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How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?

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How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?

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The thesis entitled '**How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?**' presented by **NATSUMI ESTEFANÍA THEN SHIMAZAKI**, a candidate for the degree of **Master of Science in Mathematics,** has been approved and is worthy of acceptance.

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ABSTRACT

This research study investigated how the competency-based mathematics curriculum, school type, and regional location impacted student mathematical performance in the Dominican Republic. The study was framed within the context of educational reforms and was motivated by the need to understand how these factors influenced mathematical outcomes following the implementation of Ordinance 01-2016, which revised the national evaluation system to align with the curricular reform. The scope of the project included an analysis of data from the mathematics Pruebas Nacionales (National Examinations) over a pre-ordinance period (2017 to 2022) and a post-ordinance period (2023). The dataset was provided by the Ministry of Education of the Dominican Republic (MINERD). A quantitative approach was employed, utilizing independent two-sample t-tests, one-way and two-way ANOVA, and Hierarchical Linear Modeling (HLM) methods. The results revealed that the implementation of Ordinance 01-2016 did not significantly improve student mathematical performance on the Pruebas Nacionales. The analysis showed that students from private schools consistently outperformed those from public schools, and that public schools experienced a larger decline in mean scores post-ordinance compared to private schools. Regional differences were also observed, with certain regions achieving higher mean mathematics scores than others. The implications of these results suggest that while curricular reforms can improve educational outcomes, additional measures are needed to address the inequities observed between the mathematical competency assessment instrument, the policy implementation strategy, and equity issues. Specifically, public schools require more focus and resources to improve the readiness and quality of mathematics teachers, as well as to address issues related to school infrastructure.

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CHAPTER I: INTRODUCTION

Chapter I will lay the foundation for examining the impact of the competency-based mathematics curriculum on student mathematical performance in the Dominican Republic, as measured by the mathematics Pruebas Nacionales (National Examinations) following the implementation of Ordinance 01-2016. This chapter will present a historical timeline of education policies and system restructuring, which helped set the stage for Ordinance 01-2016. It will cover research objectives, describe how the data was obtained, how it will be analyzed, and discuss ethical considerations. Furthermore, it will introduce the theoretical framework and conclude with a thorough discussion of the study's assumptions, limitations, and scope.

Introductory Paragraph

The Dominican Republic is a Spanish-speaking country located on the island of Hispaniola and is identified as a middle-income country with an economy based primarily on tourism (Central Intelligence Agency, n.d.; International Trade Administration, n.d.). It ranks among the largest economies in the Americas, with a notable growth rate compared to other Latin American countries over the last half-century (International Trade Administration, n.d.; Pozo et al., 2013). The Dominican Republic's global economic participation is characterized by the development of local financial markets, improved debt management (Central Intelligence Agency, n.d.), evolution of economic sectors, and family remittances (Pozo et al., 2013). These strategies have contributed to a steady decline in poverty, indicating positive trends in economic health and stability.

Despite its economic progress, the Dominican Republic has historically struggled in its education sector, characterized by subpar overall academic performance and inadequate funding for public schools (Hamm & Martínez, 2017). Consequently, over the past three decades, the Dominican Republic has implemented numerous reforms to enhance the overall quality of education, including mathematics. These reforms included the creation of the Pruebas Nacionales (National Examinations), which are mandatory, standardized summative exams that cover fundamental concepts from four core subjects: Spanish language arts, mathematics, social sciences, and natural sciences. The results of these exams are used by the government both to certify a student's completion of their secondary studies and to evaluate the overall quality of education.

Whether in public or private institutions, the Pruebas Nacionales are conducted simultaneously across the nation and last for two hours each (MINERD, 2011). Students have three attempts (convocatorias) per year to take them (MINERD, 2011). They account for 30% of a student's final grade, with the remaining 70% assessed by classwork in their respective educational center (i.e., presentation grade). To pass the secondary level, a student needs a combined score of 70, factoring in both scores. These standardized tests are centrally prepared by the Ministry of Education of the Dominican Republic (MINERD).

Due to their pivotal role in both informing education quality and grade promotion, the Pruebas Nacionales have been subject to significant educational policy changes to improve their reliability and effectiveness. One such policy is Ordinance 01-2016, enacted in response to earlier significant curricular and structural changes. These changes were themselves initiated in reaction to concerns regarding the quality of education, as evidenced by both national and international assessments. Another outcome of the ordinance was to formalize the introduction of Evaluaciones Diagnósticas (Diagnostic Assessments), which, like the Pruebas Nacionales, assess academic competencies but have no impact on their promotion to the next educational level (MINERD, 2016a).

With its gradual implementation, the ordinance's impact on student mathematical outcomes, as measured by the mathematics Pruebas Nacionales – the very exam it was designed to modify – is now the subject of this research. Grasping the impact of Ordinance 01-2016 on student mathematics performance on the Pruebas Nacionales requires examining the historical background that led to its enactment.

Background of the Problem

The Dominican Republic has long faced challenges in educational outcomes, especially in STEM subjects such as mathematics. This underperformance is evidenced by national and international assessments alike. In the UNESCO First and Second Regional Comparative and Explicative Studies (PERCE in 1997 and SERCE 2008, respectively), the country ranked low in mathematics (Hamm & Veras Diaz, 2021; UNESCO, 1998; UNESCO, 2008). Further assessments like UNESCO TERCE 2013 did not show significant improvement (Hamm & Veras Diaz, 2021). This trend of results continued in subsequent assessments, including the Programme for International Student Assessment (PISA) 2015, which targets 15-year-old students in Organization for Economic Cooperation and Development (OECD) member countries (Batista, 2016; Hamm & Veras Diaz, 2021). Scores further declined in PISA 2018, marking an all-time low for the Dominican Republic (Diario Libre, 2019). There was some improvement in PISA 2022, though still considerably below the mean mathematics scores obtained by other participant countries (EFE, 2023).

In tandem, mathematics performance as measured by the Pruebas Nacionales has also shown less than desirable results. Between 2008 and 2022, the mean scores were barely below 54% (MINERD, n.d.-a). However, there has been a gradual improvement, with the mean scores increasing slightly to 55.80% in 2016 (MINERD, n.d.-b) and further to 56.63% in 2023 (MINERD, n.d.c).

In the spring of 1997, the Dominican Republic enacted the Organic Law of Education 66-97 (El Congreso Nacional, 1997). This law affirmed the right to education for all citizens, outlined the state's educational responsibilities, and provided guidelines for both public and private educational institutions. Articles 60 to 62 introduced a National System for the Assessment of Educational Quality, aimed at assessing the Dominican education system's efficiency and effectiveness by providing objective data on school performance and conducting regular national exams at levels and cycles as determined by the National Council of Education (Consejo Nacional de Educación) (El Congreso Nacional, 1997; MINERD, 2020a). With it, the grading system of the national exams was revised, and the final grade combined 30% from the exam score and 70% from the average presentation grade in each subject provided by the student's educational center (MINERD, 2020a).

In 2004, Ordinance 07-2004 amended and integrated previous ordinances to regulate the Pruebas Nacionales system and define its organization, purposes, and scope (MINERD, 2011). As per this ordinance, the Pruebas Nacionales aimed to (1) raise awareness about the need for precise information on student performance at the end of educational levels and cycles, contributing to setting higher standards for national educational quality; (2) provide relevant information for curriculum planning and development; and (3) facilitate the evaluation of new competencies in line with the progressive development of the Education System (MINERD, 2011).

The efforts to improve the education system over the next thirty years were evident in the Ten-Year Education Plan 2008–2018 (Plan Decenal de Educación) and the National Pact for Educational Reform in the Dominican Republic (Pacto Nacional para la Reforma Educativa en la República Dominicana (2014–2030)). Both initiatives emphasized the importance of enhancing the national system for evaluating educational quality and improving the performance of educational system stakeholders (MINERD, 2020a).

In 2010, the Theoretical Conceptual Framework of the Pruebas Nacionales was updated for the 2011–2012 academic year to revise exam design and data analysis methodologies. The data analysis method employed was Item Response Theory (IRT), specifically the Rasch model, enabling more precise year-to-year comparisons (MINERD, 2020a). The data analysis method employed is Item Response Theory (IRT), specifically the Rasch model, enabling more precise year-to-year comparisons (MINERD, 2020a). The Rasch model is discussed in greater detail in Chapter III.

These educational reforms led to major curricular revisions and system update processes, introducing a competency-based approach through Ordinance 02-2011 and Ordinance 02-2015 (Hamm & Martínez, 2017). These ordinances marked a transition from a teacher-centered to a student-centered curriculum, accentuating the development of specific competencies (Hamm & Martínez, 2017). Competencies were defined as a student's ability to act autonomously in various contexts and are considered to evolve gradually through life (MINERD, 2015, Art. 6). Thus, comprehensive curriculum updates ensued to enhance student learning.

The Academic Structure of the education system was also reformed in 2013. Ordinance 03-2013 revised the Dominican education system's structure to align with the International Standard Classification of Education (Clasificación Internacional Normalizada de la Educación (CINE), in Spanish-speaking regions) (MINERD, 2013). This restructuring divided education into three levels, each spanning six years and subdivided into two cycles of three years. The primary goals of this policy were to adjust the educational system to more closely match the developmental stages of children (IDEICE, 2020; Hamm & Veras Diaz, 2021), and to ease the comparison of statistical data and assessment results (MINERD, 2013). These modifications directly reclassified the terminal academic year from the fourth year of high school to the sixth year of secondary, thereby impacting the data collection process of the Pruebas Nacionales.

This context set the stage for the ordinance at the heart of this study: Ordinance 01-2016. This ordinance superseded Ordinance 07-2004, modifying the National Evaluation system and assessment of learning in the Dominican Republic; it also recognized the significant role of the Pruebas Nacionales in evaluating learning outcomes and indicators of the education system's quality upon completing an educational level (MINERD, 2016a).

One of the key reforms enacted by Ordinance 01-2016 was the realignment of the Pruebas Nacionales to correspond with the newly implemented competency-based curriculum and structural adjustments (MINERD, 2016a). This realignment included specifying the mathematics domains to be assessed in the Pruebas Nacionales, as detailed in Chapter III. The ordinance also eliminated the 8th grade Pruebas Nacionales, recognizing that this level was no longer considered a terminal grade due to the structural revisions introduced by Ordinance 03-2013 (MINERD, 2016a). Replacing them, it introduced Evaluaciones Diagnósticas (Diagnostic Examinations) for secondary third grade students (formerly 9th grade) (MINERD, 2016a, Art. 4). The pilot year for these diagnostic examinations was scheduled for 2019 (MINERD, 2016a, Art. 13).

While much of the structure of the Pruebas Nacionales established by Ordinance 07-2004 was retained, Ordinance 01-2016 introduced significant changes in how these exams contribute to the final grade (MINERD, 2016a). In particular, the student's presentation grade was now based on student performance over the last cycle of secondary education (fourth, fifth, and sixth grades) (MINERD, 2016a, Art. 5). These modifications were set to be implemented following the graduation of the first cohort under the new competency-based secondary school curriculum, anticipated to occur after 2020 (MINERD, 2016a, Art. 5 Para.).

Historically, the focus was on high-stakes summative evaluations, but Ordinances 01-2016 marked a shift toward more student-centered, formative approaches in student evaluation. Recently, Ordinance 04-2023 has been introduced to align the System of Learning Evaluation with the current curriculum, providing guidelines for the secondary level.

Statement of the Problem

The proposed study aims to investigate the impact of the competency-based mathematics curriculum on student mathematical performance in the Dominican Republic, as measured by the National Examinations following Ordinance 01-2016 implementation. This ordinance emphasized the critical role of the Pruebas Nacionales (National Examinations) in gauging learning outcomes at the end of secondary education and as benchmarks of the system's effectiveness (MINERD, 2016a). Specifically, Ordinance 01-2016 restructured the Pruebas Nacionales to align with earlier reforms, including the adoption of a competency-based curriculum and academic restructuring (MINERD, 2016a).

The study will evaluate the influence of the mathematics curriculum reform on student performance in the mathematics Pruebas Nacionales, considering predictors such as school type (public or private), and geographical location (Regional Directorates and macroregions). Given that an objective of Ordinance 01-2016 is to enhance the quality of education – particularly in mathematics – understanding its effectiveness is crucial for shaping future educational policies (MINERD, 2016a). Therefore, this study seeks both to analyze the ordinance's impact and propose recommendations to further improve mathematics education in the Dominican Republic.

Significance of the Study

As the timeline demonstrates, Ordinance 01-2016 forms part of the Dominican Republic's broader efforts to address educational challenges, aiming to improve the quality of education through the revision of the evaluation system and curriculum (MINERD, 2016a). However, there is a significant gap in quantitative research evaluating the impact of these reforms on student outcomes. Moreover, research within the broader field of mathematics in the Dominican Republic has been underwhelming (González & Villegas, 2016).

In a longitudinal analysis of mathematics research In the Dominican Republic, González & Villegas (2016) examined 318 studies (bachelor's, master's, and doctoral theses) from 1994 to 2014. They identified as many as 35 themes across these studies, revealing a wide thematic range and indicating a concerning absence of focused, long-term research trends in Dominican mathematics research (González & Villegas, 2016). González & Villegas (2016) also point out the minimal use of theoretical frameworks prevalent in the global mathematics education discourse, raising concerns about the depth of critical analysis within these studies and a general oversight of international scholarly discourse.

Moreover, the historical pattern of repeating and reintroducing similar objectives through educational reforms suggests that Dominican education policy faces challenges in achieving lasting improvements. Scholars like García (2018) have criticized these policies for achieving only superficial and partial improvements.

Thus, this study seeks to contribute to the knowledge in education policy impact on student performance in mathematics by employing quantitative methods. It also aims to motivate future researchers to pursue similar quantitative analyses in the field of education. Specifically, this study directly answers the call made by Neilson and Taveras (2015) to use pre-existing administrative data for analytical purposes. They identified challenges in such an approach, including accurate linkage of observations and other potential issues arising from large-scale data collection. Despite these potential issues, they argued that it was cost-effective and highly relevant to issues involving educational policy (Neilson & Taveras, 2015).

Purpose of the Study

The proposed study aims to evaluate the impact of the competency-based mathematics curriculum on student mathematical performance in the Dominican Republic using quantitative methods. Specifically, it will examine pre-existing scores from the

Pruebas Nacionales before and after Ordinance 01-2016's implementation, focusing on overall mathematics scores while accounting for public or private schools and regional variations. By categorizing data according to these demographic factors, the study intends to investigate the relationship between these predictors and student mathematics performance in the Pruebas Nacionales at the end of secondary education.

Furthermore, the objective is to identify any specific challenges or advantages experienced by distinct groups while acknowledging the multifactorial nature of student mathematical achievement. Ultimately, the study aims to provide a comprehensive understanding of Ordinance 01-2016's effectiveness and propose recommendations for improving mathematics education and its outcomes in the Dominican Republic.

Primary Research Questions

This study aims to explore the primary research question:

- How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?

To further investigate this, the primary research question will be divided into five distinct research questions:

1. Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

2. Is school type a significant predictor for mathematics performance on the Pruebas Nacionales?

3. Is region a significant predictor for mathematics performance on the Pruebas Nacionales?

4. Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales?

5. Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales?

Research Design

The study will utilize unpooled independent two-sample t-tests, one-way and two-way Analysis of Covariance (ANOVA), and Hierarchical Linear Modeling (HLM) methods to analyze the mean mathematics scores of secondary students who participated in the Pruebas Nacionales (National Examinations) in the Dominican Republic. This analysis will compare the scores from control groups before the implementation of Ordinance 01-2016 against those of treatment groups following its implementation. Furthermore, it will explore whether mathematics scores vary significantly across school type and geographical location.

Background of the Study

1. The Pruebas Nacionales are designed for students in the sixth grade of the second cycle of secondary education. The study will focus on the mathematics subject, administered through different booklets that are randomly assigned to students to ensure an equitable examination process (MINERD, 2020a).

2. The assessment consists of multiple-choice questions with four options, one of which is correct (MINERD, 2020a).

3. The content of the items on the mathematics Pruebas Nacionales comes from the second cycle of the secondary level. For more detailed information on the specific mathematics content assessed, refer to Chapter III.

4. The exams are administered simultaneously across the country on specified dates in the school calendar, with each exam lasting two hours (MINERD, 2016a, Art. 5).

5. According to MINERD (2017a), secondary education is the stage of formal education that students enter after completing their primary education. It caters to students primarily aged between 12 and 18 years old, spanning six years and split into two cycles (MINERD, 2017a). The second cycle presents three study tracks: academic, technical-professional, and arts (MINERD, 2017a). This study will focus on the academic track, characterized by its rigor and serving as a foundational step towards higher education (MINERD, 2017a).

6. There are three exam attempts (convocatorias) each year; the study's scope covers only the first attempt, intended for students who have passed all subjects at their educational center (MINERD, 2011).

Data Collection Overview

The Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) at the Ministry of Education of the Dominican Republic (MINERD) collected and de-identified the data before supplying it to the researcher. The provided data encompasses demographic differences, including regional identifiers, educational sector, attempt (convocatoria), track, and subject area (refer to Appendix A for more details on the variables). The data is presumed to represent all sixth-year secondary students who participated in the first attempt (convocatoria) of the Pruebas Nacionales (National Examinations) in the Dominican Republic, from 2010 to 2019, and 2023. For further details on the exclusion of the years 2020 and 2021, refer to the section titled "Assumptions, Limitations, and Scope."

According to MINERD (n.d.-d), the Directorate of Evaluation of Quality oversees the improvement of educational quality by evaluating and analyzing learning achievements and related factors. It also distributes these insights to aid decision-making across different sectors of the educational system and manages the Pruebas Nacionales, Evaluaciones Diagnósticas (Diagnostic Examinations), and the country's participation in international studies (MINERD, n.d.-d). Its duties include developing exams, tools, and methodologies aligned with the curriculum, as well as issuing certifications to acknowledge the completion of studies (MINERD, n.d.-d).

Data Analysis Overview

The research will employ unpooled independent two-sample t-tests, one-way and two-way Analysis of Covariance (ANOVA), and Hierarchical Linear Modeling (HLM) methods to compare the mean mathematics scores of various independent groups that have participated in the Pruebas Nacionales (National Examinations) from 2010 to 2023. Predictors such as Ordinance 01-2016 Implementation (pre, post), school type (public, private), region (18 Regional Directorates and three macroregions: North, East, and South). All statistical analyses will be performed using R software (R Core Team, 2023).

Ethical Considerations

The data was collected and de-identified by representatives of the Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) before being supplied to the researcher, thereby protecting student confidentiality (see Appendix C). Furthermore, the research project did not involve any interaction with human subjects, posing no risk to the students involved, as participation in the Pruebas Nacionales is a mandatory component of their educational completion in the Dominican education system. Given these circumstances, the researcher received an exemption from the Institutional Review Board (IRB) process at Shawnee State University (see Appendix D).

Theoretical Framework

Evaluating the impact of education implementation on student mathematical outcomes is a complex process that requires a multi-theoretical framework. This study focuses on two overarching themes: the theoretical framework of the Dominican competency-based curriculum and Pruebas Nacionales (National Examinations) and the framework of educational policy implementation.

The theoretical framework pertaining to the Dominican curriculum, which guides the development of the Pruebas Nacionales, is supported by three theories: Piaget's Genetic Epistemology, Vygotsky's Sociocultural Theory of Cognitive Development, and Constructivism (MINERD, 2011). In the case of the Pruebas Nacionales, Bloom's Taxonomy is employed for the classification of cognitive processes (MINERD, 2011).

Finally, regarding the implementation of education policy, Fullan's (2006) Theory of Educational Change is discussed.

Genetic Epistemology

Through Genetic Epistemology, Piaget (1971) sought to explain the nature of knowledge, focusing on scientific knowledge and the psychological basis of its foundational concepts and operations (Piaget, 1971). This theory emerged with a focus on human intellectual development, particularly exploring how children develop knowledge and understanding of their environment (Piaget, 1971). Piaget proposed that children's intellectual development stems from a dynamic interplay between genetic predispositions and environmental factors (University of Wyoming, n.d.). In other words, as children interact with their surroundings, they are in a continual process of knowledge invention and reinvention (University of Wyoming, n.d.).

Singer and Revenson (1996) outline the four stages of children's cognitive development proposed by Piaget (1971), each characterized by the emergence of distinct mental structures:

- Sensory-motor stage (0–2 years): Children learn primarily through exploring the world with their senses and motor skills.
- Preoperational stage (2–7 years)**:** This stage is characterized by intuitive thinking and the development of symbolic skills.
- Concrete operational stage (7–11 years)**:** Children start to perform mental mathematical operations and think more abstractly about numbers and their relationships. They gain

the ability to reverse thoughts (e.g., addition versus subtraction), classify objects into categories, and understand that objects remain constant despite changes in physical appearance.

- Formal operational stage (11 years and beyond)**:** In this final stage, adolescents engage in more complex and abstract thinking. This stage is marked by deductive reasoning and conceiving multiple solutions to problems. No new mental structures emerge after this stage; instead, there is a deepening of understanding.

These stages are sequential and unchangeable; all children go through them in the specified order (Singer & Revenson, 1996). However, development across different domains (e.g., language and mathematics) can occur at different stages, and the age ranges provided are not rigid, especially at the upper bounds (Singer & Revenson, 1996).

The current competency-based Dominican curriculum prioritizes student-centered approaches, aligning with Piaget's (1971) perspective by emphasizing that learning and thinking require the active participation of the student. More specifically, the Dominican curriculum regards students as active individuals who engage with knowledge by interacting with their surroundings and by comparing their ideas with those of others (MINERD, 2011). The formal operational stage is particularly relevant to this study because the Pruebas Nacionales (National Examinations) have primarily been administered to students in the second cycle of secondary education, who are typically 17 to 18 years old.

Sociocultural Theory of Cognitive Development and Constructivism

Vygotsky's Sociocultural Theory of Cognitive Development asserts that human development is a socially mediated process, where children acquire cultural values, beliefs, and problem-solving skills through collaborative dialogues with more knowledgeable individuals (Mcleod, 2023). Vygotsky maintained that "learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with […] peers" (Vygotsky, 1978, p. 90). Unlike Piaget, Vygotsky argued that learning is not synonymous with development but rather precedes it (Mcleod, 2023). Unlike Piaget, Vygotsky argued that learning is not synonymous with development but rather precedes it (Mcleod, 2023).

Within the framework of the Dominican curriculum, MINERD (2011) highlights the importance of mastering fundamental concepts, procedures, and values relevant to successful development in a child's sociocultural context, rather than accumulating vast amounts of information. As a result, test items on the Pruebas Nacionales (National Examinations) are designed to connect with a broader context, linking to real-world applications (MINERD, 2011). These assessments evaluate both conceptual and procedural content, covering a range of cognitive processes from the simplest to the more complex (MINERD, 2011).

Taxonomy of Cognitive Processes (revision of Bloom's)

The Dominican curriculum is influenced by Bloom's Taxonomy (1956), as revised by Anderson and Krathwohl (2001) for classifying cognitive processes (MINERD, 2011). Specifically, the six levels of cognitive learning are organized into three complexity levels, similar to many international assessments (MINERD, 2011). The complexity of a test item is determined by the extent to which it requires the test-taker to think, and the cognitive processes needed to solve it (MINERD, 2011). Consequently, for the Pruebas Nacionales (National Examinations), items are classified into the following categories (MINERD, 2011):

- Level 1: Involves understanding facts and data, such as recalling information, defining concepts, or recognizing elements.

- Level 2: Refers to grasping basic relationships and interactions among various elements, constructing meanings given information, and making connections.

- Level 3: Entails the application of principles, problem-solving, and analysis of elements within a context, considering their relationships and implications.

In each subject area tested – Spanish, mathematics, social studies, and science – Bloom's general taxonomy is tailored to align with the specific terminology and content of the respective discipline (MINERD, 2011).

Fullan's (2006) Educational Change Theory

Fullan's (2006) Educational Change Theory was used as a framework for understanding change within educational settings. Fullan (2006) set out seven core premises that underpin educational change:

1. A focus on motivation: Improvement cannot occur without the motivation of stakeholders (Fullan, 2006). Fundamentally, Ordinance 01-2016 was enacted to address competency-based curricular reforms and to update the existing Pruebas

Nacionales (National Examinations) with the ultimate goal of assessing the quality of the education system and making changes to improve it.

2. Capacity building, with a focus on results**:** Fullan (2006) defines capacity building as "any strategy that increases the collective effectiveness of a group to raise the bar and close the gap of student learning" (p. 9). Johnson (2012) suggests that the more investments are concentrated on capacity building, the higher the likelihood of the reform being successful. The essence of competency-based curricular reform is grounded in sociocultural constructivism, emphasizing the cultivation of specific competencies in children.

3. Learning in context**:** This refers to the necessity for stakeholders engaged in educational reform to acquire new strategies and behaviors within the specific environment where changes are intended to happen (Fullan, 2006). This process involves cultural transformations within the educational setting through new norms, structures, and processes (Johnson, 2012).

4. Changing context**:** For new educational policies to be effective, they must possess the capacity to alter the broader context (Fullan, 2006). This process begins with "lateral capacity building," a method wherein individual stakeholders and their organizations first embrace the reform, subsequently catalyzing shifts in the larger context (Fullan, 2006). However, obstacles such as excessive bureaucracy, conflicts arising from collective bargaining, and managerial challenges can hinder these changes (Fullan, 2006). Ordinance 01-2016 experienced a significant disruption due to COVID-19, and

its implementation had to be postponed until 2023, two years later than initially planned (MINERD, 2016a, Art. 5 Para.).

5. A bias for reflective actions**:** Reflective action serves as a driving force for change, resulting in the emergence of a shared vision and a sense of ownership among stakeholders (Fullan, 2006). These outcomes are cultivated through an ongoing process and are considered accomplishments that result from change, rather than preconditions for it (Fullan, 2006). In essence, stakeholders will begin to display favorable behaviors which, over time, will lead to a shift in their beliefs and increased commitment to the reform (Johnson, 2012).

6. Tri-level engagement**:** Tri-level refers to (1) school and community, (2) district, and (3) state (Fullan, 2006). While achieving perfect alignment across these levels might be unrealistic, Fullan (2006) advocated for what he called "permeable connectivity," which refers to adopting strategies that encourage mutual interaction and influence both within and between the levels. When a significant number of leaders within the same system practice permeable connectivity, they have the power to transform the system itself (Fullan, 2006).

7. Persistence and flexibility in staying the course: Fullan (2006) states that the previous six premises are "complex to manage and must be cultivated over time […] [and] a strong resolve is necessary to stay the course" (p. 11). Rigid persistence often leads to resistance of equal or greater intensity (Fullan, 2006). Conversely, giving up when faced with inevitable obstacles results in no progress (Fullan, 2006).

Assumptions, Limitations, and Scope

For data collection, the researcher assumes that the data provided by the Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) accurately represents all sixth-year secondary students who participated in the first attempt (convocatoria) of the Pruebas Nacionales (National Examinations) in the Dominican Republic from 2010 to 2023. It is also presumed that the Directorate has meticulously collected data and upheld ethical standards in human subjects' research.

The author acknowledges important limitations as well as the scope to be considered in this study. These will be explored across four themes: (1) equity, (2) the impact of COVID-19 on data collection, (3) standardized assessments, and (4) inherent challenges of education policy implementation.

Equity

Three exam attempts (convocatorias) are held each year, as noted by MINERD (2011). The first attempt is intended for students who have successfully passed all subjects at their educational center (MINERD, 2011). The second attempt is reserved for students who were unsuccessful in the first attempt, as well as those who passed all subjects following a recovery period at their respective centers (MINERD, 2011). The third attempt is intended for students who failed the second attempt or were unable to take the exams previously for any reason (MINERD, 2011). The data obtained for this study focuses solely on the first attempt This limitation introduces inherent equity concerns into the study, as it concentrates on a particular segment of the student population, perhaps the most academically successful or socioeconomically advantaged.

