide evidence of desired understandings?

- Create a Disease
- Immune System Comic Strip
- Healthy Immune System Brochure

By what criteria will student products and performances be evaluated?

- Graded according to rubrics

Stage 3 – Plan Learning Experiences

WHERETO

1. Unit Hook - Use Germ Glo to identify germs spread
2. Introduce Essential Question & discuss summative unit tasks
3. Immune system vocabulary (Introduce vocabulary as needed)
4. Introduce van Leeuwenhoek – Watch Pond water video
5. Types of Microbes – bacteria & virus (coloring)
6. Bacteria & Virus Frayer Models
7. Potato Germ Lab - Handwashing (4 days – daily observations)
8. Germ vocabulary Germ Theory scientists (Semmelweis, Snow & Pasteur)
9. Diseases from Germs (Jigsaw Activity)
10. Disease Transmissions
11. Create a Disease (2 days)
12. Apple Lab – Skin (3 days – observations 1, 3 & 5)
13. Immune System Defenses (Day 1) – Overview
14. Immune System Defenses (Day 2) – Non-Specific
15. Immune System Defenses (Day 3) – Non-Specific
16. Immune System Defenses (Day 4) – Specific
17. GERM Vocabulary Bingo
18. Immune System Comic – 3 levels of defense (4-day project)
19. I Have, Who Has - Immune System
20. Outside factors that affect the Immune System (Hygiene)
21. Outside factors that affect the Immune System (Nutrition)
22. Outside factors that affect the Immune System (Stress)
23. Outside factors that affect the Immune System (Sleep)
24. Healthy Immune System Brochure (3-day project)
25. Transmission Rates
26. An epidemic affects me
27. What makes an Epidemic

Step 3 – Plan Learning Experiences (continued) Pacing Guide				
Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Day 1- Lesson 1	Day 2- Lesson 1 (cont.)	Day 3- Lesson 2	Day 4- Lesson 2 (cont.)	Day 5- Lesson 2 (cont.)
Day 6- Lesson 3	Day 7- Lesson 3 (cont.)	Day 8 - Lesson 3 (cont.)	Day 9- Lesson 4	Day 10- Lesson 4 (cont.)
Day 11- Lesson 4 (cont.)	Day 12- Lesson 4 (cont.)	Day 13- Lesson 4 (cont.)	Day 14- Lesson 5	Day 15- Lesson 6
Day 16- Lesson 6 (cont.)	Day 17- Lesson 5 (cont.)	Day 18- Lesson 6 (cont.)	Day 19- Lesson 6 (cont.)	Day 20- Lesson 7
Day 21- Lesson 7 (cont.)	Day 22- Lesson 7 (cont.)	Day 23- Lesson 8	Day 24- Lesson 8 (cont.)	Day 25- Lesson 8 (cont.)
Day 26- Lesson 8 (cont.)	Day 27- Lesson 9	Day 28- Lesson 9 (cont.)	Day 29- Lesson 9 (cont.)	Day 30- Lesson 9 (cont.)
Day 31- Lesson 9 (cont.)	Day 32- Lesson 10	Day 33- Lesson 10 (cont.)	Day 34- Lesson 10 (cont.)	Day 35- Lesson 10 (cont.)
Day 36- Lesson 11	Day 37- Lesson 11 (cont.)	Day 38- Lesson 11 (cont.)	Day 39- Lesson 11 (cont.)	Day 40- Lesson 11 (cont.)
Day 41- Lesson 11 (cont.)	Day 42- Lesson 11 (cont.)	Day 43- Lesson 11 (cont.)	Day 44- Presentations	Day 45- Unit Evaluation

Epidemics Lesson Plan #1					
Content Area: Science					
Lesson Title: Why Do I Get Sick			**Timeframe:** 2 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving		Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment: Germ Glo, UV Flashlight, Journals					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Unit Hook - Germ Glo • Introduce Essential Question	**Lesson Sequence:** Teacher will: 1. Secretively select 1 student and place germ glow on hands 2. Introduce 1st essential question and begin student discussion. Students will: 3. Write answer to 1st essential question in journals 4. Circulate through around the classroom, shake hand with 5 students and ask what they wrote down 5. Students write answers from other students in journals	• Discussion • Journals

	6. Teacher shines UV light on hands and around the classroom 7. Students discuss how 1 person spread disease throughout the classroom 8. Write vocabulary in the science journal, given words and definitions 9. Complete Science Reflection "Today I learned….". Teacher will: 10. Discuss PSA Project	
Vocabulary	➢ **Germ** ➢ **Disease**	• The thing that causes disease It can be bacteria or virus • Something that affects normal body function. It can be infectious or noninfectious.