Nortvedt and Buchholtz (2018) highlight other equity issues, pointing out intersectional disparities inherent in worldwide mathematics education assessments. For example, the Extended School Day (Jornada Escolar Extendida) Program, introduced by Ordinance 01-2014, aimed to provide eight hours of instructional time daily to ensure thorough coverage of the national curriculum (MINERD, 2014). However, Hamm and Martínez (2017) note that the Dominican Republic has historically suffered from underfunding, especially in public schools. As a result, the Extended School Day Program, which demanded substantial investments in educational infrastructure, encountered various obstacles, including significant delays in the construction of new educational facilities (Hamm & Martínez, 2017).

This situation led to a significant loss of instructional time due to inadequate classroom space, resulting in gaps in the coverage of the mathematics curriculum in public schools. Consequently, this affected the mathematical outcomes in the Pruebas Nacionales beyond the scope of Ordinance 01-2016. Within public schools, Hamm and Martínez (2017) observed that students in Extended School Day shifts tended to achieve higher scores than those in half-day schools, as evidenced by Pruebas Nacionales data. Arias (2023) reported a study that linked Dominican students' poor performance in assessments to reduced instructional time, with private institutions consistently outperforming public ones in the Pruebas Nacionales due to a closer adherence to the curriculum. Ideally, there would be a seamless match between the curriculum that students learn, what teachers teach, and the national curriculum (Arias, 2023). Rarely does a perfect alignment occur, and this disparity contributes to variations in educational outcomes (Arias, 2023). Hence, to accurately assess the impact of educational policy, a study must at least account for factors such as the type of school and regional differences. This study aims to address these considerations.

COVID-19 and Data Collection

The examination of the impact of competency-based mathematics curriculum and Ordinance 01-2016 implementation on mathematics performance in the Pruebas Nacionales encountered a major challenge in data collection due to the COVID-19 global pandemic. Ordinance 01-2016 was set to introduce changes by 2020 (MINERD, 2016a, Art. 5 Para.), with the expectation that, until then, the Pruebas Nacionales would retain the structure and content defined by Ordinance 07-2004. However, 2020 became the peak year of the COVID-19 pandemic, severely affecting the Dominican evaluation system.

Initially, the government postponed the Pruebas Nacionales through Resolution 02-2020 (MINERD, 2020b), but as the pandemic continued, Resolution 09-2020 canceled all attempts (convocatorias) for the 2019-2020 academic year, temporarily overriding Ordinance 01-2016 (MINERD, 2020c). The following academic year experienced similar disruptions, with Resolution 04-2021 canceling all attempts for the 2020-2021 academic year (MINERD, 2021). Thus, the completion of secondary education was determined based on the approval of all subjects in their educational centers, with a minimum presentation grade of 70% (MINERD, 2021). This explains the absence of data for 2020 and 2021.

The pandemic's impact on global mathematical achievements has been extensively studied, highlighting the significant negative effects of international school closures on student learning (Hammerstein et al., 2021). Arias (2022a) reported that 60.60% of teachers in the Dominican Republic felt that their students learned less in 2020 compared to previous years, attributing this decline to factors such as inadequate internet access at students' homes and educational centers. The shift to remote learning presented an additional challenge by increasing the dependence on family support for academics, with many adults of all socioeconomic backgrounds lacking the necessary academic or pedagogical skills to help with schoolwork (Arias, 2022).

Despite the readiness for implementation and pilot testing of Ordinance 01-2016 in 2020, the pandemic's ongoing impact prevented its application even two years later (Arias, 2022). It was not until 2023 that the new competency-based Pruebas Nacionales, as stipulated by Ordinance 01-2016, could be implemented (MINERD, 2023a). As a result, data from 2023 constitutes the only treatment group available for this study at the time of writing. Nevertheless, this constraint is temporary and contingent on future data collection.

Standardized Assessments

The need for systemic educational improvements in the Dominican Republic is evident, both to enhance national educational quality and to improve the country's international standing. However, according to Hamm and Veras Diaz (2021), some scholars critique the one-time data collection approach of international assessments, suggesting it may not fully capture the learning process in the Dominican Republic. Instead, they advocate for longitudinal tracking of student progress to provide a more nuanced and comprehensive understanding of academic development (Valverde et al., 2020, as cited in Hamm & Veras Diaz, 2021).

Inherent Challenges of Education Policy Implementation

Beyond underfunding and limitations of standardized testing, research has identified several barriers to effective policy implementation, including a lack of focus on implementation processes, challenges in effectively engaging stakeholders in change, and growing complexity within education governance (Viennet & Pont, 2017). The Ministry of Education in the Dominican Republic (MINERD), with its numerous subdivisions, may encounter challenges in enacting new policies. For instance, within the historical context of educational reforms and the Pruebas Nacionales, the repeated introduction of similar goals through reforms over nearly four decades suggests a difficulty in achieving lasting improvements (García, 2018). García (2018) points out at least eight instances where the ambitious educational policy initiatives of MINERD did not achieve their intended outcomes. These challenges may stem from the complexities of navigating interactions among multiple stakeholders across different levels and the need to move beyond simple top-down decision-making (Viennet & Pont, 2017).

Conclusion

The presented limitations are far from exhaustive, yet their presence does not diminish the efforts of this study. Rather, they demonstrate the complex, interdisciplinary nature of analyzing education policy implementation. One of the aims of this study is to illustrate a potential approach for employing administrative data to assess the impact of education policy on student outcomes as gauged by standardized assessments. By acknowledging these limitations, the study may inspire government data collectors to expand their data collection efforts, incorporating more details or variables to produce findings that could address the identified limitations. Ultimately, advancing towards more data-driven education policy research demands the collection and maintenance of comprehensive data sets.

Definition of Terms

- Final Grade: The cumulative academic grade obtained by combining the Presentation Grade and the Pruebas Nacionales (National Examination) scores, determining a student's completion of secondary studies and promotion into higher education in the Dominican Republic.

- Macroregion: Categorizes large geographical areas within the Dominican Republic. Regional Directorates are clustered within the North, East, and South regions, according to their geographical location.

- Presentation Grade: The academic grade that is officially recorded and published by a student's school and subsequently submitted to the Ministry of Education (MINERD).

- Pruebas Nacionales: Standardized assessments administered in the Dominican Republic to evaluate students' specific competencies in various subjects at the end of secondary education.

- Mathematics scores: The score a student receives on the mathematics Pruebas Nacionales, which contributed to their final grade and assessment of mathematical competency.

- Regional Directorate: Regional offices for the MINERD that oversee the educational institutions within their jurisdiction (refer to Appendix E for a map of the Dominican Republic divided by all 18 Regional Directorates).

- School Type: Refers to the division of schools into categories based on funding sources and administration (i.e., public or private schools).
- Shift: Refers to the arrangement where students attend classes during different times of the day, such as morning or Extended School Day shifts.

Variables

Variable for Mathematics Scores:

- Mathematics Pruebas Nacionales (National Examinations) scores (on a scale from 0-100)

Variable for Ordinance 01-2016 Implementation:

- Pre
- Post

Variable for School Type:

- Private
- Public

Variable for Regional Directorate (Regional Code):

- Barahona (Code: 100)
- San Juan de la Maguana (Code: 200)
- Azua (Code: 300)

- San Cristóbal (Code: 400)
- San Pedro de Macorís (Code: 500)
- La Vega (Code: 600)
- San Francisco de Macorís (Code: 700)
- Santiago (Code: 800)
- Mao (Code: 900)
- Santo Domingo II (Code: 1000)
- Puerto Plata (Code: 1100)
- Higüey (Code: 1200)
- Monte Cristi (Code: 1300)
- Nagua (Code: 1400)
- Santo Domingo I (Code: 1500)
- Cotuí (Code: 1600)
- Monte Plata (Code: 1700)
- Bahoruco (Code: 1800)

Variable for Macroregion:

- North
- East
- South

Summary

Chapter I set the stage for investigating the impact of the competency-based mathematics curriculum on student mathematical performance, as measured by the Pruebas Nacionales (National Examinations) following their competency-based alignment initiated through Ordinance 01-2016. Initially, it introduced the historical backdrop of the Dominican Republic's educational challenges and reforms over decades, emphasizing the country's ongoing struggle to improve the quality of mathematics education. Furthermore, the chapter presented the Pruebas Nacionales as a key instrument for measuring the education system's performance and its role in determining student promotion to the next educational level.

The research project was driven by the need for quantitative analyses of these reforms in the Dominican Republic. Given the lack of focused, long-term research trends within the country's mathematics education, this study aimed to fill a significant gap by employing quantitative methods to evaluate the reforms' impact on student mathematical performance. Additionally, it responded to calls for utilizing administrative data for educational policy analysis, emphasizing the importance of such studies in informing future policy decisions and educational practices.

By analyzing pre-existing scores from the Pruebas Nacionales before and after the implementation of Ordinance 01-2016, this study aimed to examine relationships between the policy changes and mathematics performance, while also considering other predictors such as school type and geographical location. Moreover, it sought to acknowledge limitations and explore potential confounding variables. Ultimately, the expected outcomes were to provide insights into the effectiveness of the ordinance and propose recommendations for further improvements in mathematics education in the Dominican Republic.

CHAPTER II: LITERATURE REVIEW

Chapter II will begin with an international comparative overview of what it means to master mathematics over the course of a century. This evolution entails the transition from an emphasis on factual knowledge and procedural skills to a more comprehensive understanding that encompasses problem-solving, analytical thinking, and the practical application of mathematical concepts in various contexts. This progression culminates in the adoption of mathematical competencies and the competency-based mathematics curriculum in the Dominican Republic.

Next, the concept of mathematical competencies will be explored, drawing parallels between a significant mathematical competency framework – the Danish KOM Project – and the Dominican mathematics curriculum. The chapter will also examine the updated mathematics Pruebas Nacionales (National Examinations) within the Dominican Republic and compare these to international equivalents. Finally, it will address the challenges related to teacher preparedness and compare the Dominican Republic’s strategies with efforts in other countries to address these issues.

Mastering Mathematics: A Comparative Historical Overview

What it means to master mathematics has significantly evolved over time, as thoroughly documented in the extensive survey on the conceptualization of mathematical competencies by Niss et al. (2016). The study features a timeline extending from 1930 to the present, showcasing the efforts of various Western nations to define what constitutes mastery of mathematics, alongside the evolution of mathematical competency in the Dominican Republic. The aim is to reflect on how perceptions of mathematics have transformed up to the present time, leading to the competency-based mathematics curricular reform at the heart of this study.

To do so, Niss et al. (2016) explore these diverse interpretations and evolving definitions through a series of interconnected questions:

> The point of departure for the work is the question 'what does it mean to master mathematics?' This question has a number of related questions, such as 'what does it mean to possess knowledge of mathematics?'; '…to know mathematics?'; '…to have insight in mathematics?'; '…to be able to do mathematics?'; '…to possess mathematical competence (or proficiency)?'; and '…to be well versed in mathematical practices?' (p. 613).

Beginning in the 1930s, the emphasis on mathematical mastery was primarily on the knowledge of mathematical facts (i.e., knowing what) and procedural or computational skills (i.e., knowing how) (Niss et al., 2016). By the late 1930s, these traditional ideas about the nature of mathematics education began to be challenged, and by the 1940s, mathematicians and mathematics educators pointed to problem-solving as part of what constitutes mastery of mathematics, rather than just content knowledge and computational skills (Niss et al., 2016). By the 1950s, process-oriented approaches, in general, began entering the stage of mathematics mastery (Niss et al., 2016).

At this time, the Dominican Republic had been established for just over 100 years and was amidst Rafael Leónidas Trujillo's regime. Despite the regime's challenges, it was during this period that the Dominican Republic enacted the Organic Law of Education 29-09, marking the country's formalization of the education system (El Congreso Nacional, 1951). Article 6 suggested that up to primary school, specific regulations, programs, and official government textbooks were mandated (El Congreso Nacional, 1951). Moreover, it indicated that, beyond primary education, private schools had the autonomy to select their textbooks without adhering to government rules or curricular guidelines, highlighting early distinctions between the public and private sectors (El Congreso Nacional, 1951).

Article 27 mandated that the National Council of Education (Consejo Nacional de Educación) was responsible for selecting appropriate textbooks, although it did not mention an established curriculum or, specifically, a mathematics curriculum (El Congreso Nacional, 1951). Thus, the law offered limited insights into the government's perspective on mathematical mastery, and the absence of detailed documentation from this period impeded a comparison of the Dominican mathematics curriculum with the international mathematics discourse. However, Cavani (2022) noted that the textbooks utilized during the 1960s were attributed to the Cuban author Aurelio Baldor, suggesting that the mastery of mathematics at that time was primarily focused on arithmetic, algebra, geometry, and trigonometry. In any case, the Western discourse on mathematics was already evolving to redefine mastery in mathematics more in terms of the “enactment of mathematics” (Niss et al., 2016).

In the early 1960s, the International Association for the Evaluation of Educational Achievement (IEA) proposed that mathematics achievement should be defined by matching certain levels of cognitive behavior with specific traditional mathematics content:

> “(a) knowledge and information: recall of definitions, notation, concepts; (b) techniques and skills: solutions; (c) translation of data into symbols or schema or vice versa; (d) comprehension: capacity to analyze problems, to follow reasoning; and (e) inventiveness: reasoning creatively in mathematics.” (Husén, 1967 as cited by Niss et al., 2016)

Niss et al. (2016) observed a significant shift towards recognizing more comprehensive mathematical processes, supported by the IEA’s focus on translating real data into symbolic forms, the ability to analyze problems, and creative reasoning or inventiveness. By the end of the 1960s, Modern Mathematics was introduced into Dominican Republic secondary education through an educational policy that emphasized abstract and deductive thinking (Cavani, 2022; González, 2011).

During this period, the Dominican Republic experienced significant progress in the professional development of mathematics teachers, the creation of official mathematics textbooks, and the beginning of international influences (Cavani, 2022). This transition reflected a growing awareness and discussion concerning the methodologies and approaches within the Dominican discourse on mathematics education in the 1970s.

In a 2013 interview conducted by González (2013) with Eduardo Luna, then a leading Mathematics Education researcher and professor in the Dominican Republic, Eduardo Luna recounted that in the 1980s:

> The Ministry of Education asked me to review the mathematics curriculum they had developed to adapt it to the times, since at that moment […] the idea was to teach mathematics for life. That is, to leverage mathematics to form a well-rounded individual, not just to teach them to add, but to educate them so that they learn to think, to communicate what they have done. I am referring to what today are called the mathematical competencies required for a citizen to make informed decisions, who can analyze, who understands the information given to them, that is, a citizen who contributes to society (Translated from Spanish, p. 25).

This suggests that the concepts of mathematical competency, which had been part of the international discourse since the 1970s, had made their way to the Dominican Republic at most a decade later. Teacher professional development programs in Mathematics Education enabled some Dominican students to study abroad in the 1980s, and some of these individuals now occupy important positions in government organisms such as the Ministry of Education (MINERD)'s Regional Directorates (González, 2011).

By the 1990s, the concepts of mathematical competence and competencies were already integral to the global conversation on mathematics mastery (Niss et al., 2016). In 1997, after almost fifty years, the Dominican Republic passed the Organic Law of Education 66-97, updating the longstanding Organic Law of Education 29-09 (González et al., 2013). Although specific details of the mathematics curriculum were difficult to access, this new educational framework made explicit mention of mathematics among its core subjects. Notably, Article 99 highlighted MINERD's role in promoting scientific and technological development, primarily through STEM education initiatives (El Congreso Nacional, 1997).

At the same time, the Organization for Economic Cooperation and Development (OECD), which now counted the Dominican Republic among the members of the OECD Development Centre, was formulating the Programme for International Student Assessment (PISA), incorporating insights from several key projects: the Danish KOM Project, emphasizing mathematical competencies and learning; the United States' Common Mathematical Practices; and the notion of mathematical literacy (Niss et al., 2016).

In 1999, the OECD introduced the concept of mathematical literacy within the Program for International Student Assessment (PISA) framework, as noted by Wu et al. (2021). The *PISA 2018 Assessment and Analytical Framework* described mathematical literacy as:

> "an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognize the role that mathematics plays in the world and to make well-founded jugments and decisions needed by constructive, engaged and reflective citizens" (OECD, 2018, p. 75).

Reflecting the mathematical competencies outlined in the Danish KOM Project, the PISA Mathematics Assessment introduced the concept of Mathematical Key Competencies (MCKs) (Niss et al., 2016). These competencies have since been instrumental in evaluating the mathematical competence of students worldwide (Wu et al., 2021).

After the initial PISA tests at the turn of the 21st century, countries across various continents underwent what has been termed a "PISA shock," leading to a widespread acknowledgment of the need to update their mathematics curricula to meet the evolving demands of the modern world (Boesen et al., 2018; González-Mayorga, 2023; Niss et al., 2016).

In 2014, the National Council of Education (Consejo Nacional de Educación) approved and started a comprehensive review and reform process of the Dominican education system and its curriculum (IDEICE, 2019). The subsequent year, in 2015, the Dominican Republic entered the PISA stage for the first time (IDEICE, 2018). The nation scored 328 points in both Mathematics and Science, ranking it at the bottom among the 72 countries that participated (González-Mayorga, 2023; IDEICE, 2019). Thus, the country also experienced the "PISA shock," with major local newspaper coverage of PISA being predominantly negative and using PISA as an argument regarding student performance and the quality of the educational system (González-Mayorga, 2023). Nevertheless, González-Mayorga (2023) identified a positive outcome from this, arguing that the Dominican press contributed to sparking a debate on educational quality, thereby achieving one of the OECD's primary goals with the international assessments.

While there was no explicit mention of international influences on the Dominican Republic's transition to a mathematics competency-based curriculum, it is reasonable to infer such influences from similar shifts in other countries following their own "PISA shocks." Of note, González and Villegas (2016) pointed out that Dominican research in Mathematics Education scarcely engaged with the current global discussions or innovations in the field. This "decade lag" in aligning with global educational trends may, to some extent, explain the Dominican Republic's delayed response to educational shifts witnessed globally.

Ordinances 02-2015 and 01-2016

Before the competency-based curricular reform initiated with Ordinance 02-2015, the Ministry of Education (MINERD) released a document detailing the rationale for the curriculum review and the need for its update (MINERD, 2016b). MINERD recognized that as Dominican society evolved alongside the global community, it was necessary to reassess and reaffirm various educational approaches through a comprehensive revision of the Dominican curriculum. The curriculum had remained unchanged since 1997 (Hamm & Martínez, 2017), and the goal was to ensure the national curriculum kept up with demands within scientific, technological, and cultural contexts while still preserving its constructivist approach (MINERD, 2016b). Therefore, aligning with the Ten-Year Education Plan 2008–2018 (Plan Decenal de Educación), the competency-based approach introduced in Ordinance 02-2015 was progressively adopted.

Historically, the Dominican Republic's educational methods, much like those in other nations as discussed by Niss et al. (2016), leaned towards traditional approaches dominated by rote learning. This included practices such as repetition, memorization, and the direct transmission of content by teachers (Hamm & Martínez, 2017; Näslund-Hadley et al., 2014). Such methods highly valued the acquisition of mathematical facts, covering concepts, terms, and procedural skills that involved carrying out rule-based operations accurately and efficiently (Hamm & Martínez, 2017; Niss et al., 2016). Thus, this change was primarily aimed at shifting from a teacher-centered curriculum to one that is student-centered (Hamm & Martínez, 2017), with the pilot year of implementation occurring in the 2013–2014 academic year (MINERD, 2016b).

The Dominican curriculum expects graduates to master each competency to progress to higher education and enter the job market (Hamm & Martínez, 2017). Accordingly, a wealth of international research endorses competency-based education to bridge the gap between education and employment (Boahin et al., 2014; Fan et al., 2015), and some professional programs are developing core competencies for their fields. For example, many studies suggest that competency-based education in the medical field improves learning objectives and clinical performance (Fan et al., 2015). However, research in mathematics suggests that mathematical competency alone may not be sufficient for specific context-based situations, indicating that success also depends on possessing relevant contextual knowledge (Diego-Mantencón et al., 2021).

Finally, MINERD obtains information for assessing the quality of the educational system largely through the application of the Pruebas Nacionales (National Examinations) (MINERD, 2023a). MINERD uses the results from the Pruebas Nacionales to identify learning achievements and the extent of development of specific skills and weaknesses in the system (MINERD, 2023a). Considering the new competency-based mathematics curriculum, the Mathematics Pruebas Nacionales needed to be aligned with the mathematical competencies, which was achieved through the enactment of Ordinance 01-2016.

This section provided an overview of global perspectives on mastering mathematics and examined how the Dominican Republic either aligned with or fell behind the prevailing international discourse on what it means to master mathematics. It also showed how the Dominican Republic may have sought a curricular overhaul following the "PISA shock" experienced by other countries. The Dominican Republic's engagement in PISA 2015 may have also propelled change, signaling the need for curricular reform, which had already begun prior to the international assessment. This led to the enactment of key ordinances that formalized both the curriculum revision and the modification of the Pruebas Nacionales to reflect these changes. The next section will explore mathematical competencies as a concept, examine one of the most acknowledged mathematical competency frameworks, and discuss their integration into the Dominican Mathematics curriculum.

Mathematical Competencies

The Ministry of Education (MINERD) views mathematics as an essential tool that enables individuals to understand and make sense of global phenomena intertwined with citizens' daily lives (MINERD, 2020a). Many argue that mathematics serves a broader societal function, extending beyond mere academic purposes (Niss & Højgaard, 2019; Wu et al., 2021). This view is reiterated by MINERD (2019), which identifies three distinct foci of mathematics: (1) as a practical tool for everyday decision-making; (2) as an intellectual tool, facilitating students' progression to higher levels of education; and (3) as a foundational tool for connecting and advancing other sciences, emphasizing the interdisciplinary application of mathematics in subjects beyond its domain.

Mathematics is just one of the many subjects impacted by the competency-based curricular reform. To grasp the concept of mathematical competence, it is crucial to start with a clear definition of competence itself. Many scholars define competence as mastering key elements of a specific area and possessing the capacity to undertake informed and effective actions within that domain (MINERD, 2017a; Niss & Højgaard, 2019). Niss and Højgaard (2019) emphasize that such mastery depends on a deep understanding and sound judgment. Hamm and Martínez (2017) view competencies as the proficient mastery of skills that society requires to meet challenges and devise solutions. To MINERD (2017a), competence involves the integration of concepts, attitudes, procedures, and values, enabling individuals to act independently and effectively in a variety of contexts, and it is seen as a lifelong, gradually acquired endeavor (Hamm & Martínez, 2017).

Niss and Højgaard (2019) proposed that competencies could serve as a framework for curriculum design in various contexts. MINERD revamped the secondary education curriculum to emphasize two categories of competencies: fundamental and specific (MINERD, 2017a). Fundamental competencies are designed to promote interdisciplinary connections and ensure educational consistency, covering areas such as ethics and citizenship, communication, logical, critical, and creative thinking, problem-solving, science and technology, the environment and health, and personal and spiritual growth

(Hamm & Martínez, 2017; MINERD, 2017a). Specific competencies, meanwhile, focus on the pertinent content of each subject, are organized by curriculum areas, and aim to adhere to the guidelines established by the fundamental competencies (MINERD, 2017a). Any mathematical competency is thus a specific competency.

Some authors described mathematical competence as an individual's insightful readiness to appropriately address diverse mathematical challenges within certain contexts (Niss & Højgaard, 2019). Elaborating further, Niss and Jensen (2002, as cited in Niss et al., 2016) defined mathematical competence as the ability to acquire knowledge of, comprehend, perform, apply, and critically interact with mathematics and mathematical activities in a wide range of scenarios that presently or potentially involve mathematics. Ultimately, MINERD consolidated these definitions by characterizing mathematical competency as a student's ability to act flexibly, effectively, and independently across different contexts through the integration of mathematical concepts, procedures, and reasoning (MINERD, 2020a, p. 119). This competency connects abstraction, logical reasoning, exemplification, and generalization, in addition to the practical use of these skills in solving real-world problems (MINERD, 2020a, p. 119).

A previous section examined the historical evolution of the concept of mathematical competency. The remainder of this section shifts the focus to the consensus and discrepancies in terminology across various countries and their diverse reactions to mathematical competency-based curricular reform.

Consensuses and Tensions in Terminology

Many countries have incorporated the concept of “mathematical competency” into their mathematics curricula, either by using this exact term or by referring to similar concepts such as “mathematical processes” or “mathematical proficiencies” (Boesen et al., 2018). Analyzing and comparing how different nations have implemented these ideas could provide valuable insights for the Dominican Republic (Boesen et al., 2014). A common goal of these educational reforms worldwide has been to highlight the social relevance of school mathematics – that is – by focusing on solving real-world problems in daily societal contexts (Niss et al., 2016).

Despite all employing the term “mathematical competencies” and sharing similar cultural backgrounds, Chile, Colombia, Costa Rica, the Dominican Republic, and Mexico demonstrated varied interpretations of how mathematical competencies were developed, understood, and acquired by students (Niss et al., 2016; Ruiz, 2018). For instance, in Chile, the Dominican Republic, and Mexico, competency-based curricula specifically highlighted mathematical attitudes, while Colombia prioritized the application of mathematics in scientific contexts (Niss et al., 2016). Notably, the Colombian Institute for Educational Evaluation (ICFES) was credited in the official framework of the Dominican Republic’s Pruebas Nacionales (National Examinations) (MINERD, 2020a, p. 3), showing a clear international influence on the assessment component of the mathematics competency-based curriculum. Despite the differences, a common focus among these nations was on cultivating mathematical thinking – involving algebra, numbers, statistics, probability, measurement, and geometry – through processes such as problem-solving, communication, reasoning, and modeling (Mena, 2015; Niss et al., 2016).

Several European countries adopted curricula based on mathematical competencies. By 2012, Germany had identified six essential mathematical competencies: reasoning mathematically, solving mathematical problems, engaging in mathematical modeling, utilizing mathematical representations, handling the symbolic, formal, or technical elements of mathematics, and communicating mathematically, according to a translation from German by Niss et al. (2016). Recent studies highlighted some deficiencies in the mathematical achievements of first-year university students in specific areas but observed improvements in aspects such as reasoning and the use of mathematical representations (Büchele & Feudel, 2023). This suggested that the competency-based reform may be yielding its intended results (Büchele & Feudel, 2023).

Similarly, Austria and Switzerland followed Germany's lead. Austria adopted similar standards but further introduced a nuanced three-dimensional concept of mathematical competency, which included domains of action, content domains, and a complexity dimension (Niss et al., 2016). Additionally, some Austrian researchers have made efforts to improve the competency-level models for their standardized national examinations (Siller et al., 2015). Likewise, Switzerland, taking inspiration from the United States' National Council of Teachers of Mathematics (NCTM), PISA, and German standards, adopted the Fundamental Competencies in Mathematics (Niss et al., 2016).

In contrast, Swedish educational stakeholders were relatively receptive to educational reform (Boesen et al., 2014). However, in the case of mathematics teachers, the absence of appropriate professional development impeded their ability to accurately interpret and enact changes in the classroom as envisioned by policymakers (Boesen et al., 2014). A similar issue was observed in Sri Lanka, where Egodawatte (2014) pointed out that merely altering teaching methods was not enough for a significant curricular transformation. Egodawatte (2014) also noted that the Sri Lankan curriculum had not fully embraced a competency-based model, with the suggested curricular activities still predominantly content-focused. In the case of Swedish teachers, the employment of abstract and unclear terminology complicated their understanding and implementation of new concepts, often leading to classroom practices that diverged from the objectives of the reform (Boesen et al., 2014).

The situation was even more dire in Portugal. Teachers faced challenges in implementing competency-based teaching methods due to broad definitions and practical interpretations of mathematical competencies (Niss et al., 2016). By 2016, there had been a notable shift toward prioritizing content knowledge over the concept of mathematical competency, amidst political debates and discussions regarding curriculum guidelines (Dias, 2021; Niss et al., 2016). According to Dias (2021), some tensions around the mathematics curricular reform arose from concerns that the curriculum and evaluation were being used as tools of government control and as a way to hold educational stakeholders (excluding government authorities) accountable for test results.

Although definitions of mathematical competency have differed across scholars and countries, a common thread has been the emphasis on the practical application of mathematics in various contexts within mathematics education (Wu et al., 2021). Across the globe, the significance of mathematical competency was recognized and appreciated for its implications for both national interest and individual success (MINERD, 2020a).

Consequently, countries have been committed to fostering mathematical competence among their citizens, despite their varied hurdles in implementing such educational reforms (MINERD, 2020a; Wu et al., 2021). As the Dominican Republic navigates the initial stages of curriculum reform, it can draw on global experiences to shape its approach, devising effective educational strategies and avoiding potential pitfalls. Denmark was not discussed in this context because the Danish KOM Project, which this study deemed to have specific relevance to the Dominican curriculum, is explored in the next section.

The Danish KOM Project and the Dominican Curriculum

The wide range of theoretical constructs and frameworks has led researchers to seek methods for their integration or interaction, with the goal of advancing the theoretical development of mathematics education research (Niss & Jankvist, 2023). To streamline what could otherwise be an endless exploration, this study included a section on one of the most pertinent mathematical competency frameworks available – the Danish KOM Project – and its parallels with the current Dominican mathematical competency-based mathematics curriculum. The researcher acknowledges the Danish KOM Project's considerable, though not exclusive, impact on global mathematics education initiatives, both directly and indirectly through PISA (Niss et al., 2016). The work of Luis Rico Romero and José Luis Lupiáñez Gómez (2014) in Spain has also been recognized as pivotal in the Dominican mathematics curricular reform (MINERD, 2019). Nevertheless, the researcher's approach aims to connect the Dominican Republic's curriculum with frameworks from beyond its immediate geographical location and linguistic limitations[1].

[1] The Dominican Mathematics Education graduate theses and dissertations have been noted for their limited engagement with existing international discourse (González and Villegas, 2016). During the literature review process, the researcher also noticed that the referenced literature in many of these studies

Salager-Meyer (2008) discussed the challenges faced by academic research in developing countries and proposed creating regional high-quality journals that publish in local languages and are peer-reviewed. In other words, the Dominican Republic faces a two-way street in academic research: Dominican researchers are under pressure to engage with international discourse and to gain recognition within it.

n the 1990s, the Danish government recognized deficiencies in students' mathematics outcomes across all educational levels (Niss et al., 2016). This prompted a collaborative effort between the Ministry of Education and researchers in mathematics education to address these challenges (Niss & Højgaard, 2019; Ruiz et al., 2023). This collaboration led to the creation of the Danish KOM Project, with "KOM" standing for "Competencies and Learning of Mathematics" (Niss & Højgaard, 2019; Ruiz et al., 2023). Though not the first initiative to expand on mathematical mastery, the KOM Project's profound impact on the global discourse on mathematical competency is undeniable.

The KOM Project has catalyzed various research avenues, including the integration of Mathematical Digital Technologies (MDT) as a core mathematical competency within the KOM framework (Geranious & Misfeldt, 2023), the analysis of assessments of mathematical competency (Boesen et al., 2018; Pettersen & Braeken, 2019), and the investigation of its synergies with other theoretical constructs and frameworks in mathematics education, particularly through aspects of mathematical modeling and teacher pedagogical competencies (Niss & Jankvist, 2023). Additionally, it has contributed to

primarily originated from Spanish-speaking regions or Spanish translations of non-Spanish literature, evidenced by the predominance of Spanish titles. The researcher wonders whether monolingual reference lists could be correlated with the limited mention of international discourses (González & Villegas, 2016).

studies on the integration of the KOM framework into various curricula before and after implementation (Højgaard & Sølberg, 2019; Niss et al., 2016; Solar et al., 2014).

The Danish KOM Project was initiated not as a curriculum itself but as a tool for creating new curricula to address global deficiencies in mathematics education, such as those elucidated by the "PISA-shock" (Ruiz et al., 2023). The KOM framework has reportedly been used normatively in the design of curricula (Niss & Jankvist, 2023) and has influenced various academic fields, including engineering (Arancibia Carvajal et al., 2022; Castro et al., 2015). It has also been a part of national curriculum development in countries such as Denmark, Germany, and Sweden (Niss et al., 2016; Niss & Jankvist, 2023; Pettersen & Braeken, 2019; Ruiz et al., 2023).

Description and Comparison of Competencies

The Danish KOM Project's key achievement lies in its detailed outline of mathematical competence and competencies, and their role in mathematics education (Niss & Højgaard, 2019; Ruiz et al., 2023). At its core, the KOM Project aimed to define mathematical competencies as the ability to engage in mathematical activity to address any mathematical challenge (Niss et al., 2016). The project identified eight mathematical competencies: the first four focus on posing and answering mathematical questions, while the latter four relate to the language and tools of mathematics (Niss et al., 2016; Niss & Højgaard, 2019; Niss & Jankvist, 2023). Højgaard (2022) characterized these competencies as reflecting an individual's "insightful readiness to":

1) Mathematical thinking: Engage in and critically evaluate mathematical thought processes.

2) Problem handling: Solve different theoretical and applied mathematical problems, maintaining a critical perspective towards them.

3) Modeling: Engage in and assess every stage of mathematical modeling.

4) Reasoning: Perform and assess mathematical reasoning and construct proofs.

5) Representations: Use and evaluate various representations of mathematical concepts, phenomena, problems, or scenarios.

6) Symbols and Formalism: Use and critically assess the use of mathematical symbols and formal systems.

7) Communication: Discuss and critically communicate mathematical ideas.

8) Aids and tools: Use mathematical tools and evaluate their capabilities and limitations.

A diagram capturing these concepts was depicted as a floral design, aptly named the "competency flower" (Niss & Højgaard, 2019). Each mathematical competency was represented by a distinct petal on the flower. The design purposefully showed a non-empty intersection among the petals, emphasizing the overlap and interconnectedness inherent among all competencies. For an illustration of the mathematical competency flower, refer to Niss & Højgaard (2019, p. 19).

As previously noted, the Danish KOM Project directly influenced the PISA mathematics surveys, and the Dominican secondary mathematics curriculum acknowledged the integration of specific competencies from the mathematics section of PISA, along with modifications and the inclusion of additional competencies (MINERD, 2019). According to MINERD, the reasons for adopting these competencies included their comprehensive scope, the extensive process and international participation involved in their development, and the Dominican Republic's participation in PISA since 2015 (MINERD, 2019).

According to MINERD (2019), the Dominican mathematics curriculum contained six specific competencies (pp. 43–44):

1) Reasoning and Argumentation: Differentiate statements, answer questions across contexts, and construct personal reflections.

2) Communication: Convey mathematical ideas clearly through speech and writing, using precise vocabulary and demonstrating concepts.

3) Modeling and Representation: Apply and analyze models to solve problems, communicate results, and monitor the modeling process.

4) Connection. Integrate diverse knowledge to solve problems, connect concepts, and appreciate mathematics' interdisciplinary connections.

5) Problem-solving. Define and solve problems with various strategies, interpret results, generalize solutions, find patterns, and create tables, drawings, or graphs.

6) Utilizing technological tools. Leverage technology for learning and problem-solving, including using educational software and reflecting on the societal impact of technology.

Table 1 presents a side-by-side comparison between the competencies listed in the Dominican mathematics curriculum and those from the Danish KOM Project. For each Dominican competency, there is at least one corresponding KOM competency.

Table 1. Comparison of Mathematical Competencies

Dominican Mathematics Curriculum	Danish KOM Project
Reasoning and Argumentation	Mathematical Thinking
Communication	Communication
Modeling and Representation	Modeling, Representations
Connection	Mathematical Thinking, Reasoning
Problem-solving	Problem Handling
Utilizing Technological Tools	Aids and Tools

Design

The Danish KOM Project fostered a curriculum design method resembling a 2-D matrix or content model, which proved effective in facilitating competence-based curriculum development and teacher planning (Højgaard & Sølberg, 2019). Its main goal was to incorporate competency descriptions specific to subjects, to balance the traditional focus on subject-specific content as the sole measure of mastery (Højgaard & Sølberg, 2019). Egodawatte (2014) believed that content should still be a crucial component of mathematical learning, but Højgaard and Sølberg (2019) maintained that procedural skills alone could not fully encapsulate any single competency. Thus, the KOM Project distinguished between subject-specific competencies and subject matter areas as two distinct dimensions, ensuring that specific competencies enhanced content knowledge. This differentiation clarified what students should be able to do with the content knowledge (Højgaard & Sølberg, 2019).

The updated design for the Dominican secondary mathematics curriculum featured components such as competencies, content, teaching and learning strategies, activities, resources, and assessment guidelines (MINERD, 2017a). Examples of this matrix in the secondary mathematics curriculum were available in MINERD (2017a, pp. 446–468). An advantage of this structure was that it had been shown to prompt teachers to reflect about the essence of the competencies involved (Højgaard & Sølberg, 2019). These two-dimensional models were adopted in Denmark's official mathematics curriculum (Højgaard & Sølberg, 2019) and in Chile, which also implemented a comparable model (Bezmalinovic et al., 2011).

The aim of this section was to draw parallels between the Danish KOM Project and the Dominican mathematics curriculum. By aligning it with the widely recognized framework of mathematical competencies, it bridged the gap to international discourse, allowing the literature review to expand considerably. The next sections presuppose knowledge of this framework.

Assessment of Mathematical Competencies

Obtaining insights on how mathematical competencies develop represents an important issue in the field of mathematics education (Siller et al., 2015). The integration of mathematical competencies into curricula calls for the development of assessment tools that are in sync with these curricula. Niss and Højgaard (2011) suggested that evaluating mathematical competencies should start by identifying the presence and extent of an individual's abilities in relation to the mathematical tasks they have undertaken. However, there is uncertainty about whether current evaluations comprehensively capture the wide array of skills and abilities that constitute each mathematical competency (Pettersen & Braeken, 2019). Following the comparison between the Dominican mathematics curriculum and the Danish KOM Project, this section will outline how mathematical competencies are assessed according to the Ministry of Education (MINERD).

According to MINERD (2016b), assessing a competency involves a continuous process that gathers information to help educational stakeholders understand the effectiveness of teaching and the quality of learning. This approach necessitates a comprehensive evaluation method that integrates external standardized tests, classroom assessments, and broader evaluations of the education system (MINERD, 2016b). To ensure that learning outcomes align with expectations across various levels and areas, specific achievement or performance indicators are established (MINERD, 2016b). These indicators focus on conceptual, procedural, or attitudinal content and are designed to define and encapsulate the essence of competencies (MINERD, 2016b). Consequently, evaluation methods and tools are developed to be consistent with these indicators (MINERD, 2016b). Thus, the Pruebas Nacionales (National Examinations) in the Dominican Republic serve as a key metric for evaluating the education system's effectiveness (MINERD, 2023a) and were updated by Ordinance 01-2016 to align more closely with competency indicators.

Mathematics Pruebas Nacionales (National Examinations)

The mathematics Pruebas Nacionales are designed to assess students' logical reasoning abilities and their use of mathematical tools in problem-solving across different contexts (MINERD, 2023a). According to MINERD (2023a), the outcomes of these exams played a crucial role in curriculum development, helping stakeholders identify both learning achievements and areas needing improvement (Boesen et al., 2018; MINERD, 2023a). There was a prevailing belief that aligning high-stakes tests with curricula could lead to appropriate curricular adoption, but empirical evidence to support this claim was scarce (Boesen et al., 2014). Moreover, a study by Büchele and Feudel (2023) in Germany raised concerns that assessment tools focusing primarily on symbolism and formalism might fall short in capturing the nuances of the desired process-oriented mathematical competencies. Given the high-stakes nature of the Pruebas Nacionales, their development had to be undertaken with great care to ensure dependable results.

As previously mentioned, mathematical competency cannot exist without content knowledge. To effectively develop these competencies, students needed to engage with both the content and the mathematical concepts they had learned (MINERD, 2023a; Niss & Højgaard, 2019). Consequently, the mathematics Pruebas Nacionales were designed around three key components: specific competencies (and their associated actions), thematic axes grouping mathematics content, and contextual applications of mathematical competencies. Further details about the breakdown of the mathematics Pruebas Nacionales are discussed in Chapter III.

Competency-based National Examinations

Like the Dominican Republic, many countries that have adopted a mathematical competency-based curriculum have also updated their standardized national exit examinations. During the curricular implementation phase, it is crucial to meticulously design assessments that examine the development of mathematical competencies. This section will discuss some of the successes and challenges experienced by a select group of countries.

In Costa Rica, Ruiz (2018) extensively documented the concept of mathematical competencies and their impact on the Costa Rican national examinations. They observed that to guide the development of these examinations, mathematical competency-based “specification tables” were introduced (Ruiz, 2018). However, the design of these tables severely restricted the specific competencies because they could only be associated with one general competency, and specific mathematical tasks were not allowed to be linked to more than one mathematical area (pp. 282–283). Additionally, the lack of reference to mathematical competencies in the specification tables raised concerns about the effectiveness (Ruiz, 2018).

Shifting focus to Denmark, despite being the origin of the Danish KOM Project, Ruiz et al. (2023) claimed that it achieved only partial success in terms of assessment and content. Intriguingly, they observed that in Denmark, the written component of high-stakes national examinations largely neglected competencies (Ruiz et al., 2023). Furthermore, other researchers found that even when mathematical competencies were included in some assessments, there could still be a bias towards certain competencies over others, as noted in a mathematical competency-based university assessment in Germany (Büchele & Feudel, 2023).

Niss et al. (2016) pointed out Austria’s systematic efforts to develop its own theoretical framework for mathematical competency. The Matura exam is a competency-based standardized written final examination at the conclusion of Secondary Level II. Test takers are required to demonstrate their mathematical knowledge and skills, particularly in reasoning, problem-solving, and modeling (Siller et al., 2015). According to Siller et al. (2015), competency level models help diagnose and describe the development of competencies by assessing their achievements. Moreover, these models ensure the consistency of Matura standards over the years (Niss et al., 2016).

In Sweden, a study conducted by Boesen et al. (2018) analyzed mathematical tasks in national examinations across all grade levels to determine the extent to which mathematical competencies were assessed. They found that the examinations were largely successful in aligning with the mathematical competency framework. However, they also noted that the exams rarely captured students' abilities to evaluate and reflect on their own understanding and work (Boesen et al., 2018).

As more data is collected from the implementation of the new design, MINERD might consider adopting Austria's approach of applying competency level models to thoroughly assess the development of mathematical competencies as well as avoid the challenges of overly restrictive frameworks experienced in Costa Rica.

Mathematics Teacher's preparedness

MINERD (2019) emphasized that teachers should create learning environments that promoted the development of abilities enabling students to learn autonomously and apply their knowledge effectively. Furthermore, they stressed the need for mathematics teachers to possess both subject matter expertise and pedagogical knowledge to teach that content effectively. However, it was widely acknowledged across the globe that a significant hurdle in adopting a mathematics competency-based curriculum was the lack of sufficient teacher resources, including professional competency development and the provision of didactic and pedagogical materials for teachers (Boesen et al., 2014; Niss et al., 2016). As a result, teachers who were more comfortable with traditional teaching methods and did not have explicit guidelines for adopting new methodologies often defaulted to focusing on the delivery of technical knowledge and procedural skills (Boesen et al., 2014; Niss et al., 2016). For example, Boesen et al. (2014) observed that even well-intentioned teachers in Sweden interpreted the reform through a heuristic lens, leading them to believe their teaching methods were already aligned with the mathematical competency-based curriculum, despite discrepancies between their practices and the curriculum's requirements.

Denmark also experienced curricular implementation challenges attributed to the lack of robust support for the professional development of educators and educational authorities (Ruiz et al., 2023). Ruiz et al. (2023) attributed the framework's partial success to the absence of official policies promoting professional development, resulting in classroom practices that, even over two decades after its introduction, largely focused on traditional subject matter. Similarly, Spain faced difficulties due to insufficient teacher support, compounded by significant media backlash (Niss et al., 2016). This situation contributed to perceptions that the move towards competency-based education in some countries had been more rhetorical than substantial, sparking concerns about the depth of the framework's implementation (Egodawatte, 2014; Niss et al., 2016).

Efforts to address these issues were noted in various regions. In Catalonia, a teacher professional development program focusing on mathematical competencies was developed

(Niss et al., 2016). In Sweden, in-service teacher training encouraged collaboration among teachers to interpret and apply curriculum documents to mathematics and other subjects (Boesen et al., 2014). However, given the autonomy to conduct activities as they deemed appropriate, teachers often did not move beyond their initial, superficial understanding of competency (Boesen et al., 2014). Conversely, in Sri Lanka, Egodawatte (2014) presented a contrasting viewpoint, suggesting that granting teachers more control over classroom content was not entirely detrimental. This approach was advocated because teachers viewed the curriculum as inadequate for fostering the development of mathematical competencies (Egodawatte, 2014).

In Sri Lanka, the shift to a competency-based curriculum did not lead to the significant transformation in teaching roles that was anticipated (Egodawatte, 2014). The competency-based mathematics curriculum did not require teachers to move beyond the traditional focus on content delivery. Moreover, even after receiving training in competency-based teaching methods, many educators continued to rely on conventional lecture techniques (Egodawatte, 2014). This pattern of adherence to traditional teaching methods, despite curriculum reforms, was not unique to Sri Lanka (Niss et al., 2016). Similarly, in Peru, Mello Román (2017) found that teachers felt underprepared to effectively address mathematical competencies within the curriculum. However, some educators reported improvements in the classroom attributed to the competency-based approach (Mello Román, 2017).

In the Dominican Republic, numerous education policies aimed to improve teacher professional development (INAFOCAM, 2014; Van Grieken, 2018). Despite extensive government efforts to enhance the education sector, including incentivizing teachers through scholarships and significant salary increases over the past decade (Hamm & Martínez, 2017), a 2014 study by the Instituto Nacional de Formación y Capacitación del Magisterio (INAFOCAM, National Institute for Teacher Training and Professional Development), uncovered a widespread deficiency in domain knowledge across all subjects among public school teachers (INAFOCAM, 2014).

The study surveyed 1,021 public teachers across all 18 Regional Directorates (see Appendix E), including 153 secondary mathematics teachers (INAFOCAM, 2014). The findings revealed that 97% of these mathematics teachers held university degrees, with 78% having pursued post-undergraduate studies (INAFOCAM, 2014). Among them, 86% specialized in mathematics, mostly with degrees earned within the Dominican Republic (INAFOCAM, 2014). However, calculus and statistics emerged as areas of significant difficulty, with teachers scoring approximately 25% and 26%, respectively, in these domains (INAFOCAM, 2014).

Additionally, the study observed minor regional variations in scores, noting better overall performance in the North macroregion. Interestingly, the study found no significant link between the teachers' age, academic background, years of experience, and their academic performance. Even seasoned teachers exhibited low outcomes, which starkly contrasted with MINERD's (2019) expectation that secondary mathematics teachers needed substantial expertise to effectively teach the curriculum.

Other researchers pointed out gaps in the content training of mathematics teachers (Matías et al., 2013) and suggested that the education system should concurrently train new teachers and secondary students (Cavani, 2022). Consequently, several higher education institutions broadened their programs to include master's degrees in mathematics, and the Universidad Autónoma de Santo Domingo (UASD), the leading public university in the Dominican Republic, launched a new doctoral program in mathematics (Cavani, 2022). Furthermore, the government made efforts to recruit foreign professors to educate future teachers (Cavani, 2022). Comprehensive analyses of Dominican education policies concerning teacher training were meticulously compiled by González et al. (2013) and Van Grieken (2018).

Similar to observations in other countries, Hamm and Martínez (2017) found that Dominican policymakers attributed the low quality of competency-based teaching in the Dominican Republic to various factors. These included the lack of comprehensive policies to shape the teaching profession, low entry standards for teaching candidates, and poor working conditions and infrastructure in schools, among others. Although there had been efforts in recent years to address some of these issues, the challenges facing the teaching profession in the Dominican Republic were complex and could not be fully explored in a single section. Issues such as teacher shortages, inadequate school infrastructure, and insufficient state funding, although not discussed in detail here, represented just a few of the socioeconomic factors that hindered teacher effectiveness and, as a result, the success of the competency-based mathematics curriculum in the Dominican Republic. Nevertheless, it was important to acknowledge that one significant challenge alone – teacher preparedness in terms of content knowledge – might reflect difficulties encountered by other countries in implementing a competency-based mathematics curriculum.

Summary

Chapter II provided an overview of the evolution of what it means to master mathematics worldwide and in the Dominican Republic concurrently. Initially, attention was given to the Dominican Republic's alignment with and deviations from the global discourse on mathematical competencies. Furthermore, this chapter outlined the Dominican Republic's response to the international "PISA shock" and its proactive efforts in curricular reform, including the enactment of key ordinances to revise the curriculum and the Pruebas Nacionales (National Examinations).

The second section examined mathematical competency as a concept, describing it as a student's ability to act flexibly, effectively, and independently across different contexts through the integration of mathematical concepts, procedures, and reasoning. Additionally, the section explored consensus, tensions, and even rejections of mathematical competency, as understood in different countries.

In the third section, a significant mathematical competency theoretical framework was compared with the Dominican curriculum, providing a foundation for further comparisons in subsequent sections. This part also examined how the Dominican Republic assessed mathematical competencies, particularly how the competency-based curriculum influenced the updated design of the Pruebas Nacionales. Moreover, experiences with national assessments in other countries were investigated to offer a broader perspective.

Finally, the theme of teacher preparedness emerged as a common challenge in implementing a competency-based curriculum worldwide. This highlighted, among other issues, the lack of resources available to teachers to support this transition.

CHAPTER III: METHODOLOGY

Chapter III will describe the methods to be used in this study. It will begin with a review of the research questions and provide an overview of the Dominican student population. This chapter will also explore how the Mathematics Pruebas Nacionales were designed, constructed, administered, analyzed, and graded, as well as how the results were dissemin0ated by the Ministry of Education (MINERD). Specifically, it will address how Evidence-Based Design and Item Response Theory (Rasch Analysis) are applied in the design and analysis of the instrument.

Data analysis will be conducted using Unpooled Two Sample Independent t-tests, Analysis of Variance (ANOVA), and Hierarchical Linear Modeling (HLM); the data processing methods will also be detailed. This section will also discuss the limitations of the methodology and the assumptions associated with both the instrument and the statistical model employed. Finally, the chapter will address ethical considerations.

Review of Primary Research Questions

The primary research question was:

- How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?

The study examined the following questions:

1. Is Ordinance 01-2016 a significant predictor for mathematics performance, as measured by the mathematics Pruebas Nacionales (National Examinations)?

2. Is school type a significant predictor for mathematics performance, as measured by the mathematics Pruebas Nacionales?

3. Are regional differences significant predictors for mathematics performance, as measured by the mathematics Pruebas Nacionales?

4. Are Ordinance 01-2016 and school type significant predictors for mathematics performance, as measured by the mathematics Pruebas Nacionales?

5. Are Ordinance 01-2016, school type, and region significant predictors for mathematics performance, as measured by the mathematics Pruebas Nacionales?

Settings and Participants

The Pruebas Nacionales (National Examinations) are administered to students in the sixth grade of the second cycle of secondary education. According to the current structure of the Dominican education system, sixth grade typically includes students aged 17–18 (Hamm & Veras Diaz, 2021; IDEICE, 2020). The second cycle of secondary education spans three years and is divided into three tracks: academic, technical-professional, and arts (MINERD, 2016b). This study primarily focused on the academic (general) track, as MINERD (2017a) identified it as the most rigorous and its role as a preparatory stage for higher education was emphasized (p. 29).

During the 2022–2023 academic year, there were 856,499 secondary students enrolled in both public and private schools in the Dominican Republic. Of these, 442,512 (51.67%) were female, and 413,987 (48.33%) were male (MINERD, n.d-e). A total of 707,705 students were enrolled in 2,705 public schools, while 148,794 were in 905 private schools (MINERD, n.d-e). Table 2 indicates the enrollment numbers based on the shift the students attended. Although no distinction was made between different educational levels, Table 2 reveals that approximately 51% of all Dominican students attended the Extended School Day shift, which was available in half of the schools across the country. This study primarily focused on students enrolled in the Extended School Day shift to represent most of the population. Specifically, there were a total of 95,293 students in the sixth grade (MINERD, n.d-e).

Table 2. Student Enrollment in Educational Centers by Shift

Shift	Enrollment	Educational Centers
Extended Day	1,315,547	5,298
Morning	766,773	3,867
Afternoon	287,791	1,559
Evening	90,691	611
Blended Learning	101,646	473
Saturday	18,083	152
Sunday	7,434	74
Total	**2,587,965**	**10,567**

Note. Adapted from *Resumen de Estadísticas Educativas 2022-2023* by MINERD. n.d-e.

To decentralize the management of the Dominican educational system, MINERD established 18 Regional Directorates, as outlined in Articles 103 and 104 of the General Law of Education 66-97 (El Congreso Nacional, 1997). Each Regional Directorate directly represents its community and is named after the Dominican province it serves. Table 3 provides a breakdown of enrollment in private and public secondary schools across regional districts. Refer to Appendix E for the geographical locations of each directorate on the political map of the Dominican Republic.

Notably, the directorates encompassing Santo Domingo – the capital – accounted for 36.19% of the student population. The directorate representing Santiago city accounted for 9.19% of the enrollment. Considering that these two largest cities account for almost half of the total population in this study, the researcher deemed it necessary to account for regional differences. Most students, 82.63%, were enrolled in public schools.

The Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) at the Ministry of Education (MINERD) was responsible for designing and compiling data from the Pruebas Nacionales (National Examinations) taken by all participating students (MINERD, n.d-d). The data included demographic details such as gender, region, school type, and subject-specific cumulative scores, among others (refer to Appendix A for a complete list of variables in the dataset provided to the researcher). MINERD representatives supplied the research with data primarily from the first attempt (convocatoria) collected from the years 2010 to 2023, except for 2020 and 2021. The reasons for excluding the years 2020 and 2021 are discussed in more detail in the section titled "Assumptions, Limitations, and Scope." This collection of datasets represented all students who participated in the Pruebas Nacionales from 2010 to 2023.

Table 3. Secondary Students Enrollment by School Type and Regional Directorate

Regional Directorate	Private Secondary	Public Secondary	Total
Barahona	725	19,813	**20,538**
San Juan de la Maguana	1,698	26,590	**28,288**
Azua	4,240	35,878	**40,118**
San Cristóbal	7,760	49,432	**57,192**
San Pedro de Macorís	12,990	49,096	**62,086**
La Vega	5,575	43,716	**49,291**
San Francisco de Macorís	3,714	27,741	**31,455**
Santiago	14,789	63,964	**78,753**
Mao	889	15,161	**16,050**
Santo Domingo II	37,005	125,577	**162,582**
Puerto Plata	3,679	24,668	**28,347**
Higüey	5,819	31,523	**37,342**
Monte Cristi	N/A	14,437	**14,437**
Nagua	1,708	20,458	**22,166**
Santo Domingo I	45,011	102,384	**147,395**
Cotuí	3,135	23,928	**27,063**
Monte Plata	57	18,724	**18,781**
Bahoruco	N/A	14,615	**14,615**
Total Secondary	**148,794**	**707,705**	**856,499**

Note. Adapted from *Resumen de Estadísticas Educativas por regional. 2022-2023* by MINERD. n.d-e.