Epidemics Lesson Plan #2

Content Area: Science

Lesson Title: Leeuwenhoek's Microbes	**Timeframe:** 3 Days

Lesson Components

21st Century Skills

✓	Critical Thinking and Problem Solving		Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics

Connections:

Technology Integration: YouTube Videos

Materials/Equipment: Handout 1, Venn Diagram

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Comprehend Leeuwenhoek's contribution to science • Distinguish between viruses and bacteria	**Lesson Sequence** Students will: 1. Read Handout 1 on Anton Leeuwenhoek 2. Watch short video: Leeuwenhoek & Microscopic Life https://www.youtube.com/watch?v=c_BiLl2v6OE 3. Discuss Leeuwenhoek 4. Watch Organisms found in Pond Water https://www.youtube.com/watch?v=mXqyCNAYrH4 5. Complete Science reflection "Today I learned…." 6. Discuss diseases that are waterborne 7. Write vocabulary in	• Venn Diagram • Discussion • Journals

	the science journal, given words and definitions 8. Identify, color then print microbe identification https://www.amnh.org/explore/ology/microbiology/microbes-coloring-book-scavenger-hunt 9. Compare bacteria and viruses in Venn Diagram 10. Complete Science reflection "Today I learned…."	
Vocabulary	➢ **Microbes** ➢ **Virus** ➢ **Bacteria**	• Tiny organisms that can only be seen with a microscope • A non-living microbe that infects the cells in a body and changes how they work • Living microbes that are all around us.

Epidemics Lesson Plan #3					
Content Area: Science					
Lesson Title: Where Are the Germs?		**Timeframe:** 3 Days			
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving		Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment: Potatoes, Ziplock Bags					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Understand the role handwashing has in preventing disease. • Review vocabulary	**Lesson Sequence** Students will: 1. Set up Germ Lab 2. Complete Cut & Paste Vocabulary Activity (Handout 2) 3. Observe Germ Lab 4. Complete Germ Lab 5. Complete Science reflection "Today I learned…."	• Lab Report 1 • Vocabulary Worksheet

Epidemics Lesson Plan #4					
Content Area: Science					
Lesson Title: Microbiology			**Timeframe:** 5 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving		Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment: Project 1					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Identify microbiologists • Identify methods of transmission • Describe what a vaccine is • Classify diseases by treatment	**Lesson Sequence:** Students will: 1. Watch videos about scientists related to microbiology and take notes. 2. Discuss scientists 3. Complete Science Reflection "Today I learned….". Semmelweis https://www.youtube.com/watch?v=bisJ09s384I Snow/Koch/Pasteur https://www.youtube.com/watch?v=N9LC-3ZKiok Lister https://www.youtube.com/watch?v=eElAhsSY2KA 4. Discuss scientists and their achievements	• Discussion • Journals

	5. Watch the video, identify and discuss 4 means of disease transmission https://www.youtube.com/watch?v=dbd5iydu3EY 6. In the Science Journal, draw the 4 methods of disease transmission 7. Watch the video and see how vaccines work https://www.youtube.com/watch?v=gzptBqDuLNY 8. Complete Science Reflection "Today I learned….". 9. Complete a Jigsaw activity to identify diseases and their causes 10. Complete Science Reflection "Today I learned….".	
Vocabulary	➢ **Symptom** ➢ **Transmission** ➢ **Vaccine** ➢ **Infectious** ➢ **Contagious**	• A physical condition that indicates the presence of a disease • How disease spreads to a person • A substance that stimulates the body's production of virus-fighting antibodies • A disease that can be transmitted • A disease that can be transmitted from person to person

Epidemics Lesson Plan #5					
Content Area: Science					
Lesson Title: What's My Disease			**Timeframe:** 2 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving	✓	Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment: What's My Disease?					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Microbes – viruses and bacteria – cause diseases.	**Lesson Sequence:** Students will: 1. Use what they have learned to create a disease profile according to the Project Sheet 1 2. Students self-assess their projects using the rubric.	• Disease profile • Teacher rubric for project

Epidemics Lesson Plan #6					
Content Area: Science					
Lesson Title: Our Protective Skin			**Timeframe:** 4 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving		Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment: Apples, Alcohol, Handout 4					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Identify the 3 parts of the immune system's defense against diseases	**Lesson Sequence:** Students will: 1. Set up Skin Lab 2. Observe Skin Lab 3. Complete Cut & Paste Vocabulary Activity (Handout 4) 4. Complete Skin Lab 5. Complete Science reflection "Today I learned…."	• Lab Report