Instrumentation Design

The Pruebas Nacionales (National Examinations) are annual, census-based assessments designed to evaluate the competencies attained by students in the Dominican education system. These assessments align with the new competency-based national curriculum across four subject areas, including mathematics (MINERD, 2020a). These examinations are mandatory and are administered simultaneously across the country on specific dates set by the Ministry of Education (MINERD). Each exam lasts for two hours and contributes 30 out of 100 points to the student's final grade (MINERD, 2020a), while the remaining 70 points are derived from the presentation grade (nota de presentación) provided by the educational center where the student is enrolled (MINERD, 2020a).

The cumulative score constitutes the final grade, and students must achieve a minimum of 70 points in each subject to receive the secondary education completion certificate, issued by MINERD. This certificate is a prerequisite for admission to both public and private local universities in the country.

MINERD, through the Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad), was responsible for designing, constructing, and administering the Pruebas Nacionales (National Examinations), as well as analyzing the resulting scores and disseminating the results (MINERD, 2011). As of 2011, the booklets used for the Pruebas Nacionales were physically structured as follows (MINERD, 2011, pp. 14–15):

1) Cover: Included the issuing entity, educational level and grade, type and date of the attempt (convocatoria), and the booklet number, following the printed formats of the time.

2) Instructions: Provided guidance with examples to help students answer the questions using a specified model.

3) Items: Listed in numerical order in the quantity corresponding to each level and subject area being evaluated.

4) Back cover: Featured an image of *Dulus dominicus*, the national bird of the Dominican Republic.

The exam consisted of multiple-choice questions with four options, only one of which was correct (MINERD, 2020a). This format simplified result processing, enabling faster delivery of outcomes (MINERD, 2020a). For examples of items from the mathematics section of the Pruebas Nacionales, refer to pages 130 to 134 in MINERD's *Marco de referencia para las Pruebas Nacionales del Segundo Ciclo de Educación Secundaria* (2020a).

Evidence-Based Design (EBD)

According to MINERD (2020a), the designers of the Pruebas Nacionales (National Examinations) tailored the tests to assess specific competencies in each subject area. These competencies were divided into smaller components, which served as the basis for structuring the test items. This process, referred to as "inferential reasoning" by MINERD (2020a), was conducted using Evidence-Based Design (EBD). Specifically, each competency was broken down into four sub-levels from which test items were developed. The rationale behind this approach was that not all specific competencies could be effectively evaluated using a standardized measuring instrument like the Pruebas Nacionales (MINERD, 2020a).

MINERD (2020a) referred to the first step in EBD as "domain analysis," which aimed to cover all important aspects of the specific competencies that were to be assessed. The second step, termed "affirmation," involved determining the expected knowledge and skills a student should demonstrate within that domain based on correctly answering an item (MINERD, 2020a).

The third step, called “evidence,” involved breaking down all the “affirmations” into observable aspects of student performance (MINERD, 2020a). The “evidence” defined what a student needed to know through specific “tasks” that provided the final information to determine the degree of domain acquisition or mastery (MINERD, 2020a). The fourth and final step involved developing these “tasks.” The “tasks” were defined as concrete scenarios presented to test-takers, and their responses to these scenarios – via test items – facilitated data collection on “evidence” (MINERD, 2020a).

Within each domain, the “affirmations,” “evidence,” and “tasks” were organized into levels, with at least three of each category for every level (MINERD, 2020a). A flowchart describing the EBD process for formulating test items is presented in Figure 1.

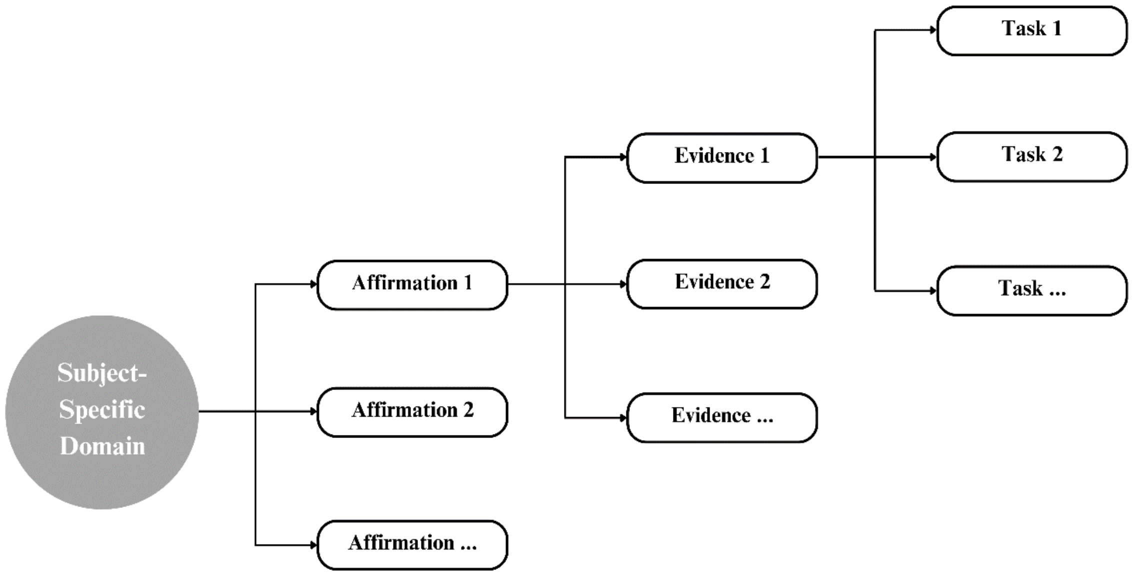

Figure 1. Evidence-Based Design Domain Analysis Flowchart

Note. Adapted from *Estrategia de Familiarización para las Pruebas Nacionales por Competencias 2023. Instructivo para el Docente. Ajustes que presentan las Pruebas Nacionales 2023 en Lengua Española, Matemática, Ciencias Sociales y Ciencias de la Naturaleza.* (pp. 12–13) by MINERD. 2023a.

Mathematics Domain and Structure of the Instrument

To gather "evidence" on the development of mathematical competencies, students had to engage with both the mathematical content and the real-world scenarios where applying this content was meaningful (MINERD, 2020a). Therefore, the Mathematics Pruebas Nacionales (National Examinations) were designed around three components: specific competencies (and their associated actions), thematic axes that grouped mathematics content, and contextual applications of these competencies.

Specific Competencies and their Actions

The mathematics section of the Pruebas Nacionales (National Examinations) condensed the six original mathematical competencies – Reasoning and Argumentation, Communication, Modeling and Representation, Connection, Problem-solving, and Utilizing Technological Tools (see "The Danish KOM Project and the Dominican Curriculum" for more details) – into three core competencies for assessment (MINERD, 2023a, p. 12):

1) Communication, Modeling, and Representation: Encompassed the ability to read, interpret, express, define, describe, represent, use mathematical language, elaborate, and explain relationships.

2) Problem-solving: Involved the skills to pose and formulate various types of mathematical problems, design and apply different strategies for solving them, as well as check, interpret, evaluate, and verify the solutions.

3) Reasoning and Argumentation: Included the ability to identify arguments, propose, justify, prove, classify, establish relationships, define, explain the importance of results, argue, analyze, and make decisions.

This restructuring aimed to narrow the focus and scope of the mathematics Pruebas Nacionales (MINERD, 2023a). The specific competencies evaluated were linked to the actions outlined in Table 4 (MINERD, 2023a).

Table 4. Actions that define Competencies

Specific Competencies	Associated Actions to the Specific Competency
Reasoning and Argumentation	Identify, propose, justify, prove, classify, establish relationships, define, express importance, explain concepts, argue, analyze, decide.
Communication	Read, interpret, express, define, describe, represent, use mathematical language, elaborate, explain relationships.
Modeling and Representation	Represent, express with graphs, identify, apply methods, model.
Connection	Employ, apply, use knowledge, identify, determine, utilize, relate, define.
Problem-solving	Solve problems using various mathematical tools.

Note. Adapted from *Estrategia de Familiarización para las Pruebas Nacionales por Competencias 2023. Instructivo para el Docente. Ajustes que presentan las Pruebas Nacionales 2023 en Lengua Española, Matemática, Ciencias Sociales y Ciencias de la Naturaleza.* (pp. 12–13) by MINERD. 2023a.

Competency Percentage Distribution

As discussed in a previous section, the mathematical competencies are further divided into "affirmations" and "evidences" regarding student mathematical performance (MINERD, 2020a). Table 5 outlines the percentage distribution of each competency in the mathematics Pruebas Nacionales (National Examinations).

Table 5 shows a strong emphasis on Problem-solving and Communication as key competencies to be tested – therefore, these were more heavily weighted in the mathematics Pruebas Nacionales (National Examinations) (MINERD, 2020a). For instance, Cruz-Pichardo (2021) observed that Dominican students who participated in the

PISA 2015 and 2018 mathematics assessments had struggled with problems requiring analytical skills, formulation, and problem-solving abilities.

Table 5. Competency Percentage Distribution in the Pruebas Nacionales

<table>
<tr><th colspan="3">Competency</th></tr>
<tr><th colspan="3">1. Communication, Modeling, and Representation</th></tr>
<tr><th>Affirmation</th><th>% of Items per Affirmation</th><th>Evidence</th></tr>
<tr><td rowspan="2">1.1 Interpret information using mathematical language, allowing for the description of a situation in diverse contexts.</td><td rowspan="2">40%</td><td>1.1.1 Identify mathematical information contained within different representations.</td></tr>
<tr><td>1.1.2 Represent situations of various natures in different types of registers (natural language, analytical, graphical, etc.).</td></tr>
<tr><th colspan="3">Competency</th></tr>
<tr><th colspan="3">2. Problem-solving</th></tr>
<tr><th>Affirmation</th><th>% of Items per Affirmation</th><th>Evidence</th></tr>
<tr><td rowspan="3">2.1 Solve problems in different contexts using mathematical tools.</td><td rowspan="3">40%</td><td>2.1.1 Propose strategies for problem-solving.</td></tr>
<tr><td>2.1.2 Apply strategies leading to problem resolution.</td></tr>
<tr><td>2.1.3 Provide solutions to problems requiring the use of mathematical tools.</td></tr>
<tr><th colspan="3">Competency</th></tr>
<tr><th colspan="3">3. Reasoning and Argumentation</th></tr>
<tr><th>Affirmation</th><th>% of Items per Affirmation</th><th>Evidence</th></tr>
<tr><td rowspan="3">3.1 Evaluate situations allowing for decision-making in different contexts.</td><td rowspan="3">20%</td><td>3.1.1 Assess the results obtained from solving a problem.</td></tr>
<tr><td>3.1.2 Justify the use of procedures applied for solving problems in various contexts.</td></tr>
<tr><td>3.1.3 Derive conclusions from the given information.</td></tr>
</table>

Note. Adapted from *Marco de referencia para las Pruebas Nacionales del Segundo Ciclo de Educación Secundaria*. (pp. 125–126) by MINERD. 2020a.

In contrast, Reasoning and Argumentation were less emphasized in the mathematics Pruebas Nacionales due to "inherent challenges" in assessing these competencies through a standardized test format (MINERD, 2020a). The reference to "inherent challenges" likely points to the Pruebas Nacionales' lack of a free-response section. Nonetheless, some researchers have proposed alternatives to traditional competency-based summative assessments (Niss & Højgaard, 2011; Ruiz, 2018).

Thematic Axes

The most relevant secondary mathematics curriculum content was organized into three thematic axes: the Algebra Axis – Arithmetic and Calculus, the Geometric-Trigonometric Axis, and the Statistics-Probabilistic Axis (MINERD, 2023a, pp. 13–14). The thematic axes are (MINERD, 2020a, pp. 127–128):

1) Algebra Axis – Arithmetic and Calculus
    a. Systems of linear equations
    b. Exponential and logarithmic equations
    c. Linear inequalities
    d. Rate of change and limits
    e. Financial mathematics
    f. Solution of linear inequalities
    g. Domain and range of exponential and logarithmic functions
    h. Simple interest, compound interest
    i. Rate conversion
    j. Calculation of payments or capital with simple interest
    k. Arithmetic operations (addition, subtraction, multiplication, division)
    l. Calculation of percentages
    m. Simplification of rational expressions
    n. Addition, subtraction, and multiplication of monomials and polynomials
    o. Solution of linear equations
    p. Solution of quadratic equations
2) Geometric-Trigonometric Axis
    a. Trigonometric ratios, sine and cosine laws

b. Calculations of areas and volumes for common shapes: triangles, quadrilaterals, pyramids, prisms, cylinders, and spheres
c. Similarity and congruence
d. Geometric properties of the circumference
e. Triangle inequality
f. Perimeters of simple figures and surface areas of solids

3) Statistics-Probabilistic Axis

a. Measures of central tendency, measures of position, measures of dispersion
b. Laplace's rule of probability: simple, exclusive, conditional events
c. Representations of different nature: bar graphs, circular graphs, line graphs

Context

The contexts refer to situations familiar to students, whether they occur at school or in extracurricular activities. These contexts are categorized as personal, family-related, social, economic, scientific, or mathematical (MINERD, 2023a). For more details, see MINERD (2020a, p. 129).

Procedure

According to MINERD (2011), once the tests were administered, the answer sheets were processed through an automated system using an optical scanner (SCANTRON). If an answer sheet was rejected by the optical reader due to issues such as improper shading, physical damage, or unclear barcodes, the sheets were manually transcribed (MINERD, 2011). A quality control check was then performed on these transcriptions (MINERD, 2011). Finally, a database was assembled from which the tests were analyzed and graded (MINERD, 2011).

Item Response Theory (IRT) and Rasch analysis

The Pruebas Nacionales (National Examinations) were analyzed using Item Response Theory (IRT) (MINERD, 2011; MINERD, 2020a). Among the estimates obtained through these models, relevant measures included the level of attribute possessed by individuals, as well as individual test characteristics such as difficulty, discrimination, and pseudo-chance (MINERD, 2020a). Through data analysis, performance levels within the population were identified, and reports were published and disseminated to inform the design of subsequent instruments (MINERD, 2020a).

Item Response Theory (IRT) is a branch of psychometrics comprising a collection of mathematical models that predict the probability of a particular response based on the interaction between an individual's latent ability and item characteristics such as difficulty and discrimination (Ackerman et al., 2023). Latent ability refers to an underlying trait or capacity an individual possesses. IRT models show the relationships among test item properties, test-taker responses to these items, and the latent trait being assessed (Matas-Terrón, 2010).

IRT modeling makes three key assumptions about the data under study. The first assumption is unidimensionality, which posits that the modeled latent ability defines the entire space of latent abilities and explains an individual's performance on a test or item (Matas-Terrón, 2010). Tests may be unidimensional, requiring only one latent ability, or multidimensional, requiring multiple latent abilities (Ackerman et al., 2023; Matas-Terrón, 2011). The second assumption is local independence, indicating that the response to one item does not affect the response to another (Matas-Terrón, 2010). The third assumption involves the Item Response Function (IRF), which models an individual's response to an item by expressing the probability of achieving a specific score at each level of the latent ability (Ackerman et al., 2023).

According to Matas-Terrón (2010, p. 3), IRT models generate the following results:

- Parameters: Difficulty, discrimination, and guessing of the item are crucial in assessing an item.
- Item Characteristic Curve (ICC): Provides a graphical representation of an item's characteristics, showing the relationship between the level of the latent ability and the item response, using probability theory.
- True score on the test: Calculated by using the sum of the estimated probabilities relative to the latent ability of all test items.
- Test Characteristic Curve (TCC): A graphical representation showing the relationship between the total test score and the latent ability level.
- Information Level: Serves as a measure of estimation accuracy.

MINERD (2011) states that since 2010, the Pruebas Nacionales have been analyzed using the IRT Rasch model. This model, favored over other logistic models of IRT, is widely employed in both national and international standardized assessments (MINERD, 2011, p. 16). The Rasch model – named after its developer George Rasch – examines test results by considering the difficulty level of the tests and the latent ability demonstrated by the student when responding to each item (MINERD, 2011, p. 16). The model's ability to calibrate and scale the administered tests, along with the use of anchor items for comparisons across attempts and years, has proven invaluable (MINERD, 2011).

According to MINERD (2011), the analysis of the Pruebas Nacionales (National Examinations) using the Rasch model has several outcomes (p. 17):

- Student ability measurement**:** It produces measures of student ability in logits, facilitating the computation of descriptive statistics. These statistics allow for comparisons between schools, regions, or across different times.
- Test reliability indicators**:** The model generates classical test reliability indicators and other parameters that provide insights into the quality of the Pruebas Nacionales.
- Comparison and equating of test forms**:** It supports the comparison and equating of different test booklet forms over time, which helps in identifying and correcting test weaknesses and supports the development of new tests and items.
- Item Difficulty and Characteristic Curves**:** The difficulty level of each item is determined, along with its characteristic curve, which predicts the probability of a student answering an item correctly.

Some of the key estimators in item analysis include: (1) the percentage of correct responses per item, (2) items left blank, (3) items that nearly all or very few students answered correctly, (4) point-biserial correlation and other measures of item discrimination, (5) difficulty levels, and (6) preferred response options (MINERD, 2011, p. 17).

Following item analysis, technical decisions were made regarding grading scales. This process involved assigning values to performance based on differences in the instruments used (such as multiple forms or booklets), their level of difficulty, and the abilities demonstrated by students according to Rasch analysis (MINERD, 2011). The grading scale ranged from 0 to 30 points (MINERD, 2011). This methodology enabled the estimation of the level of attributes possessed by individuals and test item characteristics (MINERD, 2011).

Subsequently, the reports generated from this approach served as valuable resources for test designers and academic institutions. These reports helped identify areas needing improvement and allowed for the implementation of targeted interventions (MINERD, 2020a). Reports were prepared at various levels, including national, regional, district, and individual educational institutions (MINERD, 2020a).

Data Processing and Analysis

Both data processing and analysis were performed primarily using R (R Core Team, 2023)[2].

Data Processing

The data was selected for the years 2017, 2018, 2019, 2022 for the pre-ordinance group, and 2023 for the post-ordinance group. Mathematics scores were scaled to be out of 100 points because the pre-ordinance group originally had scores scaled out of 30 points. The dataset was then filtered to include only data from public and private schools, the first attempt (convocatoria), morning and Extended School Day shifts, and the General Academic track. The data was restricted to ages 17 to 18, and records with absences or missing data were removed due to the large remaining sample size (N = 64,080).

[2] Specific tasks were performed using Microsoft Excel and Python to streamline the data processing and analysis.

The researcher identified a critical data entry error for the year 2019. Most observations were marked as "Absent" despite having a recorded mathematics score. Assuming that a mathematics score other than 0 indicated the student's presence, the researcher reassigned these cases to "Present."

Age selection, Track, and Attempt (convocatoria)

The researcher focused on students aged 17 to 18 years, aligning the study with the prevailing Dominican academic structure. The Academic track was selected because it is recognized by the Ministry of Education (MINERD) as the pathway intended to advance students to higher levels of education. The first attempt (convocatoria) was chosen because all the datasets provided to the researcher uniformly contained data about this session, unlike the other two.

Adjustments had to be made, such as recalculating the provided ages of the students using a birthday column, to ensure data accuracy. Specifically, the "Age" column was recalculated using the "Birthday" column because the ages in the pre-ordinance group did not accurately reflect the ages at which participants took the Pruebas Nacionales (National Examinations). All the data was then consolidated into a single spreadsheet.

Pre-ordinance and Post-ordinance Groups

The study included data from the years 2017 to 2023. Ordinance 22-2017 outlined that the competency-based curriculum implementation in secondary education would begin in the 2017–2018 academic year, with a phased introduction starting from 2017–2018 for fourth grade, 2018–2019 for fifth grade, and 2019–2020 for sixth grade (MINERD, 2017b). Consequently, the years 2017 through 2022 were selected for the control group to capture data prior to and during the early phase of the curriculum's implementation. For the treatment group, the year 2023 was chosen, marking the first official implementation of the competency-based curriculum in the Pruebas Nacionales.

Public and Private Schools

The study separately analyzed public and private schools, recognizing existing research that indicates public schools are at a disadvantage compared to private schools in standardized mathematics assessments (Jakaitienė et al., 2021; Sakellariou, 2017). Various factors contributing to this disparity, such as teacher unpreparedness and inadequate infrastructure, were discussed in earlier sections. Specifically, Cruz-Pichardo (2021) highlighted a significant difference in the PISA 2015 mathematics scores between Dominican public and private schools. Arias (2023) reported that private schools in the Dominican Republic consistently achieved better results than public ones on the Pruebas Nacionales. Other authors, such as Hamm and Veras Diaz (2021) and Hamm and Martínez (2017), have extensively documented the shortcomings in the Dominican public education system.

Shift Selection

To effectively compare scores between private and public schools, the researcher focused on the morning shifts and the Extended School Day shift. As detailed in the "Settings and Participants" section, these two shifts are the most prevalent, encompassing the majority of both private and public school students. The Extended School Day shift was initiated through Ordinance 01-2014, beginning in the 2014-2015 academic year (MINERD, 2014). It was implemented to expand educational coverage and increase instructional time, thereby promoting greater equity among other benefits. However, it has encountered numerous challenges in its implementation (Hamm & Martínez, 2017, pp. 293–295). Under this shift, most schools, both public and private, operate from as early as 7:30 AM to as late as 4:00 PM (MINERD, 2014, Article 6, Para. 1).

Regional Considerations

The datasets provided to the researcher contained data categorized by each Regional Directorate. As outlined in the "Settings and Participants" section, nearly half of the study participants were located in the two main cities of the Dominican Republic. Therefore, simply analyzing aggregate data of the entire country, as opposed to examining differences between regions, could have led to skewed and less nuanced research results. All students had already been grouped by Regional Directorate by the Ministry of Education (MINERD) (see Appendix E).

The National Institute for Teacher Training and Professional Development's (INAFOCAM) study divided the Regional Directorates into three natural macroregions for the Dominican Republic: North, East, and South (INAFOCAM, 2014, p. 84). Therefore, another column labeled "Macroregion" was added, and Regional Directorates were categorized as shown in Table 6:

- North region: Cotuí (Code 1600), La Vega (Code 600), Mao (Code 900), Monte Cristi (Code 1300), Nagua (Code 1400), Puerto Plata (Code 1100), San Francisco de Macorís (Code 700), Santiago (Code 800)

- East region: Higüey (Code 1200), Monte Plata (Code 1700), San Pedro de Macorís (Code 500), Santo Domingo I (Code 1000), Santo Domingo II (Code 1500)

- South region: Azua (Code 300), Bahoruco (Code 1800), Barahona (Code 100), San Cristóbal (Code 400), San Juan de la Maguana (Code 200)

Table 6. Geographical Macroregions of the Dominican Republic

Regional Directorate	Regional Code	North	East	South
Barahona	100			X
San Juan de la Maguana	200			X
Azua	300			X
San Cristóbal	400			X
Bahoruco	1800			X
Cotuí	1600	X		
Puerto Plata	1100	X		
La Vega	600	X		
San Francisco de Macorís	700	X		
Santiago	800	X		
Monte Cristi	1300	X		
Nagua	1400	X		
Mao	900	X		
Santo Domingo I	1500		X	
San Pedro de Macorís	500		X	
Higüey	1200		X	
Santo Domingo II	1000		X	
Monte Plata	1700		X	

Note. Adapted from *Dominio Conceptual: Necesidades Formativas de los Docentes de la República Dominicana*. y INAFOCAM. 2014.

Stratified Random Sampling

The pre-ordinance group had a larger sample size (N = 81,821) than the post-ordinance group (N = 32,040). To address this discrepancy, stratified random sampling (seed = 1996) was employed to achieve proportional sampling. First, the size of the post-ordinance dataset was calculated to determine the total number of observations needed from the pre-ordinance dataset. Next, the proportions of each combination of School Type and Regional Directorate in the pre-ordinance dataset were calculated. These proportions were then merged back with the pre-ordinance dataset to associate each observation with its corresponding proportion. Missing proportions due to missing data were set to 0.

The sample size for each combination was calculated based on the proportion of the total size of the smaller post-ordinance dataset. Stratified random sampling was then performed using an algorithm to ensure that the sampled pre-ordinance data matched the sample size of the post-ordinance group while retaining the original proportion of observations across the School Type and Regional Directorate variables. Finally, the pre-ordinance and post-ordinance data were consolidated into a single dataset for subsequent statistical analyses, with minor adjustments as needed. For example, some Regional Directorates did not have Private school data, specifically Monte Cristi and Bahoruco.

The resulting dataset contained a total of 64,080 observations, evenly split with 32,040 observations for the pre-ordinance group and 32,040 observations for the post-ordinance group.

Data Analysis

The researcher began by investigating whether the implementation of Ordinance 01-2016 was a significant predictor of mathematics scores in the Pruebas Nacionales (National Examinations). An unpooled two-sample independent t-test was used to compare the mean mathematics scores between groups before and after the ordinance implementation to determine if the scores were statistically different or due to random chance. Similarly, the researcher investigated whether school type was a significant predictor of mathematics performance, employing another unpooled two-sample independent t-test. Prior to conducting both tests, assumptions such as independence, normality, and homogeneity of variances were tested. Descriptive statistics, including means, standard deviations, frequencies, and percentages of the mathematics scores in each group, were provided.

Unpooled one-way Analysis of Variance (ANOVA) techniques were used to examine the differences in mean mathematics scores across the 18 Regional Directorates and public school mean scores across three macroregions (North, East, South). Assumptions such as independence, normality, and homogeneity of variances were tested prior to conducting the ANOVAs. Furthermore, the researcher investigated whether Ordinance 01-2016 and school type were significant predictors of mathematics performance. A two-way ANOVA was conducted, and assumptions of independence, normality, and homogeneity of variances were tested. Post-hoc analyses were conducted using the Bonferroni method and the Tukey-HSD method.

Following these initial analyses, the researcher employed Hierarchical Multilevel Modeling (HLM) to further investigate the data, treating region as a random effect. HLM were suitable as the data structure involved fixed effects (such as school type and ordinance implementation) and a random effect (region). The numerical codes corresponding to Regional Directorates present in the dataset were used to distinguish each region.

Limitations and Assumptions

Limitations

MINERD (2020a) pointed out that the mathematics Pruebas Nacionales (National Examinations) had limitations, including the inability to fully assess some important mathematical competencies through the standardized test format. For instance, it was difficult to evaluate mathematical proofs and formal representations, specific algorithms, or complex calculations that required the use of technology (MINERD, 2020a). Moreover, the aggregate mathematics score did not reflect specific mathematical competency data. Consequently, the researcher was unable to determine individual student achievement in each mathematical competency tested by the mathematics Pruebas Nacionales.

Moreover, Ruiz (2018) argued that a national examination, even one that reflected all elements of a mathematics competency-based curriculum – including knowledge and skills, process capabilities, and non-standardized free-response formats – still did not adequately measure creativity, critical thinking, teamwork, and interdisciplinarity. They highlighted two main points: (1) the need for a reconsideration of the national examinations, which significantly influenced student promotion in both the Dominican Republic and other countries, and (2) the need to expand assessment tools beyond standardized national examinations through the integration of additional mechanisms for final evaluation (Ruiz, 2018). Additionally, Ruiz (2018) critiqued the presentation grade (nota de presentación), which constituted a significant portion of the promotion grade (70%) in both countries, for its implications of inequity.

Assumptions

According to MINERD (2011), the Pruebas Nacionales (National Examinations) were designed around four guiding principles (p. 14):

- Equity: The Pruebas Nacionales ensured fair treatment and provided assessment and certification opportunities to all individuals who met the established criteria.
- Validity: The exams accurately reflected the learning achievements of the students and were consistent with the current curriculum.
- Reliability: Every student took the exams under the same conditions with consistent application of the tests and subsequent grading procedures.
- Transparency: All participants, especially teachers and students, had a clear understanding of the testing instrument and the learning outcomes being assessed, ensuring that all were well-informed and prepared.