<table>
<tr><th colspan="6">Epidemics Lesson Plan #7</th></tr>
<tr><td colspan="6">Content Area: Science</td></tr>
<tr><td colspan="3">Lesson Title: Our Protective Skin</td><td colspan="3">Timeframe: 3 Days</td></tr>
<tr><td colspan="6">Lesson Components</td></tr>
<tr><td colspan="6">21st Century Skills</td></tr>
<tr><td>✓</td><td>Critical Thinking and Problem Solving</td><td></td><td>Creativity and Innovation</td><td>✓</td><td>Collaboration, Teamwork, and Leadership</td></tr>
<tr><td>✓</td><td>Cross-Cultural Understanding and Interpersonal Communication</td><td></td><td>Communication and Media Literacy</td><td></td><td>Accountability, Productivity, and Ethics</td></tr>
<tr><td colspan="6">Connections:</td></tr>
<tr><td colspan="6">Technology Integration:</td></tr>
<tr><td colspan="6">Materials/Equipment: Handout 4</td></tr>
<tr><th>Goals/Objectives</th><th>Learning Activities/ Instructional Strategies</th><th>Formative Assessments</th></tr>
<tr><td>Students:
• Identify the 3 parts of the immune system’s defense against diseases</td><td>Lesson Sequence:
Students will:
1. Watch Immune System Video https://www.youtube.com/watch?v=6uwVhn-APsQ
2. Learn Immune System Song https://sciencemusicvideos.com/immune-system-main-menu/immune-system-part-1-non-specific-innate-responses-music-video-page/
3. With Partner, Play BrainPop https://www.brainpop.com/health/bodysystems/immunesystem/</td><td>• Lab Report</td></tr>
</table>

	4. Complete cut and paste Immune System Defense (Handout 5) 5. Complete Science reflection “Today I learned….”	

Epidemics Lesson Plan #8					
Content Area: Science					
Lesson Title: What's My Disease			**Timeframe:** 4 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving	✓	Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment:					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Demonstrate the function of the immune system in fighting disease	**Lesson Sequence:** Students will: 3. Use what they have learned to create a comic showing how the immune system fights disease according to the Project Sheet 2 4. Students self-assess their projects using the rubric.	• Immune Comic • Teacher rubric for project

Epidemics Lesson Plan #9					
Content Area: Science					
Lesson Title: How Many Are Sick?		**Timeframe:** 5 Days			
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving	✓	Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment:					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • Determine how quickly diseases can spread • Determine the needs of the immune system	**Lesson Sequence:** Students will: 1. Use transmission and doubling rates to determine how quickly a disease spreads (Handout 5) 2. Complete Science reflection "Today I learned…" 3. Research what the body needs to maintain a healthy immune system and create a tri-fold brochure according to Project Sheet 3 (4 days) 4. 4. Students self-assess their projects using the rubric.	• Handout 5

Epidemics Lesson Plan #10					
Content Area: Science					
Lesson Title: How Do I Feel?			**Timeframe:** 4 Days		
Lesson Components					
21st Century Skills					
✓	Critical Thinking and Problem Solving	✓	Creativity and Innovation	✓	Collaboration, Teamwork, and Leadership
✓	Cross-Cultural Understanding and Interpersonal Communication		Communication and Media Literacy		Accountability, Productivity, and Ethics
Connections:					
Technology Integration:					
Materials/Equipment:					

Goals/Objectives	Learning Activities/ Instructional Strategies	Formative Assessments
Students: • will identify Social/Emotional impacts of COVID	**Lesson Sequence:** Students will: 1. Watch a COVID PSA and discuss how their lives changed during the shutdown. https://www.brainpop.com/socialstudies/news/covid19psa/ 2. Interview 2 people to find how their lives changed during COVID shutdown and discuss 3. Draw a picture of themselves during the shutdown 4. Play games to review content and vocabulary from unit (2 days)	• Interview sheet

<table>
<tr><th colspan="6">Epidemics Lesson Plan #11</th></tr>
<tr><td colspan="6">Content Area: Science</td></tr>
<tr><td colspan="3">Lesson Title: What’s Makes an Epidemic?</td><td colspan="3">Timeframe: 8 Days</td></tr>
<tr><td colspan="6">Lesson Components</td></tr>
<tr><td colspan="6">21st Century Skills</td></tr>
<tr><td>✓</td><td>Critical Thinking and Problem Solving</td><td>✓</td><td>Creativity and Innovation</td><td>✓</td><td>Collaboration, Teamwork, and Leadership</td></tr>
<tr><td>✓</td><td>Cross-Cultural Understanding and Interpersonal Communication</td><td></td><td>Communication and Media Literacy</td><td></td><td>Accountability, Productivity, and Ethics</td></tr>
<tr><td colspan="6">Connections:</td></tr>
<tr><td colspan="6">Technology Integration:</td></tr>
<tr><td colspan="6">Materials/Equipment:</td></tr>
<tr><th colspan="2">Goals/Objectives</th><th colspan="2">Learning Activities/ Instructional Strategies</th><th colspan="2">Formative Assessments</th></tr>
<tr><td colspan="2">Students:
Students will identify and use reasons why people should work to prevent the spread of disease.</td><td colspan="2">Lesson Sequence:
Students will:
Use what they have learned to create a PSA to inform the public about a disease according to the Project Sheet
Self-assess their projects using the rubric.</td><td colspan="2">Group Project</td></tr>
</table>

Handout 1

Anton van Leeuwenhoek
Father of Microscopy and Microbiology

Anton van Leeuwenhoek (October 24, 1632 – August 30,1723); name pronounced 'Laywenhook') was a Dutch tradesman and scientist. He is known as "the father of microbiology" and for his work to improve the microscope. Using his handcrafted microscopes, he was the first to see and describe single celled organisms, which he originally referred to as *animalcules*, and which we now refer to as microorganisms. He was also the first to record microscopic observations of muscle fibers, bacteria and blood flow in small blood vessels.

Van Leeuwenhoek never wrote books, just letters to his friends about his discoveries. His hobby was grinding glass lenses. He used these powerful single lenses to make microscopes and study tiny objects. With his simple microscopes, he observed protozoa in rainwater and pond water and well water and bacteria in the human mouth and intestine. He also discovered blood corpuscles, capillaries, and the structure of muscles and nerves. His observations helped lay the foundations for the sciences of bacteriology.

Handout 2

Name _____

Vocabulary Match-Up

Color the vocabulary word, then cut out each definition and glue the correct definition beside the correct vocabulary word

Bacteria	
Disease	
Germ	
Microbe	
Virus	

✂----------

The thing that causes disease. It can be bacteria or virus	Tiny organisms that can only be seen with a microscope
Living microbes that are all around us.	Something that affects normal body function. It can be infectious or non-infectious.
A non-living microbe that infects the cells in a body and changes how they work	

Handout 3

STREP THROAT

Strep throat is a highly contagious infection of the throat, that is common in children all over the world. Its symptoms include fever, sore throat, red tonsils, and enlarged lymph nodes in the neck. The symptoms typically begin one to three days after infection and last seven to ten days. The germs that cause strep throat can spread through airborne droplets when someone with the infection coughs or sneezes, or through shared food or drinks. People can also pick up the bacteria from a doorknob or other surface and transfer them to their nose, mouth, or eyes. Because it is spread by direct, close contact with an infected person, strep throat is frequently found in school. People can prevent strep throat by washing their hands. There is no vaccine for the disease. Once a doctor confirms the diagnosis, antibiotics are given as a treatment.

✂----------

CHICKEN POX

Chickenpox is a contagious infection that causes an itchy rash with small red bumps. Before the rash starts, children can have a fever and feel achy. The rash develops into clusters of small, fluid-filled blisters and generally appears on the face, limbs, chest, and stomach. Chickenpox is highly contagious to people who haven't had the disease. It spreads easily from one person to the next because it is airborne and spreads through coughs and sneezes from an infected person. It may be spread from one to two days before the rash appears and until all lesions have crusted over. chickenpox is primarily a disease that children get. Most cases occur during the winter and spring when children are in school. It is one of the classic diseases of childhood, with most cases occurring in children under the age of 15. There is no cure for chickenpox, but most children recover within two weeks. Children can also get a vaccine that prevents it altogether.

CHOLERA

Cholera, which was first noted in 1642 by a Dutch physician, is an infectious disease that causes severe diarrhea and can lead to dehydration and even death if untreated. The first cholera pandemic occurred in India, starting in 1817 through 1824. The disease spread to Asia, the Middle East, Europe, and Africa. The movement of British military ships helped spread the disease since the ships carried people who had the disease across the world. Ships flew a yellow quarantine flag if anyone on board was suffering from cholera. No one aboard a vessel flying a yellow flag would be allowed ashore. Cholera is caused by eating food or drinking water contaminated with germs. Symptoms start two hours to five days after a person is infected. Today, cholera is found in places with inadequate water treatment and poor sanitation. Boiling water is a very effective way to disinfect the water, as it kills the germs that cause cholera. Besides, washing hands can help to stop the spread. Doctors give cholera patients antibiotics to kill the disease in their bodies. They also must drink a mixture of sugar, salt, and water to replace the fluids that they lose from diarrhea.

✂----------

POLIO

Polio is a contagious infection that can be disabling or even life-threatening. It is spread from person-to-person in close contact. People are contagious for 2 weeks before they have symptoms, so they could infect a lot of people. The germ that causes polio infects a person's spinal cord, which can cause paralysis so that a person cannot move parts of the body. The symptoms of polio are sore throat, fever, tiredness, headache, and stomach pain. For most people, the symptoms last for two to five days and then they get better. However, some people have more serious symptoms. Their muscles weaken and they cannot walk. Some people's throats and chests get paralyzed and they die because they cannot breathe. In the 1940s, parents were frightened to let their children go outside, especially in the summer when the virus seemed to be at its worst. Luckily doctors developed a vaccine for polio and almost no one gets it now, because there is no cure.