Ethical Considerations

The Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) at the Ministry of Education (MINERD) collected and anonymized the data before providing it to the researcher, thereby ensuring student confidentiality. Consequently, the research project did not involve direct interaction with any human subjects. Due to these considerations, along with the compulsory nature of the Pruebas Nacionales (National Examinations), the researcher received an exemption from the Institutional Review Board (IRB) process at Shawnee State University (see Appendix D).

However, the researcher was unable to confirm the extent to which the provided dataset was equitable, valid, or reliable, given that testing conditions can vary significantly by location and administrators. This limitation, along with other assumptions mentioned in a previous section, will be considered when interpreting the study's findings.

Summary

Chapter III began with a review of the primary research questions and a description of the setting and participants. Demographic descriptions obtained from the Ministry of Education (MINERD) website dashboards were used to describe the population.

The design of the Pruebas Nacionales (National Examinations) was detailed in terms of Evidence-Based Design (EBD), including its components: domain, affirmations, evidence, and tasks. Furthermore, the specific mathematical competencies were outlined along with their associated actions, the percentage distribution of test items per affirmation, the specific mathematical content tested, and the contexts in which applying mathematical knowledge is relevant.

Data processing was conducted by MINERD using SCANTRON technology with careful quality control. Data analysis was also performed by MINERD using Item Response Theory (IRT) and Rasch analysis techniques. The datasets assembled by MINERD for each year following this extensive process were provided to the researcher for this study. The researcher further processed the datasets to focus on a specific subset of students aged 17–18 years who attended the Extended School Day shift and were enrolled in the Academic track on the first attempt (convocatoria) of the mathematics Pruebas Nacionales. The students were categorized by year (pre-ordinance or post-ordinance), by whether they attended public or private schools, and by geographical location.

Finally, the chapter discussed the study's limitations and assumptions, along with a review of the ethical considerations. This study received an exemption from Shawnee State University's Institutional Review Board.

CHAPTER IV: RESULTS

Chapter IV will present the results of the analyses conducted to investigate the impact of Ordinance 01-2016, school type, and region on student mathematics performance in the Pruebas Nacionales (National Examinations). This section will reiterate the settings and participants of the study, the instrumentation, procedures, and the research questions. Each research question will be addressed, beginning with descriptive statistics followed by inferential statistics and their associated assumptions. These will include independent t-tests, one-way and two-way Analysis of Variance (ANOVA), and a Hierarchical Multilevel Model (HLM).

Setting and Participants

The Pruebas Nacionales (National Examinations) are yearly standardized assessments administered to students in the sixth grade of the second cycle of secondary education in the Dominican Republic. These exams evaluate the competencies attained by each student across four subject areas, including mathematics, aligning with the new competency-based national curriculum (MINERD, 2020a). Each exam contributed 30% to the student's final grade, with the remaining 70% coming from the presentation grade (nota de presentación) provided by the educational center where the student was enrolled (MINERD, 2020a). To receive the secondary education completion certificate, students must achieve a minimum of 70% in each subject.

Typically, test-takers are students aged 17–18 (Hamm & Veras Diaz, 2021; IDEICE, 2020). During the 2022–2023 academic year, 856,499 secondary students were enrolled in public and private schools (MINERD, 2023a). Of these, 707,705 were enrolled in public schools, and 148,794 were in private schools (MINERD, 2023a). Participants were categorized based on year (pre-ordinance or post-ordinance), whether they attended public or private schools, and by region. Public and private schools were analyzed separately due to existing research indicating that public schools are often at a disadvantage compared to private schools in standardized mathematics assessments (Arias, 2023; Cruz-Pichardo, 2021; Jakaitienė et al., 2021; Sakellariou, 2017).

To effectively compare scores between private and public schools, the researcher focused on the Extended School Day shift, the most prevalent schedule in both school types. Most Extended School Day schools operate from 7:30 AM to 4:00 PM, and 51% of students nationwide attended the Extended School Day shift. Also, to capture regional nuances in mathematics performance, geographical location was considered. To decentralize the educational system, MINERD established 18 Regional Directorates representing their respective communities and named after the provinces they served.

Only students enrolled in the Academic track were considered because this track was recognized by the Ministry of Education as the pathway to advance students to higher education (MINERD, 2017a). Students absent for the first attempt (convocatoria) of the mathematics Pruebas Nacionales were excluded. The first attempt was selected because all datasets provided to the researcher uniformly contained information on this attempt.

The study utilized data from 2017 to 2023. Ordinance 22-2017 outlined the gradual implementation of the competency-based curriculum in secondary education, starting from the 2017–2018 academic year (MINERD, 2017b). Consequently, the control group (pre-ordinance) consisted of students from 2017 to 2019, capturing data from the early phases of the curricular implementation. The treatment group (post-ordinance) focused on students from 2023, marking the first official implementation of the new design of the Pruebas Nacionales in terms of the competency-based mathematics curriculum.

Instrumentation and Procedures

The mathematics Pruebas Nacionales were designed to evaluate student's attainment of mathematical competencies, following the update of the National Evaluation System by Ordinance 01-2016. The Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) was responsible for designing and compiling data from the Pruebas Nacionales (National Examinations). The dataset included demographic details such as gender, region, school type, zone type, and school district. Data was provided to the researcher primarily containing data from the first attempt (convocatoria) from 2010 to 2023, excluding the years 2020 and 2021 due to COVID-19 disruptions (see "Assumptions, Limitations, and Scope").

The mathematics Pruebas Nacionales followed an Evidence-Based Design (EBD) to assess specific mathematical competencies. The exam designers tailored it to assess competencies divided into smaller components (i.e., domains, affirmations, tasks), which served as the basis for structuring the test items (MINERD, 2020a). The exam focused on three mathematical competencies: Communication, Modeling, and Representation (40% of the test items); Problem-Solving (40%); and Reasoning and Argumentation (20%) (MINERD, 2023a). Thematic axes grouping mathematical content included the Algebra Axis, Geometric-Trigonometric Axis, and Statistics-Probabilistic Axis (MINERD, 2023a). Evidence-Based Design ensured that the exam accurately measured students' mathematics performance in each of these areas (MINERD, 2020a). Finally, to analyze the Pruebas Nacionales, MINERD utilized Item Response Theory (IRT) and the Rasch model to measure student ability and item characteristics (MINERD, 2011).

Data Processing

Data cleaning was performed to correct various data entry errors, including wrongly calculated ages of students at the time of the test and issues with the 2019 data. The researcher focused on students aged 17–18 years, aligning with the current Dominican academic structure. Students were categorized as belonging to the pre-ordinance group if they took the Pruebas Nacionales (National Examinations) in 2017, 2018, 2019, or 2022, and as belonging to the post-ordinance group if they took the national examination in 2023. The students were further categorized based on whether they attended public or private schools and by their Regional Directorate, which was further classified into macroregions. Only those enrolled in the Morning and Extended School Day shifts were considered. Additionally, only students in the Academic track were included in the study to allow for more balanced comparisons between school types. Students who were absent for the first attempt (convocatoria) of the mathematics Pruebas Nacionales were excluded from the analysis.

Following the data sifting, the pre-ordinance group, due to the inclusion of more years, had considerably more records than the post-ordinance group. Therefore, the researcher employed a stratified random sampling method to ensure that the pre-ordinance group matched the post-ordinance group in sample size while maintaining the original proportions of data from each school type and each Regional Directorate.

Research Questions and Results

The research questions for this study were:

1. Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

2. Is school type a significant predictor for mathematics performance on the Pruebas Nacionales?

3. Is region a significant predictor for mathematics performance on the Pruebas Nacionales?

4. Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales?

5. Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales?

The following sections will provide:

- Descriptive statistics for all relevant variables, including frequencies of observations and mean mathematics Pruebas Nacionales scores across school types and Regional Directorates.

- Inferential statistical analyses, along with a review of their underlying assumptions.

Research Question 1: Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

Descriptive Statistics

The descriptive statistics summarizing mean mathematics scores pre- and post-ordinance implementation are shown in Table 7. Before the ordinance implementation, the mean mathematics scores were 62.37 (SD = 10.39), based on a sample of 32,040 students, representing 50% of the total sample. After the ordinance was implemented, the mean scores dropped to 58.48 (SD = 13.08), again based on a sample of 32,040 students (50%) out of a total sample size of N = 64,080. This suggests that the average mathematics performance decreased following the ordinance.

Table 7. Descriptive Statistics for Mean Mathematics Scores over Ordinance 01-2016 Implementation

Ordinance 01-2016	Mean	Standard Deviation	Frequency
Pre-ordinance	62.37	10.39	32,040 (50%)
Post-ordinance	58.48	13.08	32,040 (50%)

Two sample Independent T-test

An unpooled two-sample independent t-test examined the claim that the difference in mean mathematics scores across pre-ordinance and post-ordinance implementation groups was significant. A priori power analysis was conducted using G*Power 3.1.9.7. The results indicated that to achieve the desired power of .80, a sample size of 102 subjects was needed; therefore, adequate power was not a concern since the sample size was 64,080 subjects. A boxplot of mathematics scores over ordinance implementation status is presented in Figure 2.

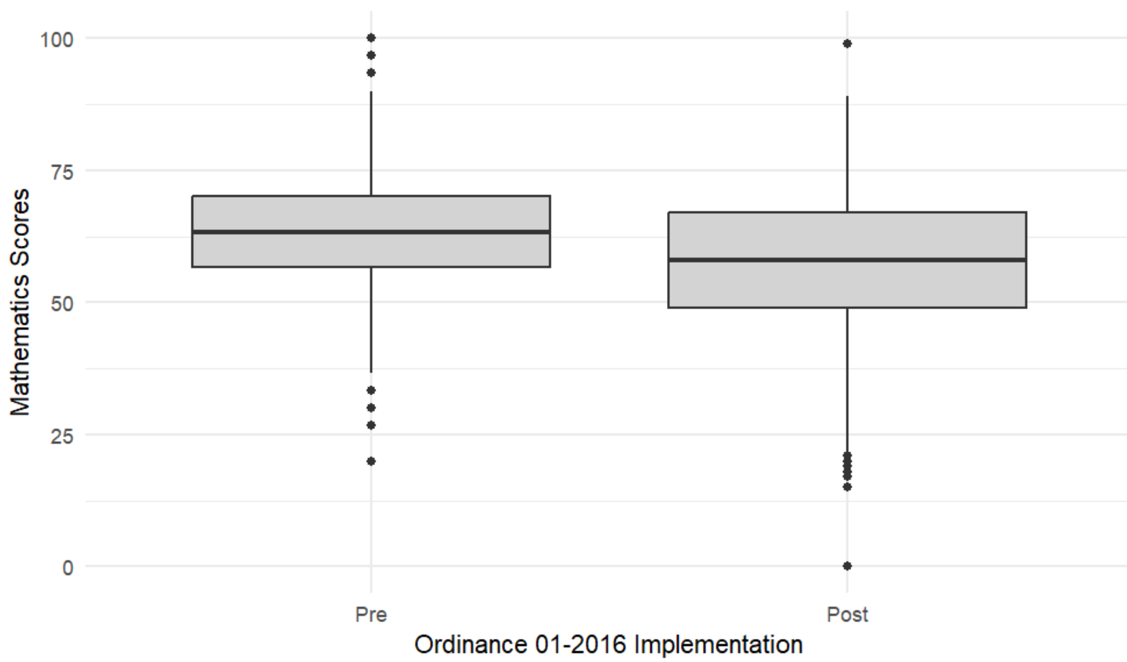

Figure 2. Boxplot of Mathematics Scores before and after Ordinance 01-2016 Implementation

Since the samples were collected randomly from each population, independence may be assumed; however, the results from the Kolmogorov-Smirnov test indicated possible threats to the normality assumption (pre-ordinance: D = 0.096, p < .001; post-ordinance: D = 0.032, p < .001). The results from Levene's test indicated concerns with the equal variance assumption, F(1, 64,078) = 1,682.50, p < .001.

On average, mathematics scores for students in the pre-ordinance group (M = 62.37, SD = 10.39) were significantly higher than those in the post-ordinance group (M = 58.48, SD = 13.08), t(60,691) = 41.65, p < .001, with 95% CI [3.70, 4.07]. A small to medium effect size was represented, Cohen's d = 0.34, with 95% CI [0.32, 0.35].

Research Question 2: Is school type a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

Descriptive Statistics

The descriptive statistics summarizing mean mathematics scores by school type (public vs. private) are shown in Table 8. Public schools had mean scores of 58.14 (SD = 10.89), based on a sample of 46,549 students, representing 73% of the total sample. In contrast, private schools had higher mean scores of 66.50 (SD = 12.57), from a sample of 17,531 students, accounting for 27% of the total sample (N = 64,080). The data shows that, on average, students in private schools outperformed their peers in public schools in mathematics.

Table 8. Descriptive Statistics for Mean Mathematics Scores by School Type

Ordinance 01-2016	Mean	Standard Deviation	Frequency
Public	58.14	10.89	46,549 (73%)
Private	66.50	12.57	17,531 (27%)

Two sample Independent T-test

An unpooled two-sample independent t-test examined the claim that the difference in mean mathematics scores across public and private school types was significant. A priori power analysis was conducted using G*Power 3.1.9.7. The results indicated that to achieve the desired power of .80, a sample size of 102 subjects was needed; therefore, adequate power was not a concern since the sample size was 64,080 subjects. A boxplot of mathematics scores by school type is presented in Figure 3.

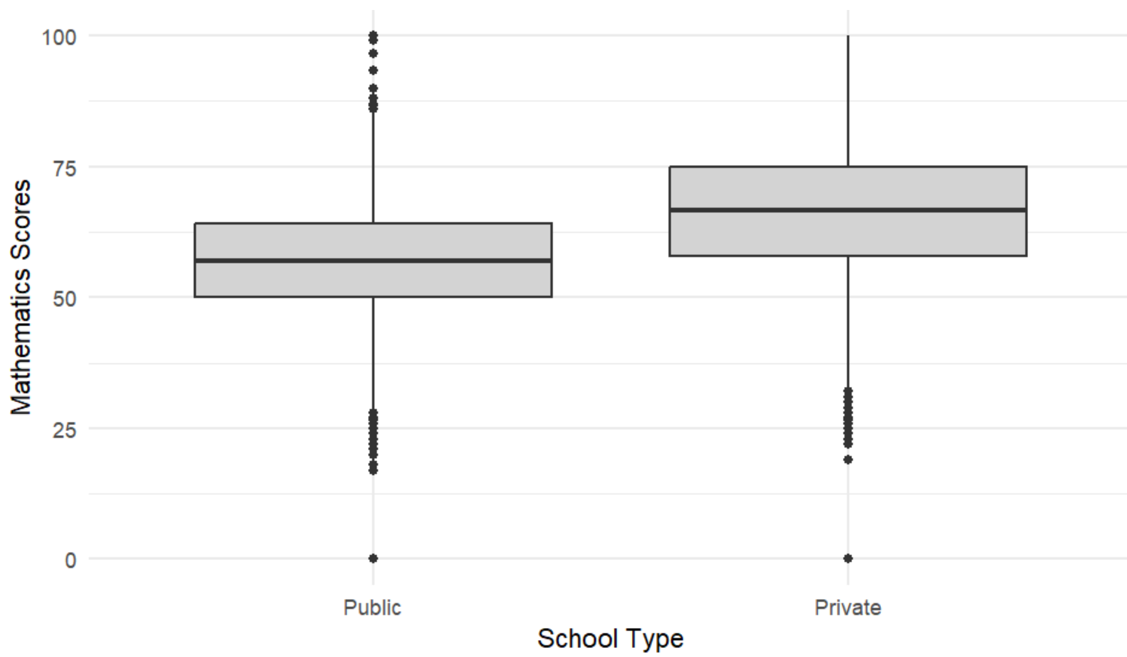

Figure 3. Boxplot of Mathematics Scores by School Type

Since the samples were collected randomly from each population, independence may be assumed; however, the results from the Kolmogorov-Smirnov test indicated possible threats to the normality assumption (public: $D = 0.047$, $p < .001$; private: $D = 0.039$, $p < .001$). The results from Levene's test indicated significant concerns with the equal variance assumption, $F(1, 64{,}078) = 512.68$, $p < .001$.

On average, mathematics scores for students in private schools ($M = 66.50$, $SD = 12.57$) were significantly higher than those in public schools ($M = 58.14$, $SD = 10.89$), $t(27{,}995) = -77.69$, $p < .001$, with 95% CI [-8.57, -8.14]. A large effect size was represented, Cohen's $d = -0.93$, with 95% CI [-0.95, -0.90].

Research Question 3: Is region a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

Descriptive Statistics

The descriptive statistics summarizing mean mathematics scores by Regional Directorate are shown in Table 9. The data showed that Santo Domingo I had the highest mean mathematics score at 64.92, with a sample size of 13,076 (20.41%). Higüey had the next highest mean score at 62.64, based on 2,135 students (3.33%), followed by Santiago with a mean score of 61.69, based on 4,833 students (7.54%). The lowest mean score was in Bahoruco, at 55.92, from 768 students (1.2%). Most Regional Directorates had mean scores between 56 and 60, with varying sample sizes proportional to the true population sizes.

Table 9. Descriptive Statistics for Mean Mathematics Scores by Regional Directorate

Regional Directorate	Regional Code	Mean	Standard Deviation	Frequency
Barahona	100	58.96	11.39	997 (1.56%)
San Juan de la Maguana	200	57.29	11.90	1,528 (2.38%)
Azua	300	57.50	10.76	3,231 (5.04%)
San Cristóbal	400	57.82	11.07	2,739 (4.27%)
San Pedro de Macorís	500	60.12	11.56	4,286 (6.69%)
La Vega	600	60.60	11.24	4,436 (6.92%)
San Francisco de Macorís	700	58.99	10.96	2,939 (4.59%)
Santiago	800	61.69	12.00	4,833 (7.54%)
Mao	900	59.44	10.40	1,564 (2.44%)
Santo Domingo II	1000	59.51	11.56	11,903 (18.58%)
Puerto Plata	1100	59.99	11.52	2,790 (4.35%)
Higüey	1200	62.64	11.20	2,135 (3.33%)
Monte Cristi	1300	57.51	10.40	1,439 (2.25%)
Nagua	1400	57.03	10.39	1,963 (3.06%)
Santo Domingo I	1500	64.92	13.02	13,076 (20.41%)
Cotuí	1600	56.64	10.85	1,858 (2.90%)
Monte Plata	1700	56.11	11.38	1,595 (2.49%)
Bahoruco	1800	55.92	9.43	768 (1.2%)

The descriptive statistics summarizing mean mathematics scores by macroregion are shown in Table 10. In the North region, public school students had a pre-ordinance mean score of 60.35 (SD = 8.78), which decreased to 55.84 (SD = 11.85) post-ordinance. Similarly, private school students had a pre-ordinance mean score of 67.14 (SD = 10.70), which slightly decreased to 65.23 (SD = 13.24) post-ordinance.

In the East region, public school students had a pre-ordinance mean score of 60.94 (SD = 9.44), which dropped to 56.63 (SD = 12.24) post-ordinance. Private school students had a pre-ordinance mean score of 68.03 (SD = 11.93), decreasing slightly to 65.72 (SD = 13.31) post-ordinance.

Finally, in the South region, public school students had a pre-ordinance mean score of 59.51 (SD = 8.52), which dropped to 54.30 (SD = 11.73) post-ordinance. Private school students had a pre-ordinance mean score of 64.71 (SD = 11.62), which decreased to 61.06 (SD = 12.31) post-ordinance.

Table 10. Descriptive Statistics for Mean Mathematics Scores by Macroregion

Macroregion	School Type	Pre Mean (SD)	Pre Frequency (%)	Post Mean (SD)	Post Frequency (%)
North	Public	60.35 (8.78)	9,277 (14.48%)	55.84 (11.85)	8,692 (13.56%)
	Private	67.14 (10.70)	1,912 (2.98%)	65.23 (13.24)	1,941 (3.03%)
East	Public	60.94 (9.44)	9,716 (15.16%)	56.63 (12.24)	10,516 (16.41%)
	Private	68.03 (11.93)	6,428 (10.03%)	65.72 (13.31)	6,335 (9.89%)
South	Public	59.51 (8.52)	4,192 (6.54%)	54.30 (11.73)	4,156 (6.49%)
	Private	64.71 (11.62)	515 (0.8%)	61.06 (12.31)	400 (0.62%)

One-Way Analysis of Variance (ANOVA)

An unpooled one-way ANOVA examined the difference in mean mathematics scores across the 18 Regional Directorates. Since the samples were collected randomly from each population, independence could be assumed. The Kolmogorov-Smirnov test was applied to the residuals of the ANOVA to check for normality. The results indicated potential threats to the normality assumption ($D = 0.020$, $p < .001$), suggesting that the residuals were not normally distributed. Levene's test for homogeneity of variance indicated significant concerns with the equal variance assumption, $F(17, 64{,}062) = 38.17$, $p < .001$.

The results revealed a statistically significant difference in mean mathematics scores across regions, $F(17, 13{,}376) = 191.44$, $p < .001$. A large effect size was observed, Cohen's $f = 0.49$. A boxplot of the mathematics scores across the regions is presented in Figure 4.

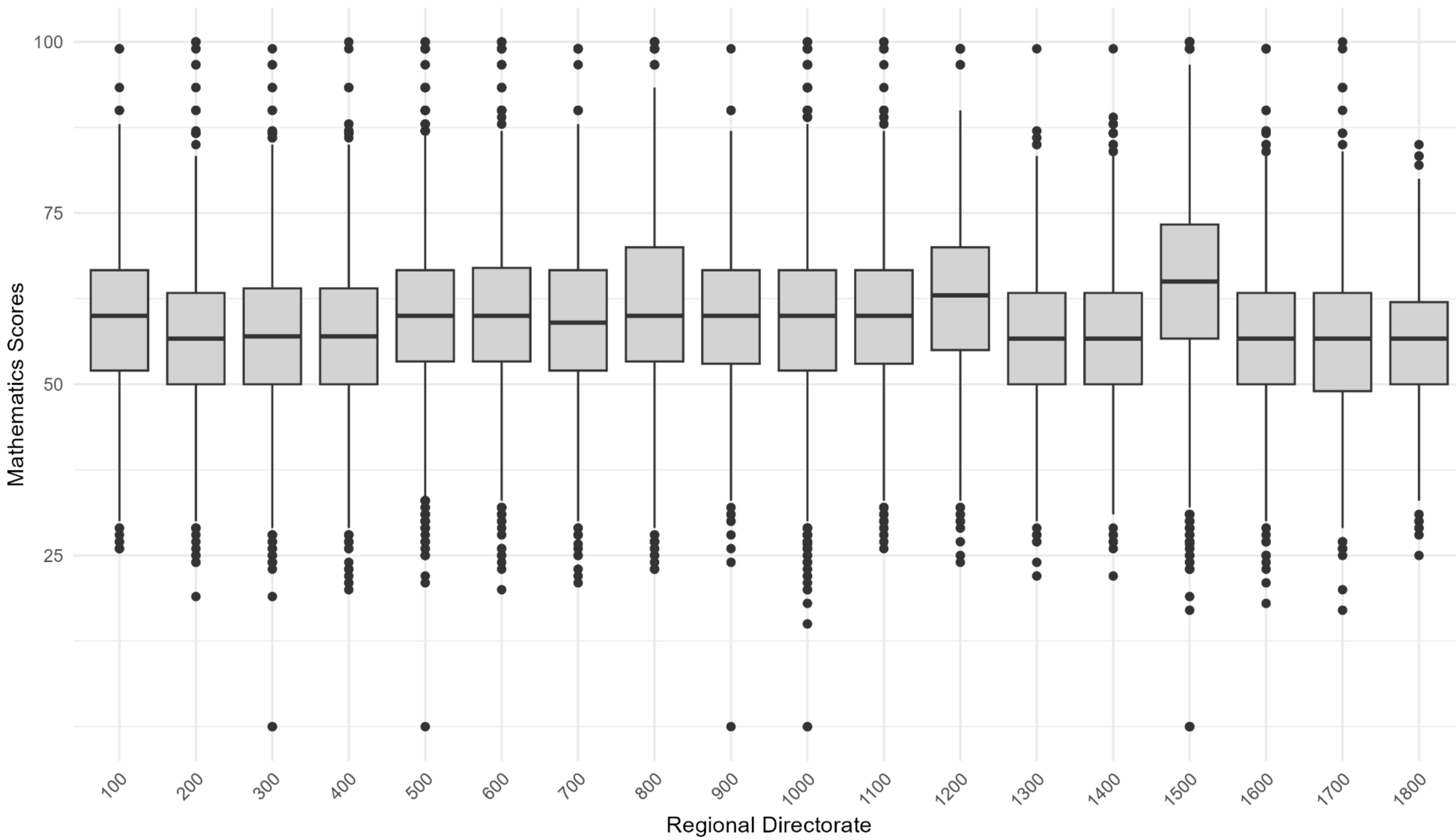

Figure 4. Boxplot of Mathematics Scores by Regional Directorate (represented by their Regional Code)

Post-hoc Analysis

Pairwise comparisons were conducted to investigate the differences between various regions, adjusting for multiple comparisons using the Bonferroni method. Significant differences ($p < .05$) were noted in multiple regional pairings, as summarized in Table 14 (see Appendix F). Specifically:

San Pedro de Macorís (5):

- Significant differences with Regional Directorates San Juan de la Maguana (200[3]), Azua (300), and San Cristóbal (400) (all $p < .001$).

La Vega (6):

- Significant differences with Regional Directorates Barahona (100) ($p < .01$), San Juan de la Maguana (200), Azua (300), and San Pedro de Macorís (500) (all $p < .001$).

San Francisco de Macorís (7):

- Significant differences with Regional Directorates San Juan de la Maguana (200) ($p < .001$), Azua (300) ($p < .001$), San Cristóbal (400) ($p < .05$), San Pedro de Macorís (500) ($p < .01$), and La Vega (6) ($p < .001$).

Santiago (8):

- Significant differences with Regional Directorates Barahona (100) ($p < .001$), San Juan de la Maguana (200) ($p < .001$), Azua (300) ($p < .001$), San Cristóbal (400) ($p < .001$), San Pedro de Macorís (500) ($p < .001$), La Vega (600) ($p < .01$), and San Francisco de Macorís (700) ($p < .001$).

Mao (9):

- Significant differences with Regional Directorates San Juan de la Maguana (200) ($p < .001$), Azua (300) ($p < .001$), San Cristóbal (400) ($p < .01$), Santiago (800) ($p < .001$).

Santo Domingo II (10):

[3] Regional Code of the Regional Directorate.

- Significant differences with Regional Directorates San Juan de la Maguana (200), Azua (300), San Cristóbal (400), La Vega (600), and Santiago (800) (all $p < .001$).

Puerto Plata (11):

- Significant differences with Regional Directorates San Juan de la Maguana (200), Azua (300), San Cristóbal (400), and Santiago (800) (all $p < .001$).

Higüey (12):

- Significant differences with Regional Directorates Barahona (100), San Juan de la Maguana (200), Azua (300), San Cristóbal (400), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100) (all $p < .001$).

Monte Cristi (13):

- Significant differences with Regional Directorates San Pedro de Macorís (500) ($p < .001$), La Vega (600) ($p < .001$), San Francisco de Macorís (700), Santiago (800) ($p < .001$), Mao (900) ($p < .001$), and Santo Domingo II (1000) ($p < .001$).

Nagua (14):

- Significant differences with Regional Directorates Barahona (100) ($p < .01$), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100), and Higüey (1200) (all $p < .001$).

Santo Domingo (15):

- Significant differences with Regional Directorates Barahona (100), San Juan de La Maguana (200), Azua (300), San Cristóbal (400), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100), Higüey (1200), Monte Cristi (1300), Nagua (1400) (all $p < .001$).

Cotuí (16):

- Significant differences with Regional Directorates Barahona (100), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100), Higüey (1200), Santo Domingo (1500) (all $p < .001$).