Handout 4

Name _____

Vocabulary Match-Up

Color the vocabulary word, then cut out each definition and glue the correct definition beside the correct vocabulary word

Vaccine	
Infectious	
Symptom	
Transmission	
Contagious	

✂----------

How disease spreads To a person	A disease that can be transmitted from person to person
A disease that can be transmitted	A physical condition that indicates the presence of a disease
A substance that stimulates the body's production of virus-fighting antibodies	

Handout 5

Transmission rates

Some diseases are more communicable than others

Transmission rate – how many people can be infected by 1 person
Doubling rate – how long it takes to double the number of people with the disease.

Example:
Bubkis Disease
Transmission rate = 4%
Doubling rate = 5 days
How long before 1000 people are infected?

Sick	4	8	16	32	64	128	256	512	1024	
Days	0	5	10	15	20	25	30	35	40	

Name_____

1. Use the table to determine when 1,000 people will be infected by the Rimple virus. The Rimple virus is not very contagious. 1 person will infect 3 people. The number of people with Rimple virus doubles every 6 days.

People										
Days										

2. Below are 2 diseases. Predict which disease will reach 1,000 people first.

I believe that 1,000 people will get _____ first

because _____.

Use the tables to determine when 1,000 people will be infected by Nipsey or Trickle virus. viruses.

- 1 person with Nipsey virus infect will infect 6 people. The number of people with Nipsey doubles every 4 days.

- 1 person with Trickle virus will infect 4 people. The number of people with Trickle doubles every 6 days.

Nipsey Virus

People										
Days										

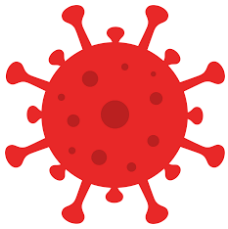
Trickle Virus

People										
Days										

Was your prediction correct? Why or Why not? _____

_____.

Handout 6



Covid Interview

I interviewed: ___ _____

Name 1 thing you needed but was sold out:

Name 2 things you miss:

Name 3 show/movie you've watched:

Name 4 things you can't wait to do again

Name 5 people you miss:

Immune System BINGO

G	E	R	M

Choose terms from the list below and write them in the boxes on the GERM card above. Use tokens and cover the terms when you hear me read out the term's definition.

G Words	E Words	R Words	M Words
germ	pathogen	microbe	antigen
vaccine	antibodies	disease	phagocyte
infectious	noninfectious	bacteria	mucus
skin	cilia	cancer	contagious
lymph nodes	viruses	hygiene	antibiotic
immunity	antiseptic	tonsils	measles

I Have, Who Has

I have the first card. Who has the body system that defends?	I have the immune system Who has the microbe that causes disease?	I have pathogen Who has the common name for a pathogen?
I have germ Who has resistance to disease?	I have immunity Who has the term that means catching or contagious?	I have infectious Who has the covering for our body in the 1st line of defense?
I have skin Who has drugs that treat the immune system?	I have antibiotics Who has a disturbance of normal body structure or activity?	I have disease Who has one way infectious disease is transmitted?

I have infected water or food Who has the response in the 2nd line of defense?	I have inflammatory response Who has a childhood disease that has a vaccine available?	I have chickenpox Who has a substance the body cannot recognize?
I have antigen Who has something to make your immune system stronger?	I have a balanced diet, exercise, and sleep Who has a sign a person has a disease?	I have symptom Who has the substance that white blood cells produce?
I have antibodies Who has weakened or killed microbes, usually injected?	I have vaccine Who has the system that assists the immune system to protect the body?	I have the lymph system And I have the last card!

Lab 1

Where Are the Germs? - Directions

Purpose: You will determine the place in the classroom where the most germs are found.

Hypothesis: Make a guess where you think you will find the most germs. Why do you think that will happen?

Materials:3 thin slices of raw potato; 3 small Ziploc bags per team

Procedures:

1. Slice a raw potato into thin slices about $\frac{1}{4}$ inch thick.

2. Choose 2 areas around the school that you think will contain a lot of germs. Go to those areas with your potato in a Ziploc bag. Rub your fingers over the area and then rub over the slice of potato.

3. Seal in a plastic Ziploc bag and label 'Germ Potato', with the location the sample was taken from.

Repeat steps 2 and 3 with the 2nd slice.

4. Wash your hands with soap and water and then rub your fingers over the 3rd slice of potato.

5. Seal the clean potato in a plastic Ziploc bag and label it 'Control'. Make sure you include the area you collected the germs from so you can match them later to compare.