Monte Plata (17):

- Significant differences with Regional Directorates Barahona (100) ($p < .001$), Azua (300) ($p < .05$), San Cristóbal (400), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100), Higüey (1200), Santo Domingo (1500) (all $p < .001$).

Bahoruco (18):

- Significant differences with Regional Directorates Barahona (100) ($p < .001$), San Cristóbal (400) ($p < .05$), San Pedro de Macorís (500), La Vega (600), San Francisco de Macorís (700), Santiago (800), Mao (900), Santo Domingo II (1000), Puerto Plata (1100), Higüey (1200), Santo Domingo (1500) (all $p < .001$).

One-Way Analysis of Variance (ANOVA)

Unpooled one-way ANOVA techniques were employed to examine the difference in mean mathematics scores in public schools across the macroregions. The focus on public schools was chosen to facilitate comparisons with the INAFOCAM (2014) teacher readiness study, which included only public school teachers (p. 22). Since the samples were collected randomly from each population, independence could be assumed. The Kolmogorov-Smirnov test was applied to the residuals of the ANOVA to check for normality. The results indicated potential threats to the normality assumption ($D = 0.031$, $p < .001$), suggesting that the residuals were not normally distributed. Levene's Test for Homogeneity of Variance revealed significant concerns with the equal variance assumption, $F(2, 46{,}546) = 31.64$, $p < .001$.

The results revealed a statistically significant difference in public schools' mean mathematics scores across macroregions, $F(2, 22{,}992) = 81.09$, $p < .001$. A small effect size was observed, Cohen's $f = 0.08$. A boxplot is presented in Figure 5.

The results of the Tukey HSD test indicated that the mean mathematics scores in public schools in the North region were 0.53 units lower than in the East region, with 95% CI [-0.79, -0.27], $p < .001$. The mean mathematics scores in public schools in the South region were 1.78 units lower than in the East region, with 95% CI [-2.11, -1.45], $p < .001$. Furthermore, the mean mathematics scores in public schools in the South region were 1.25 units lower than in the North region, with 95% CI [-1.59, -0.91], $p < .001$.

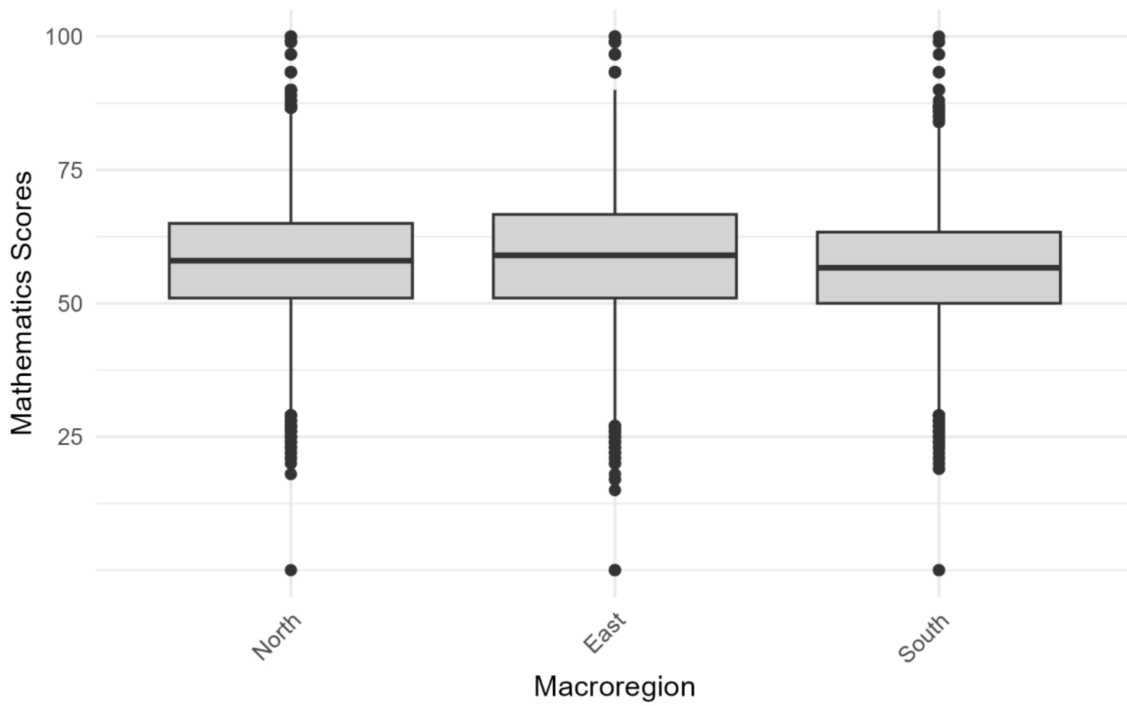

Figure 5. Boxplot of Public Schools Mathematics Scores by Macroregion

Research Question 4: Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales (National Examinations)?

Descriptive Statistics

The descriptive statistics summarizing mean mathematics scores by school type are shown in Table 11. For public schools, the pre-ordinance mean score was 60.38 (SD = 9.07), based on a sample of 23,185 students (36.18%). The post-ordinance mean score dropped to 55.92 (SD = 12.03), based on a sample of 23,364 students (36.46%). For private schools, the pre-ordinance mean score was 67.58 (SD = 11.73), based on a sample of 8,855 students (13.82%). The post-ordinance mean score decreased slightly to 65.39 (SD = 13.29), based on a sample of 8,676 students (13.54%).

Table 11. Descriptive Statistics for Mean Mathematics Scores by School Type

School type	Pre-ordinance Mean (SD)	Post-ordinance Mean (SD)
Public	60.38 (9.07)	55.92 (12.03)
Private	67.58 (11.73)	65.39 (13.29)
School type	**Pre-ordinance Frequency (%)**	**Post-ordinance Frequency (%)**
Public	23,185 (36.18%)	23,364 (36.46%)
Private	8,855 (13.82%)	8,676 (13.54%)

Two-Way Analysis of Variance (ANOVA)

A two-way ANOVA was conducted to examine the effects of school type (public vs. private) and the implementation of Ordinance 01-2016 (pre- vs. post-ordinance) on mathematics scores in the Pruebas Nacionales (National Examinations), as well as to explore the interaction between these two factors.

The analysis found significant effects of school type and Ordinance 01-2016 implementation on mathematics scores. The main effect of school type was significant, $F(1, 64{,}076) = 7{,}084.80$, $p < .001$, with a medium effect size, Cohen's $f = 0.33$, and achieved post hoc power of .99. Similarly, the main effect of the ordinance was significant, $F(1, 64{,}076) = 1{,}882.80$, $p < .001$, with a small to medium effect size, Cohen's $f = 0.17$, and achieved post hoc power of .99. The interaction effect between school type and ordinance implementation was also significant, $F(1, 64{,}076) = 131.20$, $p < .001$, with a small effect size, Cohen's $f = 0.05$, and achieved post hoc power of .99, indicating that the ordinance affected public and private schools differently. A boxplot is included in Figure 6.

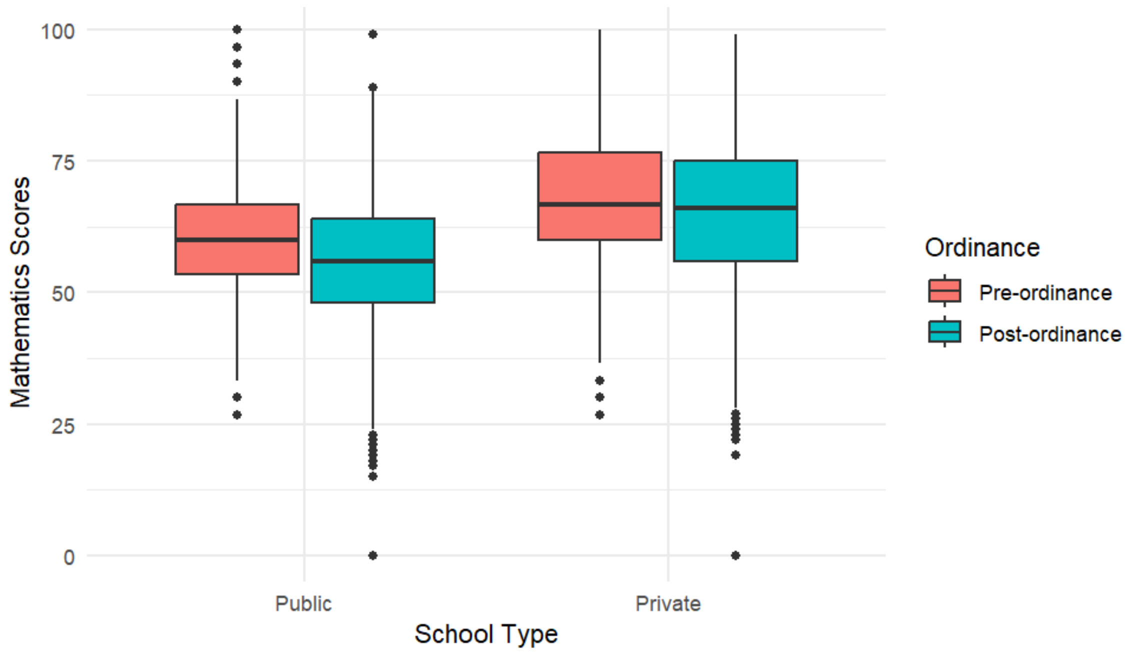

Figure 6. Boxplot of Mathematics Scores by School Type and Ordinance 01-2016 Implementation

The results of the Tukey HSD test indicated the following:

- The mean mathematics scores in pre-ordinance private schools were 7.20 units higher than in pre-ordinance public schools, with 95% CI [6.84, 7.56], $p < .001$.
- Post-ordinance public schools scored on average 4.46 units lower than pre-ordinance public schools, with 95% CI [-4.73, -4.20], $p < .001$.
- Post-ordinance private schools scored on average 5.01 units higher than pre-ordinance public schools, with 95% CI [4.65, 5.37], $p < .001$.
- Post-ordinance public schools scored on average 11.79 units lower than pre-ordinance private schools, with 95% CI [-12.02, -11.30], $p < .001$.
- Post-ordinance private schools scored on average 2.20 units lower than pre-ordinance private schools, with 95% CI [-2.62, -1.75], $p < .001$.

- Post-ordinance private schools scored on average 9.47 units higher than post-ordinance public schools, with 95% CI [9.11, 9.83], $p < .001$.

Since the samples were collected randomly from each population, independence could be assumed. The Kolmogorov-Smirnov test was applied to the residuals of the ANOVA to check for normality. The results indicated potential threats to the normality assumption ($D = 0.048$, $p < .001$), suggesting that the residuals were not normally distributed. Levene's test for homogeneity of variance indicated significant concerns with the equal variance assumption, $F(3, 64{,}076) = 852.55$, $p < .001$.

Research Question 5: Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales (National Examinations)?

Descriptive Statistics

The descriptive statistics summarizing mean mathematics scores by Regional Directorate and school type before and after ordinance implementation are shown in Table 12. Prior to the ordinance, mean scores for public schools varied between 57.95 and 60.92, whereas private schools had mean scores ranging from 57.41 to 72.04. Following the ordinance implementation, the mean scores for public schools decreased, ranging from 52.51 to 60.60. For private schools, the mean scores ranged from 55.92 to 70.66. The data suggest that, on average, private schools consistently outperformed public schools across all Regional Directorates, both before and after the ordinance was implemented.

Handling missing data

The researcher encountered missing data for private schools specifically in the Regional Directorates of Monte Cristi (Code 1300) and Bahoruco (Code 1800). For this reason, both regions were excluded from the Hierarchical Linear Model.

Table 12. Mean Mathematics Scores by Regional Directorate and School Type before and after Ordinance 01-2016 Implementation

Regional Directorate	Regional Code	School Type	Pre-ordinance Mean (SD)	Pre-ordinance Frequency (%)	Post-ordinance Mean (SD)	Post-ordinance Frequency (%)
Barahona	100	Public	61.43 (8.78)	426 (0.66%)	54.46 (11.51)	452 (0.71%)
		Private	71.54 (9.80)	52 (0.08%)	63.87 (12.49)	67 (0.1%)
San Juan de la Maguana	200	Public	57.96 (8.83)	681 (1.06%)	52.96 (11.59)	675 (1.05%)
		Private	72.04 (12.85)	116 (0.18%)	70.66 (9.98)	56 (0.09%)
Azua	300	Public	59.90 (8.94)	1,304 (2.03%)	54.77 (11.58)	1,482 (2.31%)
		Private	60.61 (10.02)	262 (0.41%)	58.14 (11.36)	183 (0.29%)
San Cristóbal	400	Public	60.35 (9.12)	1,345 (2.1%)	54.77 (12.26)	1,215 (1.9%)
		Private	59.96 (9.09)	85 (0.13%)	59.05 (12.05)	94 (0.15%)
San Pedro de Macorís	500	Public	60.91 (8.59)	1,567 (2.45%)	56.35 (11.99)	1,682 (2.62%)
		Private	66.66 (11.67)	536 (0.84%)	63.27 (13.42)	501 (0.78%)
La Vega	600	Public	62.20 (9.07)	1,896 (2.96%)	56.44 (11.67)	1,795 (2.8%)
		Private	68.25 (9.48)	346 (0.54%)	65.09 (12.78)	399 (0.62%)
San Francisco de Macorís	700	Public	59.86 (8.89)	1,336 (2.08%)	56.61 (12.22)	1,136 (1.77%)
		Private	62.69 (10.48)	244 (0.38%)	61.89 (13.16)	223 (0.35%)
Santiago	800	Public	60.72 (8.47)	1,730 (2.7%)	55.63 (11.84)	1,533 (2.39%)
		Private	69.15 (11.03)	782 (1.22%)	68.21 (12.73)	788 (1.23%)
Mao	900	Public	60.92 (8.92)	794 (1.24%)	58.02 (11.74)	697 (1.09%)
		Private	57.41 (7.62)	49 (0.08%)	55.92 (12.27)	24 (0.04%)
Santo Domingo II	1000	Public	59.65 (9.51)	3,821 (5.96%)	55.72 (11.84)	4,089 (6.38%)
		Private	64.64 (10.83)	1,943 (3.03%)	61.96 (12.54)	2,050 (3.2%)
Puerto Plata	1100	Public	60.02 (8.57)	939 (1.47%)	56.48 (11.63)	1,134 (1.77%)
		Private	67.88 (11.05)	338 (0.53%)	63.35 (13.33)	379 (0.59%)
Higüey	1200	Public	63.83 (8.97)	760 (1.19%)	60.6 (12.10)	1,086 (1.69%)
		Private	65 (10.90)	130 (0.2%)	68.94 (11.23)	159 (0.25%)
Monte Cristi	1300	Public	60.04 (8.52)	752 (1.17%)	54.74 (11.50)	687 (1.07%)
		Private	N/A	N/A	N/A	N/A
Nagua	1400	Public	59.47 (8.55)	945 (1.47%)	54.22 (11.50)	899 (1.4%)
		Private	60.48 (7.68)	70 (0.11%)	56.73 (11.48)	49 (0.08%)
Santo Domingo I	1500	Public	61.14 (9.63)	2,828 (4.41%)	57.82 (12.55)	2,815 (4.39%)
		Private	69.97 (12.13)	3,816 (5.96%)	68.06 (13.25)	3,617 (5.64%)
Cotuí	1600	Public	57.95 (8.19)	885 (1.38%)	53.77 (12.19)	811 (1.27%)
		Private	64.94 (9.07)	83 (0.13%)	62.68 (14.02)	79 (0.12%)
Monte Plata	1700	Public	60.17 (9.22)	740 (1.15%)	52.51 (11.88)	844 (1.32%)
		Private	71.11 (1.92)	3 (0%)	54.88 (11.28)	8 (0.01%)
Bahoruco	1800	Public	58.18 (7.64)	436 (0.68%)	52.96 (10.66)	332 (0.52%)
		Private	N/A	N/A	N/A	N/A

Hierarchical Linear Model

Hierarchical Linear Modeling (HLM) examined the relationships within and between different levels of grouped data, making it more effective at accounting for variance among variables at various levels (Woltman et al., 2012). To determine whether HLM was necessary, the researcher performed a one-way ANOVA to confirm that the variability of mathematics scores by Regional Directorate was significantly different from zero (Woltman et al., 2012). The random intercept-only model showed a statistically significant improvement over the intercept-only model, χ^2 (1) = 3049.26, $p < .0001$, indicating that the intercepts vary significantly across Regional Directorates. Additionally, the AIC/BIC values were lower for the random intercept-only model compared to the intercept-only model, suggesting a better model fit.

Adding the fixed effects of Ordinance implementation and school type significantly improved the overall fit of the model, SD = 1.63, with 95% CI: [59.13, 60.76], χ^2 (2) = 6202.42, $p < .0001$. Allowing school type to vary across Regional Directorates, while keeping the fixed effects of ordinance implementation and school type, further decreased the AIC/BIC values and significantly improved the model fit, with SD = 1.58, 95% CI: [59.18, 60.75], χ^2 (2) = 553.20, $p < .0001$. This result indicated significant variability in the effect of school type across Regional Directorates when controlling for ordinance implementation and school type. The slopes and intercepts were significant and negatively correlated, cor = -.23, with 95% CI: [-0.49, 0.07].

Regression coefficients, standard errors, degrees of freedom, test-statistics, and p-values are presented in Table 13. The two significant predictors of mathematics scores were post-ordinance t(62000) = -42.9, p < .0001, with 95% CI: [-4.00, -3.65] and private school, t(62000) = 5.79, p < .0001, with 95% CI: [4.02, 8.13].

Table 13. Regression Parameter Estimates

	Estimate	SE	DF	t-value	p-value
(Intercept)	60.00	0.40	62,000	150	< .0001
Post-ordinance	-3.83	0.09	62,000	-42.9	< .0001
Private School	6.07	1.05	62,000	5.79	< .0001

The assumptions of linearity, homoscedasticity, and independence of residuals were not a concern, as the plot of the standardized residuals against the predicted values did not show a clear pattern, as illustrated in Figure 7. However, the results indicated possible threats to the normality assumption (D = 0.021, p < .001), suggesting that the residuals were not normally distributed.

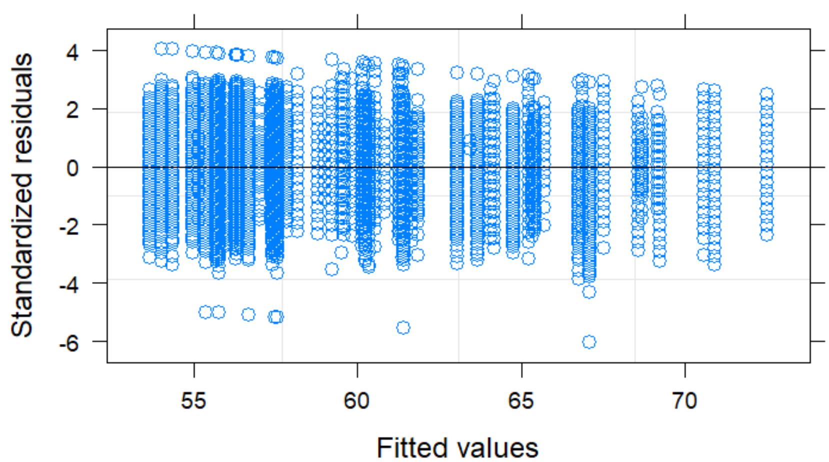

Figure 7. Plot of Standardized Residuals against Fitted Values

Summary

This study investigated the impact of Ordinance 01-2016, school type, and regional differences on mathematics scores in the Pruebas Nacionales (National Examinations). The aim was to determine whether the new competency-based curriculum in the Dominican Republic affected students' mathematical competency, as measured by the Pruebas Nacionales.

The first research question was: "Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales?" The analysis examined whether the mean mathematics scores differed significantly between pre-ordinance and post-ordinance implementation groups using an unpooled two-sample independent t-test. Despite indications from the Kolmogorov-Smirnov and Levene's tests suggesting potential concerns with normality and equal variance assumptions, the results showed that pre-ordinance mean scores were significantly higher than post-ordinance mean scores, with a small to medium effect size.

The second research question was "Is school type a significant predictor for mathematics performance on the Pruebas Nacionales?" Despite concerns about normality and equal variance assumptions from the Kolmogorov-Smirnov and Levene's tests, the results demonstrated a significant difference in mean scores. Private school students had significantly higher mean scores compared to public school students, with the difference being statistically significant and a large effect size.

The third research question was “Is region a significant predictor for mathematics performance on the Pruebas Nacionales?” The unpooled one-way ANOVA analysis revealed significant differences in mean mathematics scores across the 18 Regional Directorates. Despite potential threats to normality and equal variance assumptions suggested by the Kolmogorov-Smirnov test and Levene’s Test, the ANOVA results confirmed a statistically significant difference in mean scores among regions, with a large effect size. Post-hoc pairwise comparisons using the Bonferroni method identified numerous significant differences between specific regions.

Another unpooled one-way ANOVA analysis revealed significant differences in mean mathematics scores in public schools across the three macroregions (North, East, South). Although there were potential threats to normality and equal variance assumptions, the ANOVA results showed a statistically significant difference in scores among macroregions, with a small effect size. Post-hoc analyses using the Tukey HSD method showed that mean scores in public schools in the North region were 0.53 units lower than those in the East region, scores in the South region were 1.78 units lower than in the East region, and scores in the South region were 1.25 units lower than in the North region.

The fourth research question was “Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales?” Two-way ANOVA analysis demonstrated significant effects of both factors on mathematics scores. Private schools had significantly higher scores than public schools, with a medium effect size and high power. The implementation of the ordinance also had a significant impact, with a small to medium effect size and high power. The interaction effect between ordinance implementation and school type was significant, though with a small effect size. Post-hoc analyses using the Tukey HSD method revealed that pre-ordinance private schools scored 7.20 units higher than pre-ordinance public schools, and post-ordinance private schools scored 9.47 units higher than post-ordinance public schools. Additionally, pre-ordinance public schools scored 4.01 units higher than post-ordinance public schools, while pre-ordinance private schools scored 2.20 units higher than post-ordinance private schools.

The fifth research question was "Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales?" Hierarchical Linear Modeling (HLM) was deemed necessary due to significant variability in mathematics scores across Regional Directorates, as shown by a one-way ANOVA. The random intercept-only model significantly improved over the intercept-only model with lower AIC/BIC values. Including fixed effects for Ordinance implementation and school type further enhanced the model fit, and allowing school type to vary by region improved it even more. Key predictors were post-ordinance implementation and private school attendance. Assumptions of linearity, homoscedasticity, and independence were satisfied, though there were concerns regarding the normality of residuals.

CHAPTER V: SUMMARY

The purpose of this quantitative study was to determine the effect of the competency-based curriculum on students' mathematics performance in the Dominican Republic, as measured by the Pruebas Nacionales (National Examinations) after Ordinance 01-2016 implementation. The primary objective was to assess the impact of recent education policies in the Dominican Republic and to analyze how the results from pre-existing data, collected and provided by the Ministry of Education (MINERD), related to the existing literature on competency-based mathematics curricula and student performance on standardized assessments.

Recall the primary research question:

- How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?

This final chapter discusses the study's limitations and provides recommendations for future research possibilities to address the following research questions:

(R1): Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

(R2): Is school type a significant predictor for mathematics performance on the Pruebas Nacionales?

(R3): Is region a significant predictor for mathematics performance on the Pruebas Nacionales?

(R4): Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales?

(R5): Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales?

The Pruebas Nacionales were selected as the measuring instrument due to the availability of data, their mandatory nature, and their high-stakes implications for secondary students in the Dominican Republic. These exams serve as the gateway to university and are explicitly and implicitly considered valid and reliable measures of mathematical competency attainment by the Ministry of Education (MINERD). The target population for this study consisted of 17- to 18-year-old full-time students in the Academic track, attending both public and private schools across all Regional Directorates of the Dominican Republic.

Furthermore, this chapter will also analyze the findings within the context of the theoretical framework of the Dominican curriculum, namely Genetic Epistemology, the Sociocultural Theory of Cognitive Development, the Taxonomy of Cognitive Processes (revision of Bloom's), and Fullan's (2006) Educational Change Theory.

Interpretation of the Findings

In this section, each research question will be addressed with a discussion of both the descriptive and inferential statistics. Where applicable, the validity of the evidence, strengths and weaknesses of the results, and any potential sources of bias will be discussed (University Health Network, n.d.). Adequate power was not a concern due to the large sample sizes. However, the assumptions of normality and equal variances were uniformly violated.

Research Question 1: Is Ordinance 01-2016 a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

The descriptive statistics for mean mathematics scores in the Pruebas Nacionales before and after the implementation of Ordinance 01-2016 showed a decrease in mean performance post-implementation by 3.89 points. Both the pre-ordinance mean score (62.37, SD = 10.39) and the post-ordinance mean score (58.48, SD = 13.08) were out of 100 points. Given a passing grade cut-off point of 70%, neither the traditional nor the competency-based curriculum showed evidence of improvement in mathematics scores on average. The results of the unpooled two-sample independent t-test showed a significant difference in pre-ordinance and post-ordinance mean scores, indicating that, on average, scores were significantly higher before the ordinance than after, with a small to medium effect size.

The presentation grade carried the most weight (70%) in the final score determining whether a student passed on their first attempt (convocatoria). A student who did not perform well (less than 70% or less than 21 points out of 30) in the mathematics portion of the Pruebas Nacionales could still pass with ease on their first attempt. The presentation grade is typically dependent upon individual teacher criteria or, at most, the educational center criteria. Thus, a student with a sufficiently high presentation grade had little incentive to perform well in the Pruebas Nacionales. Considering this, the median mathematics presentation grade changed very little from the pre-ordinance group (Mdn = 82.86) to the post-ordinance group (Mdn = 85). Most students would have needed to obtain only about 38% on the mathematics Pruebas Nacionales to be promoted.

A further look into the data revealed that nearly 92% of the pre-ordinance sample and approximately 87% of the post-ordinance sample were promoted on their first attempt in the mathematics Pruebas Nacionales. This situation raises opportunities to investigate potential grade inflation in secondary mathematics in the Dominican Republic. However, it also raises concerns about the extent to which MINERD could utilize the results of the Pruebas Nacionales to evaluate the effectiveness of the competency-based curriculum or the education system as a whole (MINERD, 2023a).

Research Question 2: Is school type a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

The descriptive statistics showed that students in private schools had higher mean mathematics scores compared to their peers in public schools. Public schools had a mean score of 58.14 (SD = 10.89), while private schools had a mean score of 66.50 (SD = 12.57). These findings align with research suggesting that public schools are disadvantaged compared to private schools in standardized mathematics assessments (Arias, 2023; Cruz-Pichardo, 2021; Jakaitienė et al., 2021; Sakellariou, 2017). The results of the unpooled two-sample independent t-test showed that the difference in mean mathematics scores between public and private schools was statistically significant. On average, mathematics scores were significantly higher for students in private schools than for those in public schools, with a large effect size.

In the unprocessed dataset, there were three distinct categories representing school type: public, private, and semi-official (charter). The latter was excluded to facilitate comparisons between school types and tracks. There were over 16 unique track categories listed in the original dataset: Evening, Extended School Day, Saturday, Morning, Sunday, Afternoon, Morning-Afternoon, Morning-Afternoon-Evening, No Track, Morning-Evening, Morning-Saturday, Morning-Afternoon-Saturday, Morning, Complete or Full, and Semi-presential. The researcher focused only on Morning and Extended School Day tracks, both of which typically operate between 7:30 AM and 4:00 PM, to support the comparison between public and private schools. Many private schools typically operate within the bounds of an Extended School Day track. However, the exclusion of the large variety of tracks available mostly to public schools did not capture the nuances of track and resource availability that typically affect public schools (Hamm & Martínez, 2017).

Research Question 3: Is region a significant predictor for mathematics performance on the Pruebas Nacionales (National Examinations)?

The descriptive statistics showed considerable variation in mean mathematics scores across different Regional Directorates. Santo Domingo I had the highest mean mathematics score, followed by Higüey and Santiago. It is worth noting that both Santo Domingo and Santiago are the largest cities in the Dominican Republic, accounting for approximately half of the sample size. Most Regional Directorates had mean mathematics scores between 56 and 60 out of 100. Moreover, the unpooled one-way ANOVA results showed statistically significant differences in mathematics performance between regions, with a large effect size. Another unpooled one-way ANOVA revealed statistically significant differences in mathematics performance between macroregions, with a small effect size.

The post-hoc analysis using the Bonferroni method revealed that many Regional Directorates had significant differences with San Pedro de Macorís (Code 500) in the East region. This indicates that the mathematics performance of students in schools governed by this Regional Directorate was significantly different from those in other regions. Furthermore, Regional Directorates in the North region showed significant differences with many Regional Directorates in the South region and among themselves. For instance, several Regional Directorates in the North region had significant differences with La Vega (Code 600), San Francisco de Macorís (Code 700), Santiago (Code 800), Mao (Code 900), and Puerto Plata (Code 1100). Finally, there were significant differences among the Regional Directorates in the South with those in both the North and East macroregions.

The post-hoc analysis using the Tukey's Honestly Significant Difference (HSD) method also revealed that mean scores in public schools in the North region were significantly lower than those in the East region, and, in turn, mean scores in the South region were significantly lower than those in the East region. These results aligned with INAFOCAM (2014)'s mathematics teacher results. However, there was no practical difference, with less than a 2-point difference between each macroregion, in this study.

As introduced in Chapter III, the Regional Directorates were established by MINERD to decentralize the management of the educational system, representing the provinces they are named after. Therefore, the underlying causes for the significant differences in mean mathematics scores could be attributed to specific interventions or initiatives undertaken by each Regional Directorate.

Research Question 4: Are Ordinance 01-2016 and school type significant predictors for the mathematics performance on the Pruebas Nacionales (National Examinations)?

The descriptive statistics revealed that both public and private schools experienced a decline in mean mathematics scores after the ordinance was implemented. Specifically, public schools saw a decrease from 60.38% to 55.9%, while private schools declined from 67.58% to 65.39%. The two-way ANOVA results indicated significant main effects for both school type, with a medium effect size, and ordinance implementation, with a small to medium effect size. Additionally, there was a significant interaction effect with a small effect size. This indicated that the ordinance implementation had a differential impact on public versus private schools, with public schools showing a larger decrease in mean scores.

Post-hoc analysis using the Tukey HSD method revealed that, prior to the ordinance, private schools had significantly higher mean mathematics scores compared to public schools, with a mean difference of approximately 7 points. This indicated that private schools were outperforming public schools in mathematics. After the implementation of Ordinance 01-2016, this difference slightly increased; private schools continued to score higher on average compared to public schools, with the gap widening to approximately 10 points.

Both public and private schools experienced a decline in scores after the implementation of Ordinance 01-2016. The mean mathematics scores for public schools dropped significantly by approximately 5 points. Private schools also experienced a decline in mathematics scores post-ordinance, but the decrease was smaller compared to public schools. In private schools, the decrease was approximately 2 points, which, while statistically significant, was practically negligible.

Research Question 5: Are Ordinance 01-2016, school type, and region significant predictors for the mathematics performance on the Pruebas Nacionales (National Examinations)?

The descriptive statistics showed significant differences in mean mathematics scores, with private schools consistently outperforming public schools from all Regional Directorates both before and after the implementation of Ordinance 01-2016. Due to missing private school data in the Regional Directorates of Monte Cristi and Bahoruco, these regions were excluded from the analysis.

Hierarchical Linear Modeling (HLM) was used to examine the relationships within and between different levels of grouped data, accounting for variance among predictors at various levels. A one-way ANOVA confirmed significant differences in mathematics scores across Regional Directorates, consistent with the model used in Research Question 3. The random intercept-only model showed significant improvement over the intercept-only model. Adding the fixed effects of ordinance implementation and school type significantly enhanced the model fit, aligning with the model used in Research Question 4.

Allowing school type to vary across Regional Directorates while maintaining the fixed effects of ordinance implementation and school type also significantly improved the model fit. This suggested significant differences in the effect of school type across Regional Directorates while controlling for ordinance implementation and school type. Moreover, the slopes and intercepts were significantly and negatively correlated.

The regression analysis identified two significant predictors of mathematics scores: post-ordinance and private school enrollment. The assumptions of linearity, homoscedasticity, and independence of residuals were met.

This model aggregated the previous models and demonstrated that Ordinance 01-2016, school type, and region were significant predictors of student mathematics performance on the Pruebas Nacionales. Private schools consistently outperformed public schools, and the implementation of the ordinance coincided with a further decline in scores for both school types, with a more pronounced decrease observed in public schools. Despite the slight reduction in mathematics scores for private schools, they continued to maintain higher mean scores compared to public schools.

Connections to Existing Literature

The findings indicated that, on average, students performed better on the mathematics Pruebas Nacionales (National Examinations) before the ordinance was implemented than afterward. This aligned with Burkhardt and Schoenfeld (2018), who asserted that despite advances in formative and summative examinations, there was little evidence of a practical difference in the impact on student learning.

As noted in Chapter I, the Dominican Republic has consistently faced challenges with mathematics performance in both national and international assessments (Hamm & Veras Diaz, 2021; UNESCO, 1998, 2008). Notably, the country observed a decline in PISA scores in 2015 and 2018, with a minor improvement in 2022 (Diario Libre, 2019; EFE, 2023).

The mean scores for the mathematics Pruebas Nacionales between 2008 and 2022 remained around 54% for all test-takers (MINERD, n.d.-a). However, a slight improvement was observed, with the mean score increasing from 55.80% in 2016 to 56.63% in 2023, when considering all test-takers (MINERD, n.d.-b, n.d.-c). This trend suggested that the declining mean mathematics scores post-ordinance were consistent with the historical performance trends in the Dominican Republic.

The findings also aligned with the idea that the ordinance may have introduced factors adversely affecting students' performance on the mathematics Pruebas Nacionales. The remainder of this section will discuss the effects directly linked to the ordinance implementation, including teacher readiness during policy implementation, non-uniform curricular changes, and equity issues between public and private schools. Furthermore, the differential impact of COVID-19 disruptions will be examined.

Teacher Preparedness and Equity Gaps across School Types

The Ministry of Education (MINERD) recognized that successfully implementing the new curriculum required significant investment in teacher training and development (Hamm & Martínez, 2017). Supporting this, the national budget for teacher training was increased by 59% between 2012 and 2014 (Hamm & Martínez, 2017). It is worth noting that the international discourse surrounding competency-based mathematics curricula reported that deficient professional development and a lack of pedagogical resources led teachers to rely on traditional methods due to the absence of proper guidelines for implementing the new curriculum (Boesen et al., 2014; Niss et al., 2016).

For instance, in Sri Lanka, Egodawatte (2014) suggested that merely changing the curriculum to a competency-based model did not ensure teachers would adopt both the curriculum and its associated methods. Similarly, Ruiz et al. (2023) noted that the partial success of the competency-based curriculum in multiple countries was due to a lack of professional development. As a result, classrooms continued with traditional approaches even decades after the curriculum's introduction (Ruiz, 2023). Moreover, Boesen et al. (2014) showed that well-intentioned mathematics teachers in Sweden interpreted the competency-based reform in their own ways and believed their practices were already aligned with the new curriculum, thereby not making the necessary changes. In Portugal, the adoption of a competency-based curriculum was met with resistance, and concerns were raised about whether the curriculum and its evaluation through national examinations were used to shift the blame for student performance from government authorities to other educational stakeholders (Dias, 2021; Niss et al., 2016).

In contrast, while there was little evidence that Dominican mathematics teachers intentionally rejected the curricular reform, there were clear indications that teacher unpreparedness contributed to lower post-ordinance mathematics scores. Therefore, Cavani (2022) suggested that Dominican teachers should be trained simultaneously with secondary students. Nevertheless, despite numerous education policies, scholarships, and financial incentives, effective teacher training and development at all levels remained pervasive challenges in the Dominican Republic (Hamm & Martínez, 2017; Van Grieken, 2018).

Hamm and Martínez (2017) noted that public school candidates were required to complete university teaching programs at higher education institutions. This statement was supported by INAFOCAM's (2014) study, which reported that approximately 87% of surveyed teachers obtained a bachelor's degree related to mathematics, with nearly half of the 152 participants graduating from Universidad Autónoma de Santo Domingo (UASD). In the Dominican Republic, many higher education institutions have introduced new mathematics programs. Additionally, Cavani (2022) reported that the government has even recruited foreign professors to train future teachers. Hamm and Martínez (2017) emphasized that the quality of graduates would increase if these institutions aligned their teacher profiles with the new standards, as outlined in Table 15.5 on page 296 of their report.

Despite these initiatives, a 2014 study by the National Institute for Teacher Training and Professional Development (INAFOCAM) highlighted significant concerns regarding public school mathematics teachers' proficiency in the topics they were supposed to teach across all Regional Directorates (2014). Notably, teachers on average scored less than 40% in each thematic axis, which fundamentally corresponded to the axes assessed by the mathematics Pruebas Nacionales in Chapter III (INAFOCAM, 2014). Hamm and Martínez (2017) further identified several factors contributing to the low quality of competency-based teaching, including low entry standards for aspiring teachers. To address this, MINERD collaborated with the Asociación Dominicana de Profesores (ADP, Dominican Teacher's Union) to establish guidelines for evaluating teachers according to the current competency-based curriculum (Hamm & Martínez, 2017).

In public schools, candidates also had to pass a competitive examination (concurso de oposición), after which they were contracted for one year before they could meet the criteria for a long-term contract (Hamm & Martínez, 2017). Recently, however, the ADP severed its ties to the competitive examination due to multiple complaints, including a lack of transparency by MINERD in showing teachers' scores, denial of result revisions, and concerns about how the psychometric examinations had been calibrated (Sánchez, 2024). In contrast, private schools have much more flexibility in their hiring processes and might not require teacher certification nor adherence to the national curriculum (Hamm & Martínez, 2017). Ironically, holding socioeconomic factors constant, private school students consistently outperformed public school students despite not necessarily adhering to the competency-based curriculum, contrary to Arias' (2023) reports.

The finding that students in private schools significantly outperformed those in public schools, both overall and before and after ordinance implementation, aligned with Cruz-Pichardo (2021) and the study reported by Arias (2023). Cruz-Pichardo noted that the Dominican sample size for PISA 2015 and 2018 comprised approximately 80% public school students and 20% private school students, reflecting similar proportions to this study. Furthermore, Cruz-Pichardo (2021) observed that the overall mathematics performance of students attending private schools was higher on average than those attending public schools, with results showing a statistically significant difference.

Arias (2023) reported a study in the Dominican Republic using Pruebas Nacionales data to compare overall public and private school performance. Poor performance in public schools compared to private schools was attributed to reduced instructional time (Arias, 2023). To address this issue, the Dominican Republic enacted Ordinance 01-2014, which introduced the Extended School Day Program (Jornada Escolar Extendida) (MINERD, 2014). This program aimed to provide public school students with eight hours of daily instructional time to ensure closer adherence to the national curriculum, among other goals (MINERD, 2014). However, Hamm and Martínez (2017) reported that these objectives faced obstacles due to underfunding. The Extended School Day Program required substantial investments, leading to delays in constructing the necessary educational facilities to accommodate all public school students (Hamm & Martínez, 2017).

Although both types of schools experienced a decline in mean mathematics scores post-ordinance, the decline was significantly smaller in private schools compared to public schools. This disparity revealed that public schools were more adversely affected following ordinance implementation. These findings aligned with Nortvedt and Buchholtz's (2018) literature review on assessment in mathematics education, which viewed issues related to equity and policy as intertwined with assessment methodology. As discussed, many of the disadvantages public school students faced were systemic. Therefore, the achievement gaps between public and private school students may indicate inequity (Nortvedt & Buchholtz, 2018).

Regional Differences

The findings also suggested that the differences in mathematics scores across Regional Directorates were significant and partially consistent with INAFOCAM's (2014) study. Furthermore, mean scores differed significantly across macroregions (North, East, South). When grouping the Regional Directorates by the Dominican Republic's natural macroregions (North, South, East), INAFOCAM (2014) reported descriptive statistics showing severe deficiencies among secondary mathematics teachers across all mathematical thematic axes (see Chapter III) in all regions. The lowest overall mean scores in INAFOCAM's (2014) study were attributed to the South region. This was consistent with the findings of this study, where the South region also had the lowest mean scores for public school students.

However, despite INAFOCAM's (2014) study showing that teachers in the North region had the highest mean scores, the findings of this study indicated no practical difference between the East region and North region mean scores for public school students. Although there were statistically significant differences between all regions, the difference was less than 2 points overall. INAFOCAM's (2014) study was limited by a low teacher count per Regional Directorate (fewer than 15 respondents each), which may have resulted in low statistical power and thus limited generalizability. This limitation might have been a reason for the grouping by macroregions.

Additional Barriers to Ordinance Success

The findings were consistent with the shortcomings of education policy implementation highlighted by Viennet and Pont (2017), which included a lack of focus on implementation processes, failure to engage all stakeholders in the change, and overly complex education governance. Simply having the acceptance of a stakeholder – such as teachers –was not enough, as the absence of professional development could impede their ability to interpret and enact changes as envisioned by the policymakers (Boesen et al., 2014).

The ineffectiveness of Ordinance 01-2016 also aligned with a historical pattern of Dominican education policies, which had been criticized by scholars like García (2018) for having little impact on improving student performance. García (2018) noted that many ordinances and policies repeated and reintroduced similar objectives, making it even more difficult for researchers to identify the appropriate policies to consider. García (2018) demonstrated that several educational policies by MINERD had significant shortcomings, suggesting that this repetition and reintroduction of similar objectives could confuse stakeholders, including policymakers themselves. This topic was further explored in the context of Fullan's (2006) Educational Change Theory in the section "Implications for Theory and Research."

That mean mathematics scores were significantly higher before and after the ordinance could be attributed to several other factors, including the COVID-19 disruptions discussed in Chapter I. These disruptions directly postponed the implementation of Ordinance 02-2015, which introduced the mathematics competency-based curriculum, and subsequently delayed the pilot year for the new Pruebas Nacionales (National Examinations) design from the target year of 2020 to 2023. As a result, the researcher was left with a much less diverse post-ordinance group in terms of the years considered. This limitation could be addressed by collecting data in future years.

Hammerstein et al. (2021) highlighted that student learning was negatively impacted by international school closures due to COVID-19. The sudden shift to remote learning created an unprecedented dependence on family support for academics, and many inexperienced adults from all socioeconomic backgrounds could not meet the academic or pedagogical needs that children usually received at school (Arias, 2022b). Arias (2022b) reported that most teachers in a Dominican Republic survey felt that their students had learned less during the peak of the pandemic in 2020 compared to previous years. One of the main factors attributed to this learning decline was an equity issue: inadequate access to resources at students' homes and educational centers. This issue disproportionately affected socioeconomically disadvantaged students, who were largely enrolled in public schools (Arias, 2022b). Again, policy – albeit a different one, discussed in detail in "Assumptions, Limitations, and Scope" – was intertwined with equity, in alignment with Nortvedt and Buchholtz (2018).

Despite international hurdles in implementation, the importance of mathematical competency and the shift towards a student-centered, competency-based mathematics curriculum was widely acknowledged by numerous countries (Niss et al., 2016). This broad recognition was evident from the widespread acceptance by education authorities. Although definitions of mathematical competency varied across academic sources and countries, the international community consistently viewed their respective versions of mathematical competency as crucial for both national prosperity and individual success (MINERD, 2020a; Wu et al., 2021).

Implications for Theory and Research

Chapter I included descriptions of several theoretical frameworks supporting both the development of the current Dominican competency-based curriculum and the Pruebas Nacionales. These frameworks included Genetic Epistemology, the Sociocultural Theory of Cognitive Development, and the Taxonomy of Cognitive Processes (revision of Bloom's). Furthermore, in the context of education policy implementation, Fullan's (2006) Educational Change Theory was considered. The following sections will discuss how the results of this study align with each theoretical framework.

Curriculum and Design of its Evaluation Instrument

Piaget's (1971) Genetic Epistemology aimed to explain the nature of knowledge, focusing on human intellectual development and how children develop understanding through interactions with their environment. Piaget proposed four stages of cognitive development: sensory-motor (0–2 years), preoperational (2–7 years), concrete operational (7–11 years), and formal operational (11 and beyond), each marked by distinct mental structures (Singer & Revenson, 1996). In the formal operational stage, teenagers engage in more complex and abstract thinking, characterized by deductive reasoning and considering multiple approaches to a single problem (Singer & Revenson, 1996).

The mathematics Pruebas Nacionales assesses the six mathematical competencies described in Chapter II's "Description and Comparison of Competencies" and restructure them into three specific mathematical competencies: (1) Communication, Modeling, and

Representation, (2) Problem-solving, and (3) Reasoning and Argumentation. As shown in Table 5, the first competency is evidenced by identifying information contained within different representations and representing diverse situations in various formats (natural language, analytical, graphical, etc.). The second competency is evidenced by proposing strategies for problem-solving, applying strategies leading to problem resolution, and providing solutions to problems requiring the use of mathematical tools. The third competency is evidenced by assessing results obtained from solving a problem, justifying the use of procedures applied for solving problems in various contexts, and deriving conclusions from given information. All these competencies and their evidence align with what is expected from a teenager in the formal operational stage of Genetic Epistemology.

The stages of cognitive development occur in a fixed sequence and are unchangeable; however, development across different domains, such as mathematics, can occur at different stages, and the given ages for said development are not rigid (Singer & Revenson, 1996). Hence, there are non-traditional students who also take part in the Pruebas Nacionales each year. Their mathematics performance following ordinance implementation should also be studied (see "Limitations and Recommendations for Future Research").

The Dominican curriculum utilized Bloom's Taxonomy, revised by Anderson and Krathwohl (2001), to classify cognitive processes (MINERD, 2011). These cognitive processes are organized into three complexity levels, with the complexity of a test item determined by the time and effort required for the test-taker to reach a solution (MINERD, 2011). As discussed in Chapter I, test items are categorized into three levels. The first level primarily involves factual data and information recall, the second level focuses on understanding relationships among elements and constructing meanings, and the third level encompasses applying principles, problem-solving, and analyzing elements within a given context.

Both Piaget's Genetic Epistemology and Vygotsky's Sociocultural Theory of Cognitive Development emphasized the role of environmental and social interactions in shaping children's cognitive development. They learn cultural values, beliefs, and problem-solving skills from their surroundings and more knowledgeable individuals, inventing and reinventing themselves in the process (Mcleod, 2023; University of Wyoming, n.d.). Therefore, the new competency-based curriculum in the Dominican Republic prioritizes student-centered methods, aligning with Piaget's perspective that children develop knowledge and thinking skills through active participation and interaction with their environment and other individuals (MINERD, 2011). As shown in Table 5, three affirmations are evaluated in the mathematics Pruebas Nacionales based on diverse contextual scenarios: a student's ability to interpret information using mathematical language and describe the context, solve problems using mathematical tools in context, and assess situations for decision-making in context.

Finally, the fact that public and private schools had different mathematics scores reflected equity issues, with public schools being at a clear disadvantage both pre-ordinance and with an increased gap post-ordinance. This aligned with Piaget's (1971) proposal that environmental factors play a crucial role in children's intellectual development and academic performance.

Fullan's (2006) Educational Change Theory

Fullan's (2006) Educational Change Theory provided a framework for understanding change in educational settings through seven core premises: (1) focus on motivation, (2) capacity building with a focus on results, (3) learning in context, (4) changing context, (5) bias for reflective actions, (6) tri-level engagement, and (7) persistence and flexibility (Fullan, 2006). In this section, a discussion of how well the Ministry of Education (MINERD) addressed each premise of Ordinance 01-2016 is presented.

Fullan (2006) suggested that, first and foremost, an educational policy required the motivation of stakeholders. Ordinance 01-2016 resulted from a larger educational reform called the National Pact for Educational Reform in the Dominican Republic 2014–2030 (Pacto Nacional para la Reforma Educativa en la República Dominican), which aimed, among other things, to establish a comprehensive, systematic, and permanent evaluation culture in the educational system (MINERD, 2016a). According to Ordinance 01-2016, the Directorate of Quality Evaluation, within the framework of the educational Pact, consulted multiple educational stakeholders a year prior to the enactment of the ordinance. Based on their opinions, they developed a plan that incorporated suggestions and contributions from various sectors to update the evaluation of the competency-based curriculum and strengthen its use for improvement (MINERD, 2016a). Additionally, the ordinance mentioned that educational administrators and experts holding key positions within the Dominican educational system were consulted prior to its enactment. Arguably, gathering information on the opinions of multiple stakeholders was evidence of the focus on motivation purported by Fullan (2006).

Fullan (2006) conceived capacity building as "any strategy that increases the collective effectiveness of a group to raise the bar and close the gap of student learning" (p. 9). The essence of competency-based curricular reform was grounded in sociocultural constructivism, which emphasized the cultivation of specific competencies in children. A broader capacity-building example would be the subsequent enactment of Ordinance 22-2017, which established the process of validation for the new competency-based curriculum and its evaluation system, both for public and private schools (MINERD, 2017b). The curriculum design contained teaching and learning strategies, media and resources, and clear indications of how to evaluate learning, including more student-centered approaches such as four mandatory formative assessments to track students' attainment of subject-specific competencies (MINERD, 2017a). However, the researcher wondered how well this initiative was monitored closely at the school level.

Despite the implications for both public and private schools to implement a competency-based curriculum, the researcher's experience as an American-type private school teacher in the Dominican Republic gave the impression that private schools were generally given considerable instructional freedom to operate. Hamm and Martínez (2017) confirmed that private school teachers had more flexibility in hiring practices and often did not need teacher certifications. The study's findings showed that, on average, private schools outperformed public schools in the mathematics Pruebas Nacionales both before and after the ordinance. Therefore, it would be interesting to study how instructional methods in private schools were related to higher mathematics performance in the Pruebas Nacionales before and after the ordinance when controlling for socioeconomic factors.

A fourth premise suggested that for Ordinance 01-2016 to be effective, it had to possess the ability to alter the broader context (Fullan, 2006). Lateral capacity building, a method wherein stakeholders and organizations adopted the reform (Johnson, 2012), was partially observed by policymakers and educational administrators alike adopting and contributing to the reform. However, as discussed in "Connections to Existing Literature," the top-down decision met obstacles with insufficient mathematics teacher preparation, which likely hindered the implementation of the ordinance.

The fifth premise stated that reflective action resulted in a sense of ownership among stakeholders, yielding an increased commitment to the reform (Fullan, 2006; Johnson, 2012). In the sixth premise, Fullan (2006) advocated for "permeable connectivity," which referred to adopting strategies that encouraged mutual interaction between the school and community, the district, and state levels. Based on the findings, the effect of Ordinance 01-2016 was inconclusive, and an initial analysis indicated a negative effect rather than the desired one. As discussed previously, the fifth and sixth premises were areas of improvement for MINERD to focus on to effectively implement and evaluate the true effect of the new competency-based curriculum on mathematics student performance. This could explain why Fullan (2006) identified persistence and flexibility in staying the course as the seventh and final premise. Fullan (2006) acknowledged the complexity of the earlier premises and emphasized the importance of persistent efforts in implementation, advising against abandoning the initiative due to early obstacles, such as negative outcomes with insufficient data.

Limitations and Recommendations for Future Research

Due to the complexity and broad nature of the research questions, the researcher recognized the potential for more detailed future research by addressing some of the identified limitations of this study, as follows:

- Age restriction: The sample was limited to students aged 17-18 years, aligning with the formal operational stage in Piaget's Genetic Epistemology, discussed in the theoretical framework of this study. However, this excluded other test-takers, including students from age groups beyond teenagehood. Future studies could include students from all age groups, subdivided accordingly.

- School type, zone type, and shift**:** The study considered only public or private school students, excluding a third category present in the original dataset: semi-official or charter schools. Moreover, the original dataset included data from various types of zones: urban, marginal-urban, rural, rural-tourist, isolated-rural, urban-tourist, etc. The study was also limited to morning and Extended School Day shifts for a more effective comparison between public and private schools, since conventional private schools typically follow the morning shift. However, this excluded over 12 other shifts – mostly in effect in public schools – such as night, Saturday, Sunday, afternoon, and morning-afternoon shifts, to name a few.

  Pre-ordinance years had different naming conventions for shifts than post-ordinance years. For example, the researcher assumed that "matutino" and "matutina" referred to the same "morning" shift in Spanish. The researcher also assumed that Extended School Day shifts in public schools could be effectively compared to morning shifts in private schools. Future research could focus on comparing both between and within pre- and post-ordinance public and private schools, breaking them down by Regional Directorate, school shifts, and zones.

- Regional differences: This study did not explore regional differences in detail. Examining regional levels can be valuable, as Regional Directorates represent their communities in MINERD. While clustering the Regional Directorates into macroregions did not show overall practical differences between macroregions in public school mean mathematics scores, some Regional Directorates experienced sharp declines in mean scores of nearly 10 points. For instance, the Regional Directorate of Monte Plata (Code 1700) experienced the largest drop, with a nearly 8-point mean difference, with a sample size of 740 students pre-ordinance and 844 students post-ordinance. Monitoring private schools might be more difficult due to low statistical power in more rural areas such as Monte Plata. The second largest drop was in Barahona (Code 100), with a 7-point mean difference, and sample sizes of 426 students pre-ordinance and 452 students post-ordinance. Barahona private schools mirrored public schools in mean mathematics score decline. A preliminary unpooled one-way ANOVA showed statistically significant differences between mean mathematics scores in private schools in Barahona. A post hoc analysis revealed that two particular educational centers scored over 16 points higher on average than another educational center. The Regional Directorate of Barahona could explore the practices of the higher-performing private schools to identify successful strategies in secondary mathematics education.

- COVID-19 impact: The negative impact of COVID-19 on student mathematics performance has been well-documented, as discussed in Chapter I. However, quantifying the exact effect of COVID-19 disruptions on mathematics scores post-ordinance is challenging. One thing is certain: COVID-19 limited the availability of post-ordinance data. The researcher only had access to data from a single year, 2023, the pilot year of the new competency-based curriculum on the Pruebas Nacionales. Future research could collect more data as the new competency-based curriculum becomes more widely adopted and educational stakeholders become more accustomed to it.

- Mathematics Pruebas Nacionales scores: The mathematics scores in the Pruebas Nacionales were provided as an aggregate of all mathematical competencies, as discussed in Chapter II, without a breakdown of each individual competency. Multiple scholars have found important insights about how different mathematical competencies have been attained individually. For example, Büchele and Feudel (2023) observed overall deficiencies in the mathematical performance of first-year university students yet noted improvements in reasoning and the use of mathematical representations. Also, Cruz-Pichardo (2021) observed that Dominican students who participated in the PISA 2015 and 2018 mathematics assessments faced significant challenges with problems requiring problem-solving, formulation, and analytical skills. Analyzing mathematical competencies separately by categorizing test items could uncover insights about how well certain mathematical competencies are attained.

- One-time Standardized Measuring Instruments: Standardized assessments like the Pruebas Nacionales (National Examinations) and PISA have been criticized for their lack of nuance in capturing the learning progress of students (Valverde et al., 2020, as cited in Hamm & Veras Diaz, 2021). Instead, these scholars advocate for longitudinal tracking of students. Ordinances 02-2016 and 04-2023 introduced Evaluaciones Diagnósticas (Diagnostic Examinations) as formative assessments conducted prior to the high-stakes Pruebas Nacionales, allowing schools to identify areas of improvement in the four core subjects, including specific mathematical competencies. Morales Romero (2020) employed Evaluaciones Diagnósticas (Diagnostic Examinations) data to explore socioeconomic insights, concluding that students from higher socioeconomic status families and schools with leadership holding graduate-level degrees performed significantly higher. Tracking students from the Evaluaciones Diagnósticas and Pruebas Nacionales could provide a more nuanced view of academic progress.