6. Leave the bags in a warm dark cabinet for three days.

7. Answer the questions and record your observation on the Lab Recording Sheet

Where are the Germs? - Lab Recording Sheet

Team Members: _____

Hypothesis: We think _____

because_____

Record the differences you observed on the potato slices

Tested School Area	Day 1			Day 2			Day 3		
	Germ Potato #1	Germ Potato #2	Control Potato	Germ Potato #1	Germ Potato #2	Control Potato	Germ Potato #1	Germ Potato #2	Control Potato
Notes									

On a separate piece of paper write the lab report. Make sure to include a heading and a summary of the experiment. Include the answers to the below questions in the conclusion. Attach the recording sheet to your lab report.

Questions:

1. What was the purpose of the control?
2. What were the independent variables? What was the dependent variable?
3. Was there a significant difference between the "Germ Hands" samples and the control sample? If so, describe the differences.
4. Which area had the most germs?
5. Did your hypothesis prove correct? Why or why not?
6. What was the purpose of the lab?

Lab 2

Our Protective Skin - Directions

Purpose: The skin is the body's largest organ. Its tough outer covering protects the body from invading microorganisms.

Hypothesis: Look at the materials we are using today and predict what will happen to the apples if the skin is injured.

Materials: 4 small apples, pencil, paper, Q-tip or cotton swab, rubbing alcohol (per team)

Procedures:

1. Wash and dry all 4 apples.
2. Take 4 pieces of paper and label them 1 to 4. Place them side by side in a safe location where they can sit for 5 days.
3. Apple 1 is the control. Place it on paper 1.
4. Take Apple 2 and rub your fingers all over it. Place it on paper 2.
5. Take Apple 3 and make several holes in it with a pencil, at least 6 but no more than 10. Rub your fingers all over it and place it on paper 3.
6. Take Apple 4 and make several pencil holes in it. Rub your fingers all over it. Then take a Q-tip and dip it in rubbing alcohol and carefully swab each pencil hole. Place it on paper 4.
7. Write observations for days 1, 3, and 5.

Our Protective Skin - Lab Recording Sheet

Team Members: _____

Hypothesis: We think _____

because_____

Record the differences you observed on the apples

Apples	Day 1	Day 3	Day 5
Apple 1 (Control)			
Apple 2 (Rubbed)			
Apple 3 (Holes)			
Apple 4 (Alcohol)			

On a separate piece of paper write the lab report. Make sure to include a heading and a summary of the experiment. Include the answers to the below questions in the conclusion. Attach the recording sheet to your lab report.

Questions:

1. What was the purpose of the control?
2. What were the independent variables? What is the dependent variable?
3. Why were the apples washed at the beginning of the lab?
4. Why were holes poked in the apples?
5. Why was apple 4 swapped with alcohol?
6. Did your hypothesis prove correct? Why or why not?
7. What was the purpose of the lab?

Science Lab Rubric			
Criteria		**Points**	
Heading	Missing 2 or more of the following: Title, Problem/Purpose or Hypothesis (0)	Missing at least 1 of the following: Title, Problem/Purpose and/or Hypothesis (1)	Includes Title, Problem or Purpose & Hypothesis (2)
Summary	There is no summary of the experiment (0)	The summary is missing the list of materials or lab procedures. (2)	The summary includes the list of materials and lab procedures. (4)
Data/ Observations	No data or observations included (2)	Data and Observations include at least 1 graph, chart, or drawings. (4)	Data and Observations are shown in graphs, charts, drawings, etc. (6)
Conclusion	The conclusion is incomplete and does not relate to the problem. (3)	The conclusion includes no reflection on learning. (5)	The conclusion relates to the problem and reflects on what was learned (8)
Total points		**/20**	

What's My Disease? – Project 1

Task:

You are a microbiologist who has found a new disease. You must inform the rest of the world about your new discovery. Use what you have learned to create a Disease Profile.

Your disease profile should include:

- Symptoms, causes, and treatment options for your disease.
- Preventive actions you can take to keep from getting it
- History-where and when it originated, details regarding the initial cases

Make sure you include a picture of your newly found germ.

Make sure you follow the project rubric to make sure you get a good score.

ODC

Office of Disease Control
Prevention & Control

Disease Profile

Microbiologist: _____

Disease: _____

Responsible Infectious Agent: Virus Bacteria

Infectious or Contagious:

Symptoms:

Transmission:

Treatment:

The Immune System's 3 Lines of Defense – Project 2

Task:

You will use the graphic organizer to guide you to create a comic strip of how a microbe made its way past the first 2 lines of defense and is destroyed in the third level. Remember, antigens and antibodies fit together like puzzle pieces. The antigen fits into the antibody. Be creative and give the comic strip a title. You have 3 class periods to complete this project, so use your time wisely.

Your comic strip can be horizontal or vertical. It must mention-

1. skin and other entry points for microbes
2. non-specific response to microbes
3. specific responses to microbes

Frame 1: Where does the microbe come from? What kind of microbe is it?
Frame 2: How is it transmitted?
Frame 3: How does it get past the 1st line of defense?
And so on……BE CREATIVE!

Make sure you follow the project rubric to make sure you get a good score.

Comic Strip Graphic Organizer

Maintaining A Healthy Immune System – Project 3

Task:

This is a research project. We have learned about the immune system and how important it for your body. Now it's time to find out how to keep the immune system healthy.

Create a tri-fold brochure that tells what the immune system needs to stay healthy. Use online and print resources to find out what the immune system needs. You must include information on:

Balanced Diet
Rest & Exercise
Personal Hygiene
and Vaccines

- The tri-fold can be hand-drawn or you can use the template below to create it on the computer.
  https://docs.google.com/presentation/d/1xubWKiKNANLQvNEHGdcb44Y53bfoH9ZYDCvrN66SGdI/edit?usp=sharing
- It must include pictures to represent each of the immune system needs.

Be creative and give the brochure a title. You have 4 class periods to complete this project, so use your time wisely.

Make sure you follow the project rubric to make sure you get a good score.

Prevent the Epidemic! – Project 4

Task:

A Public Service Announcement (PSA) is a message to the public. Its objective is to raise awareness or change the public's attitudes towards some social issue. It can be a video or a handout brochure.

Follow the links below to view some PSAs. Make sure you watch them all.
https://www.youtube.com/watch?v=eywBa0xfQFw
https://www.youtube.com/watch?v=rClJW9gnchc
https://www.youtube.com/watch?v=5JrtpCM4yMM
https://www.youtube.com/watch?v=ON6hAudgqMg

This is a group project. Think about all the things you have learned about viruses, how your body fights them, and how they spread. With your team:

- Create a disease. (You CANNOT use the disease you created for your 1st project).
- Create a PSA to show how the school should work to prevent the spread of your disease.
- Write a letter to the school, explaining why they should follow your plan.
- Present your PSA to the class

You have 8 class periods to complete this project, so use your time wisely.

Make sure you follow the project rubric to make sure you get a good score

Important - This project counts as a double grade

Project Rubric			
Criteria	**Points**		
Explanation of Ideas & Information	Uses inappropriate facts and irrelevant details to support science ideas (3)	Uses some appropriate facts and details to support science ideas (5)	Uses appropriate facts and descriptive details to support science ideas (8)
Essential Question	I cannot explain how my project relates to the essential question (1)	I can somewhat explain how my project relates to the essential question (3)	I can clearly explain how my project relates to the essential question (5)
Communication	I cannot explain or communicate Science ideas. (0)	I can explain or communicate some Science ideas. (1)	I can clearly explain and communicate science ideas. (2)
Creativity and Neatness	My project does not demonstrate creativity and neatness (2)	My project demonstrates either creativity or neatness (4)	My project demonstrates both creativity and neatness (6)
Organization	Does not include everything required in the presentation (1)	Includes almost everything required in the presentation (2)	Includes everything required in the presentation (4)
Total points	**/25**		

Appendix B: Raw Data

1st Grade CoGAT Scores

Student	PBL=1 non-PBL=2	HG=1 non-HG = 2	Verbal	Quantatitve	Non-Verbal	Composite
1	1	2	187	229	210	209
2	1	2	201	189	199	196
3	1	2	173	208	191	191
4	1	2	182	182	170	178
5	1	2	187	172	210	190
6	1	2	177	172	191	180
7	1	2	162	156	191	170
8	1	2	165	172	210	182
9	1	2	162	197	199	186
10	1	2	182	182	199	188
11	1	2	201	189	199	196
12	1	1	162	169	210	180
13	1	1	182	177	229	196
14	1	1	165	189	191	182
15	1	1	177	189	191	186
16	1	1	211	172	186	190
17	1	1	169	197	199	188
18	1	1	201	197	199	199
1	2	2	177	208	210	198
2	2	2	166	172	229	189
3	2	2	152	169	186	169
4	2	2	155	165	154	158
5	2	2	162	153	177	164
6	2	2	152	153	181	162
7	2	2	144	151	177	157
8	2	2	144	165	191	167
9	2	2	152	156	191	166
10	2	2	142	162	210	171
11	2	2	152	165	210	176
12	2	1	142	148	182	157
13	2	1	152	156	182	163
14	2	1	149	172	190	170
15	2	1	152	160	182	165
16	2	1	142	158	182	161
17	2	1	152	177	184	171
18	2	1	156	174	175	168

2nd Grade CoGAT Scores

Student	PBL=1 non-PBL=2	HG=1 non-HG = 2	Verbal	Quantatitve	Non-Verbal	Composite
1	1	2	174	198	204	192
2	1	2	156	174	200	177
3	1	1	187	193	190	190
4	1	1	169	193	182	181
5	1	1	169	193	200	187
6	1	2	174	180	177	177
7	1	2	174	203	184	187
8	1	2	164	189	193	182
9	1	1	187	198	196	194
10	1	2	174	169	193	179
11	1	1	187	177	193	186
12	1	1	174	180	204	186
13	1	1	191	186	187	188
14	1	2	171	182	180	178
15	1	2	174	193	190	186
16	1	1	220	209	204	211
17	1	1	180	167	213	187
18	1	2	174	189	190	184
19	1	2	212	209	229	217
20	1	2	199	182	180	187
1	2	2	152	165	210	176
2	2	2	142	148	182	157
3	2	1	164	165	193	174
4	2	1	152	156	182	163
5	2	1	149	172	190	170
6	2	2	152	160	182	165
7	2	2	142	158	182	161
8	2	2	152	177	184	171
9	2	1	156	**174**	**175**	168
10	2	2	**138**	**160**	196	165
11	2	1	166	165	180	170
12	2	1	**161**	**167**	**175**	168
13	2	1	166	163	182	170
14	2	2	156	152	169	159
15	2	2	140	180	182	167
16	2	1	191	186	204	194
17	2	1	164	172	193	176
18	2	2	164	177	204	182
19	2	2	191	189	210	197
20	2	2	174	167	184	175

3rd Grade CoGAT Scores

Student	PBL=1 non-PBL=2	HG=1 non-HG = 2	Verbal	Quantatitve	Non-Verbal	Composite
1	1	2	193	195	207	198
2	1	2	191	190	201	194
3	1	2	193	178	192	188
4	1	2	196	188	189	191
5	1	2	193	197	210	200
6	1	2	196	179	207	194
7	1	2	196	232	213	214
8	1	2	199	204	217	207
9	1	2	203	195	203	200
10	1	2	191	220	213	208
11	1	2	225	204	222	217
12	1	1	199	186	217	201
13	1	1	244	252	205	234
14	1	1	191	183	189	188
15	1	1	208	213	207	209
16	1	1	196	208	222	209
17	1	1	203	208	195	202
18	1	1	208	232	217	219
19	1	1	191	232	213	212
20	1	1	208	213	213	211
1	2	2	172	176	203	184
2	2	2	188	183	203	191
3	2	2	167	149	172	163
4	2	2	186	174	171	177
5	2	2	176	170	189	178
6	2	2	186	168	205	186
7	2	2	199	213	199	204
8	2	2	183	174	207	188
9	2	2	184	172	201	186
10	2	2	188	179	207	191
11	2	2	186	184	217	196
12	2	1	183	167	192	181
13	2	1	199	179	184	187
14	2	1	188	179	185	184
15	2	1	191	171	195	186
16	2	1	191	192	201	195
17	2	1	181	176	189	182
18	2	1	178	184	199	187
19	2	1	191	175	194	187
20	2	1	184	184	203	190

4th Grade CoGAT Scores

Student	PBL=1 non-PBL=2	HG=1 non-HG = 2	Verbal	Quantatitve	Non-Verbal	Composite
1	1	1	208	232	217	219
2	1	2	203	193	191	196
3	1	1	205	197	201	201
4	1	2	203	178	196	192
5	1	2	200	183	213	199
6	1	1	213	220	234	222
7	1	2	187	207	192	195
8	1	2	179	201	196	192
9	1	1	235	207	222	221
10	1	2	178	188	216	194
11	1	1	205	227	227	220
12	1	1	213	204	195	204
13	1	1	224	199	234	219
14	1	1	217	204	216	212
15	1	1	235	207	194	212
16	1	2	200	214	202	205
17	1	2	217	207	216	213
18	1	2	217	227	245	230
19	1	2	217	210	234	220
1	2	1	178	184	199	187
2	2	2	168	174	192	178
3	2	1	196	175	184	185
4	2	2	203	173	202	193
5	2	2	183	173	210	189
6	2	1	168	210	219	199
7	2	2	186	195	185	189
8	2	2	180	178	174	177
9	2	1	205	**174**	**196**	192
10	2	2	**173**	**173**	198	181
11	2	1	**192**	**214**	245	217
12	2	1	**217**	**180**	**186**	194
13	2	1	196	180	204	193
14	2	1	**198**	**180**	**206**	195
15	2	1	**213**	**183**	**185**	194
16	2	2	174	178	201	184
17	2	2	194	165	192	184
18	2	2	203	210	216	210
19	2	2	213	201	219	211