- Dataset limitations**:** The dataset provided to the researcher primarily contained first attempt (convocatoria) data. The reasons a student might not reach a first attempt are fundamentally determined by an insufficient presentation grade or absences, the latter of which the researcher excluded from this study. An insufficient grade can be attributed to various factors beyond a student's actual mathematical performance. Future research could focus on how different hierarchical levels might predict mathematics presentation grades, contributing to the extensive body of research concerning the consistency of grade assignments at the school level.

A non-exhaustive list of limitations and future research recommendations was provided. The study had limitations in its design, such as focusing on students aged 17-18 years, excluding other age groups, and only including public and private school students, leaving out charter schools. The processed data was limited to morning and Extended School Day shifts, excluding over 12 other shifts primarily in public schools and zone types. Regional differences were not explored in detail, but a demonstration of how they might be clustered naturally was provided to ease future comparisons. The impact of COVID-19 limited the availability of post-ordinance data to a single year (2023), making it challenging to quantify its exact effect on mathematics scores. Also, the Pruebas Nacionales mathematics scores were provided as an aggregate without a breakdown of each competency. Standardized assessments like the Pruebas Nacionales and PISA have been criticized for their lack of nuance, prompting scholars to advocate for longitudinal tracking to capture students' learning progress more accurately. Finally, future research could explore the relationship between presentation grades and different hierarchical levels, and how these factors might correlate with Pruebas Nacionales attempts (convocatorias) and ultimately mathematics performance.

Future researchers interested in investigating the effects of education policy should narrow the scope of their research questions. While the broadness of this study allowed for discussion based on the results obtained, it hindered the researcher, leaving a desire for more detailed expansions in each area discovered. Academic research is often not straightforward, especially when dealing with interdisciplinary subjects such as education policy implementation. As the study progressed, new insights and confounding factors were discovered. However, practical reasons and time constraints did not allow for deeper exploration of each subject, leaving these for future research to expand upon.

Conclusion

Between 2011 and 2017, the Dominican Republic implemented significant reforms in its academic structure and curriculum, particularly impacting secondary mathematics education. These reforms introduced a competency-based approach, shifting traditional teaching methods to more student-centered ones. The Ministry of Education (MINERD) dedicated substantial efforts to redefine what it means to master mathematics, identify specific mathematical competencies, and highlight their importance in society. The reforms also involved the engagement of various stakeholders and the development of new approaches to learning evaluation. This included the creation of diagnostic (formative) examinations and the updating of national (summative) examinations to align with the new competency-based curricular guidelines.

The Pruebas Nacionales (National Examinations) are standardized national exams developed by the Ministry of Education of the Dominican Republic (MINERD). Administered annually to students in their final year of secondary school, these mandatory exams contribute 30% of the final grade required for certificate attainment. The remaining 70% is based on the presentation grade assigned by the student’s educational center. To obtain a certificate of completion for the Pruebas Nacionales, a student must achieve a minimum overall score of 70%. These exams assess specific competencies in core subjects such as Spanish language arts, mathematics, social sciences, and natural sciences.

Obtaining a certificate of passing is a prerequisite for college admission in the Dominican Republic.

The creation of the Evaluaciones Diagnósticas (Diagnostic Examinations) and the updates to the Pruebas Nacionales (National Examinations) were initially and directly influenced by the enactment of Ordinance 01-2016. However, the researcher found that education policies rarely act in isolation. Thus, while the study focuses on the effect of Ordinance 01-2016, it also considers the impact of other closely related ordinances, such as Ordinance 02-2016 (MINERD, 2016a), Ordinance 22-2017 (MINERD, 2017b), and Ordinance 04-2023 (MINERD, 2023b). In fact, it was not until the academic year 2022-2023 that the design of the Pruebas Nacionales was tangibly modified (MINERD, 2023a). This realization ultimately served as the basis for distinguishing between the control group (pre-ordinance) and the treatment group (post-ordinance).

With these considerations in mind, the study primarily focused on evaluating student mathematics performance using pre-existing data from the mathematics Pruebas Nacionales (National Examinations). The objective was to assess the practical and statistical significance of Ordinance 01-2016 (and its successors), school type (public versus private), and region (classified both by the 18 Regional Directorates as defined by MINERD and by natural macroregions: North, East, and South) as significant predictors of student mathematics performance in the Dominican Republic. The analyses revealed statistically significant differences in mathematics scores across all predictors and selected combinations of predictors.

The study found that, on average, the pre-ordinance group (students enrolled in 2017, 2018, 2019, and 2022) performed better in the mathematics Pruebas Nacionales than the post-ordinance group (2023). Furthermore, it was observed that private schools generally outperformed public schools. These findings are consistent with those reported by Arias (2023), which indicated that students in public schools performed worse than their private school counterparts across all Pruebas Nacionales, primarily due to less adherence to the curriculum.

However, both Hamm and Martínez (2017) and the researcher's own experience as a secondary mathematics teacher suggest that strict adherence to the curriculum alone does not fully explain the superior outcomes in private schools. Private schools' hiring practices often do not require teaching certifications or competitive examinations – unlike public schools – and some international schools do not follow the Dominican competency-based curriculum for mathematics. These findings further align with Cruz-Pichardo's (2021) study on PISA 2015 and 2018 mathematics performance.

The findings of this study also align with the report by Hamm and Martínez (2017) on the struggles of Dominican schools to enhance educational outcomes. These challenges are attributed to a significant loss of instructional time, poorer infrastructure, and insufficient mathematics teacher preparation, particularly at the secondary level (Cavani, 2022; Hamm & Martínez, 2017; INAFOCAM, 2014). It is important to note that the INAFOCAM (2014) study focused on public school teachers from all Regional Directorates and macroregions.

When considering school type and ordinance, private schools had higher pre-ordinance and post-ordinance mean mathematics scores than public schools. The researcher observed that public school students exhibited a sharper decline in post-ordinance mean mathematics scores compared to their private school peers. This suggests a potential equity gap in mathematics assessments that is intertwined with education policy, indicating a systemic issue (Nortvedt & Buchholtz, 2018).

There were also significant differences in mean mathematics scores across the 18 Regional Directorates. Inspired by the teacher preparedness study conducted by INAFOCAM in 2014, the researcher categorized each Regional Directorate into three natural macroregions: North, East, and South (2014). Although there were statistically significant differences in mean mathematics scores among all macroregions, with the East region having the greatest overall advantage and the South being the most disadvantaged, the researcher concluded that there was no practical difference between the macroregions, partially aligning with INAFOCAM's (2014) results.

Finally, a Hierarchical Linear Model aggregated the previous models and demonstrated that Ordinance 01-2016, school type, and Regional Directorate were significant predictors of student mathematics performance on the Pruebas Nacionales. Allowing school types to vary across Regional Directorates, it was observed that private schools consistently outperformed public schools, and the implementation of the ordinance coincided with a further decline in scores for both school types.

Implications for Practice

The primary implication of the findings is the need to approach the improvement of mathematical competency in the Dominican Republic as an interplay between mathematics assessment, education policy, and equity issues, as suggested by Nortvedt and Buchholtz (2018). They claimed that despite a plethora of studies focusing on mathematics assessment development or implementation, other aspects were often ignored (Nortvedt & Buchholtz, 2018). The series of ineffective education policies reported by García (2018) and the reintroduction of similar initiatives over many decades indicate that despite efforts to change how students are assessed (competency-based curriculum), the education policies that allow it to occur (Ordinances 01-2016, 02-2016, 22-2017, and 04-2023), and equity issues (clear public versus private school differences in outcomes), the Ministry of Education (MINERD) should consider the connection between these elements rather than treating them as individual steps or issues to address separately (Nortvedt & Buchholtz, 2018).

Thus, the findings of this study showed that the answer to the original research question, "How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?" cannot be derived solely from the mathematics data provided by the Pruebas Nacionales (National Examinations). The experience of conducting this research aligns with Nortvedt and Buchholtz's (2018) belief that "the strong relationship between teaching, learning, and assessment and between methodology, equity, and policy are challenging to disentangle without oversimplifying" (p. 567).

On Assessment

In 2011, MINERD published a Theoretical and Conceptual Framework of National Examinations, outlining the theories, principles, and concepts guiding the design, implementation, and evaluation of the Pruebas Nacionales. According to MINERD (2011), one of the main objectives of the mathematics Pruebas Nacionales is to assess the quality of learning achievements in mathematical competencies obtained by students.

Authors such as Burkhardt and Schoenfeld (2018) have discussed that despite significant strides to implement more student-centered standardized assessment formats, such as formative and summative assessments, there is little evidence of a practically different impact on learning. Other authors have challenged the extent to which standardized assessments capture the development of mathematical competencies (Pettersen & Braeken, 2019). Moreover, Büchele and Feudel (2023) caution that skewed results can occur if the measuring instrument is not carefully designed to evaluate each mathematical competency equitably. Table 5 appears to address these issues, but access to the more detailed dataset containing individual test item scores would resolve this conundrum (see "On Data Access" section).

Furthermore, evidence-based policy results have often been oversimplified to support different stakeholder narratives, resulting in biased analyses of policy success (Nortvedt & Buchholtz, 2018). Nortvedt and Buchholtz caution against stakeholders' overreliance on correlating overall results and rankings, assuming rank as an indicator of quality education. The Pruebas Nacionales could be affected by skewed results or bias, so the information it provides should be used primarily to "identify possible insights or shortcomings in mathematics education," as proposed by Nortvedt and Buchholtz (2018), rather than to make potentially harmful comparisons, such as those between school districts within a Regional Directorate. Additionally, the Pruebas Nacionales has been the subject of at least one cheating controversy involving a district-level technician who released the answers to some exams. Students were also discovered using cellphone text messages to answer test items, which are prohibited during the test session (Hoy, 2009). The researcher also recalls similar rumors of cheating occurring during their own high school years.

It is also important to note that even though the study's findings were statistically significant, their practical significance was not as pronounced. As discussed in a previous section, the Pruebas Nacionales only account for 30% of the final grade needed for promotion into higher education. This means that students with higher presentation grades are not incentivized to perform well on the Pruebas Nacionales. This realization directly conflicts with Fullan's (2006) first premise: that improvement cannot occur without the motivation of stakeholders. One way to mitigate this potential shortcoming is to incentivize students for high performance on the Pruebas Nacionales through scholarships provided by both government authorities and higher education institutions, as well as recognition awards.

On formative assessments, the recommendations include continuing to schedule them at regular intervals throughout the academic year. Results from formative assessments should be used to create individualized learning plans for students, widely known as differentiated learning. Although MINERD has already standardized formative assessments through the Evaluaciones Diagnósticas (Diagnostic Examinations), another recommendation would be to explore the development of a formative test similar to the NWEA MAP Growth. This test, widely used in local and international private schools with American-type curricula, measures the mathematical competency growth of test takers. Furthermore, it is adaptive and can track longitudinal measures of student growth, allowing stakeholders to make more nuanced data-driven decisions, as proposed by Valverde et al. (2020, as cited by Hamm & Veras Diaz, 2021).

Finally, summative assessments like the Pruebas Nacionales should reflect the goals and competencies outlined in the competency-based curriculum. Questions should be designed to require students to apply, analyze, synthesize, and evaluate information (i.e., higher-order thinking). Given the many infrastructural issues reported primarily in public schools, ensuring that summative assessments are consistent and fair across different schools and regions means making sure testing centers (typically schools themselves) have appropriate testing conditions. Of course, grading criteria and procedures should remain standardized to maintain equity in the evaluation process.

On Policy

In the Educational Change Theory framework, Fullan (2006) described seven core premises for understanding changes in educational systems. In the sections titled "Implications for Theory and Research" and "Connections to Existing Literature," the researcher noted that lateral capacity building – wherein stakeholders at all levels adopt and facilitate the implementation of the policy – was only partially achieved. One of the most prevalent reasons for this shortcoming was insufficient teacher preparation from multiple angles.

While many universities in the Dominican Republic have developed programs to address teacher unpreparedness, pervasive issues with teachers' mathematical content knowledge have been noted by studies such as Cavani (2022) and INAFOCAM (2014). Although teacher standards aligned with the new competency-based curriculum have been updated (Hamm & Martínez, 2017), these studies suggest that MINERD should collaborate more closely with universities and teacher training institutions to develop specialized programs that better prepare future teachers.

For instance, most participants in INAFOCAM's (2014) study came from Universidad Autónoma de Santo Domingo (UASD), a leading public university with a history of underfunding, overcrowded classrooms, ongoing protests, and poor infrastructure at both the main campus and satellite campuses (Bonilla, 2018; Noticias SIN, 2024). Since these factors have been identified as affecting academic performance in public schools (Hamm & Martínez, 2017), it is reasonable to believe they might also affect the learning quality of teachers, who, as learners themselves, are students. Hence, MINERD should collaborate more closely with both UASD and the Ministry of Higher Education, Science, and Technology (MESCyT) to develop improved secondary mathematics teacher preparation programs.

Both public and private schools could establish mentorship programs where seasoned mathematics teachers help less experienced teachers, addressing the issue of low entry standards. Although it might seem easier to simply not allow entry for teachers who do not meet every standard, especially in public schools, the Dominican Republic has pervasive issues with teacher shortages (Arias, 2022b). These shortages have been attributed to delayed MINERD appointments (Arias, 2022b; Féliz, 2021) following the competitive exams (concurso de oposición) and protests by the Asociación Dominicana de Profesores (ADP, National Teacher's Union) (Diario Libre, 2024). Some of the demands by the ADP will be briefly discussed in the next section. Thus, the solution goes beyond simply blaming teachers' content knowledge deficiency or lack of teaching experience. It is also an equity issue, as the teachers' union largely represents public school teachers, who are thus more disadvantaged.

Although private schools, on average, did not experience as much negative impact, their mean scores are still below the 70% passing grade. Many private school teachers do not require teaching certifications, which could affect student mathematics performance. Therefore, private schools should invest in continuous certification programs for mathematics teachers as part of their professional development efforts. As many private schools, including those where the researcher has taught, move towards more student-centered approaches, they could implement ongoing professional development workshops focusing on competency-based teaching strategies. Furthermore, private school leadership should utilize feedback from teachers and students alike, along with data from formative assessments, to make continuous improvements.

To improve lateral capacity building, reflective action, and permeable connectivity – the fourth, fifth, and sixth premises of Fullan's (2006) Educational Change Theory, respectively – MINERD can expand its policy feedback mechanisms. Policy feedback currently appears to occur primarily before implementation, but the researcher stresses the need for MINERD to enhance feedback mechanisms that allow teachers, students, and parents to provide input on the current state of policy implementation. MINERD should make necessary adjustments by leveraging the Regional Directorates and the specific districts they oversee while making data-driven adjustments that are locally oriented. This implies regional support programs through targeted interventions, such as using data to identify Regional Directorates and schools with greater deficiencies in mathematics outcomes and allocating resources as needed.

On Equity

MINERD (2011) notes that one of the main objectives of the Pruebas Nacionales is to measure the equity of the education system. The findings show that public school students consistently underperform compared to their private school peers, both before and after the ordinance. As discussed previously, the new competency-based curriculum is largely aimed at public schools, since private schools have more flexibility in their curricula. Yet, the early effects of the ordinance indicate no evidence of improvement in mean mathematics scores in public schools. Moreover, the difference in mean scores between pre-ordinance and post-ordinance groups is larger for public school students compared to their private school peers, who barely experienced any practical difference in mean scores.

Although MINERD aims to improve conditions for all students, a significant emphasis is on enhancing conditions for public schools and their students, given that they are state-funded. For instance, the effects of insufficient instructional time, poor or nonexistent infrastructure, and other socioeconomic factors on the mathematics performance of many public school students cannot be ignored. Hence, the first recommendation to address equity issues is naturally to increase funding for public schools.

As mentioned before, financial incentives alone were not sufficient to attract qualified teachers for recruitment. Furthermore, deficient infrastructure, inadequate teacher development programs, and low salaries are part of the protest agenda of the Asociación Dominicana de Profesores (ADP, Dominican Teacher's Union) (Fernández, 2024). Interestingly, a report by Diario Libre (2024) showed the Federation of Association of Fathers, Mothers, Guardians, and Friends of the School (FEDAPMAE) protesting the ADP disruptions. Protests like these evidence stakeholder clashes at the teacher and parent levels, with little involvement from other stakeholders who have more authoritative power to fix the underlying equity issues that have persisted over the years. Again, this emphasizes that to improve mathematics performance in the Dominican Republic, the interplay between education policy and equity cannot be ignored.

Since a mathematics competency-based curriculum emphasizes a shift to student-centered approaches, MINERD should continue to foster the implementation of student-centered activities such as project-based learning and formative assessments, ensuring that teachers are continuously updated on best practices. Furthermore, MINERD should continue developing more student support programs to provide academic assistance to struggling students through tutoring, mentoring, and after-school programs. With the enactment of Ordinance 04-2023, many of these responsibilities still largely fall on teachers, which could affect the quality of the extra academic support (MINERD, 2023b). Finally, and especially in public schools, it is crucial to ensure that all students have access to the technology, electricity, and reliable internet required to support modern educational practices.

On Data Access

Efforts to demonstrate data-driven transparency have been increasing in various ministries, including the Ministry of Education. MINERD's efforts have largely been through carefully crafted dashboards (MINERD, n.d.-a; MINERD, n.d.-b; MINERD, n.d.-c). While the dashboards are useful for certain research questions, they have limited applications, especially for more in-depth analyses beyond descriptive statistics according to preset parameters.

The existence of a MINERD website titled "Estadísticas de Pruebas Nacionales (National Examinations)" (Pruebas Nacionales Statistics) suggests an intention to release raw data. However, the researcher observed that the website has remained empty since they first opened it last year and continues to be so as of July 2024 (MINERD, n.d.-g). Furthermore, although the Portal Nacional de Datos Abiertos de la República Dominicana (National Open Data Portal) was created to provide interested stakeholders with raw data generated using state funds, the Education section is currently lacking in content. For instance, it did not contain the data pertaining to this study as of July 2024 (Portal Nacional de Datos Abiertos de la República Dominicana, n.d.).

The findings of this research imply that it is possible to obtain the necessary educational raw datasets, but not without experiencing bureaucratic hurdles. An initial approach to obtain the data resulted in a well-intentioned MINERD representative directing the researcher to publicly available dashboards, but without access to raw data (see

Appendix B). It was only after several attempts that a representative from the Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) graciously provided the datasets that would ultimately be processed to form part of the statistical basis of this study (see Appendix C). The researcher argues that this process could be avoided entirely by providing links to all relevant raw datasets, with anonymous student information and perhaps even private educational center names. Doing so aligns with the Pruebas Nacionales' objective of being more accountable to society and sharing that accountability with involved stakeholders. Of course, the researcher recognizes that some raw data cannot be made public due to national security reasons.

Moreover, if every ministry in the Dominican Republic adopted this approach, it would not only increase transparency but also provide growing numbers of Dominican data analysts and data scientists with opportunities to uncover insights using advanced data analysis techniques. The Ministry of Economy, Planning, and Development (MEPyD)'s building will host a local Big Data event in August 2024, in which the researcher intends to participate for the first time (BigDataDO, n.d.). The website for this event suggests that previous challenges have involved general COVID-19 or happiness datasets. Whether the usage of that data is general or intended to uncover some insight specific to the Dominican Republic is unclear. However, one thing is certain: it is crucial now more than ever to leverage the creativity of up-and-coming data analysts and data scientists with datasets that are relevant to them.

Furthermore, the Ministry of Education should incentivize independent education researchers to produce quality quantitative studies using pre-existing administrative data, as it is cost-effective (Neilson & Taveras, 2015) and has already been collected and sorted by the reputable Dominican Institute for Evaluation and Research on Educational Quality (IDEICE). Plainly put, the National Open Data Portal is a fantastic initiative, but the website clearly needs an update, at least in the "Education" section.

This sentiment stems from the researcher's experience teaching mathematics at both secondary and university levels and recognizing the potential pedagogic value of releasing pre-existing administrative data for students, which is arguably relevant since it is student data. Given that statistics (which encompasses data analysis in the curriculum) were identified as subjects with significant teacher deficiencies in INAFOCAM's (2014) teacher study, having access to relevant data for project-based learning could enrich students' learning experiences. This approach aligns with competency-based methods and supports Fullan's (2006) Educational Change Theory premises such as "capacity building," "learning in context," "changing context," and "a bias for reflective action."

Indeed, the significance of this study was to answer Neilson and Taveras's (2015) call to use pre-existing administrative data to determine whether a certain education policy was implemented effectively and whether it had a differential impact across school types and geographical location. The original dataset provided to the researcher contained at least 29 variables, some categorical (e.g., Regional Directorates) and some quantitative (e.g., mathematics scores, mathematics presentation grades). There are numerous ways that the extensive Pruebas Nacionales data could be processed and analyzed to gain insights that official data analysts might inadvertently miss due to the specificity of some questions or simply the natural diversity of human curiosity (see "Limitations and Recommendations for Future Research"). This data-driven approach could help fill the research gap in mathematics education mentioned by González and Villegas (2016) and Neilson and Taveras (2015) without the bureaucratic hurdles to obtain the correct datasets. Finally, it would increase accountability among stakeholders by promoting greater transparency.

Closing note

The seventh premise of Fullan's (2006) Educational Change Theory is "persistence and flexibility in staying the course." Fullan (2006) acknowledged the complex challenges associated with the other premises, advocating for persistence in the face of obstacles such as stakeholder resistance and early seemingly negative results. Internationally, many countries have adopted competency-based mathematics curricula, transforming the teaching and learning of mathematics from traditional teacher-centered methods to student-centered ones.

Research supports the idea that students learn best using student-centered approaches; therefore, it is crucial for MINERD to continue implementing these methodologies to improve student mathematics outcomes in the Dominican Republic. This study was designed to offer a multifactorial perspective on the research question: "How did the competency-based curriculum, school type, and regional location impact student mathematical performance in the Dominican Republic?" This approach also aimed to highlight the need for all stakeholders to be cautious about results and to recognize the complexity of addressing historically deficient student mathematics performance, especially at the secondary level.

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Appendix A: Explanation of Variables

Data Collection Explanation of Variables as provided by the Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad)

Variables	Explanation of Variables
REGIONAL_NOMBRE	Regional Directorate
REGIONAL_CODIGO	Regional Code
DISTRITO_NOMBRE	District Name
DISTRITO_CODIGO	District Code
SECTOR	School Type
ZONA	Zone Type
PERIODO	Period
CONVOCATORIA	Attempt
TANDA	Shift
CODIGO_CENTRO	Educational Center Code
NOMBRE_CENTRO	Educational Center
CODIGO_RNE	Student RNE (Identification Number)
ID_ESTUDIANTE	Student ID
EDAD	Student's Age
SEXO	Student's Gender
GRADO	Grade
MODALIDAD	Academic Track Code
nombre_modalidad	Academic Track
ESPECIALIDAD	Specialty Code
nombre_especialidad	Specialty
SECCION	Section to which a Student belongs
pres_Esp	Presentation Grade in Spanish Language Arts
resp_esp	Spanish Language Arts Exam Score
fina_esp	Final Grade in Spanish
pres_Mat	Presentation Grade in Mathematics
resp_mat	Mathematics Exam Score
fina_mat	Final Grade in Mathematics
pres_Soc	Presentation Grade in Social Sciences
resp_soc	Social Sciences Exam Score
fina_soc	Final Grade in Social Sciences
pres_Nat	Presentation Grade in Natural Sciences
resp_nat	Natural Sciences Exam Score
fina_nat	Final Grade in Natural Sciences
Condicion	Condition of Student

Appendix B: Dataset Request I

Dataset request to the Ministry of Education (MINERD) and Initial Response

GOBIERNO DE LA
REPÚBLICA DOMINICANA

EDUCACIÓN

Santo Domingo, D.N.
23 de octubre de 2023

OAI-R-1046-2023

Señor(a)
Natsu Then Shimazaki
Sus Manos. -

Distinguido:

Cortésmente, sirva la presente para saludarle y a la vez dar cumplimiento a la Ley General de Libre Acceso a la Información Pública No. 200-04, en atención a la solicitud de información que nos suscribiera, de referencia No. **SAIP-SIP-000-86700** recibida en fecha **28 de septiembre de 2023** relativa a:

. formación sobre la población (Estudiantil Dominicana) con variable como: 1-Tipo de escuela (publica/privada).
2-Puntuacion en las pruebas Nacionales (Matemática).
3-La región Geográfica de las escuelas de todas las regiones.
4-Algun resultado base de años anteriores (resultados diagnósticos o pruebas nacionales de 8vo pos al 2016 y después del cambio de modalidad de 6to grado).

En ese sentido y en respuesta a su requerimiento, sírvase encontrar anexa la comunicación d/f **23/10/2023**, suscrita por el **Sr. Jhannia Rodriguez**, Analista Técnica de Planificación, en respuesta a su requerimiento.

Sin nada más sobre el particular y en la mejor disposición de continuar sirviéndole, le saluda,

Atentamente,

Sra. Yoanny María Muñoz Frías
Directora de la Oficina de Libre
Acceso a la Información Pública

YM/nb

MINISTERIO DE EDUCACION
Oficina de Acceso a la Información
Santo Domingo, R.D.

Av. Máximo Gómez No. 2, D.N, Rep. Dom **Tel 809- 688-9700. www.ministeriodeeducacion.gob.do**

Jhannia Claudette Rodriguez Rodriguez

De:	Jhannia Claudette Rodriguez Rodriguez
Enviado el:	lunes, 23 de octubre de 2023 8:54 a. m.
Para:	Anunciada Garcia
CC:	Kathia Josefina Fortunato Nunez
Asunto:	Respuesta OAI 1975-2023

Buenos Días!!

En atención a la solicitud núm. OAI-1975-2023 recibida en fecha 18/10/2023, adjunto el link del portal, están todas las informaciones que pide el documento

https://siie.minerd.gob.do/tableros-de-informacion

¡Por favor confirmar recibido!

Appendix C: Dataset Request II

Email Exchange with Directorate of Evaluation of Quality (Dirección de Evaluación de la Calidad) Representatives

RV: Solicitud de datos estadísticos

Eddy Manuel Reyes Reyes

To:Natsumi Then Shimazaki
Cc:Yanile Altagracia Valenzuela Calderon;Leris Mercedes Neris Guzman;Elizabeth Rincon Santana;Freysy Vicente D´Oleo

Thu 10/12/2023 11:07 AM

CAUTION: This email originated from outside of the organization. Do not click links or open attachments unless you recognize the sender and know the content is safe. Do not provide your username or password.

Saludos cordiales:

Le estamos enviando las bases de datos de pruebas nacionales desde los años 2010-2019 y 2022, así como la correspondiente al 2023, mediante enlaces mostrados a continuación:

Pruebas Nacionales 2010-2019 y 2022
[REDACTED LINK]

Pruebas Nacionales 2023
[REDACTED LINK]

Quedamos atentos.

Eddy Reyes
Analista de datos estadísticos, DEC

De: Leris Mercedes Neris Guzman <leris.neris@minerd.gob.do>
Enviado el: jueves, 12 de octubre de 2023 12:26 p. m.
Para: Eddy Manuel Reyes Reyes <eddy.reyes@minerd.gob.do>; Freysy Vicente D´Oleo <freysy.vicente@minerd.gob.do>
Asunto: RV: Solicitud de datos estadísticos

De: Yanile Altagracia Valenzuela Calderon <yanile.valenzuela@minerd.gob.do>
Enviado: lunes, 2 de octubre de 2023 9:39 a. m.
Para: Natsumi Then Shimazaki <thenshimazakin@mymail.shawnee.edu>
Cc: Leris Mercedes Neris Guzman <leris.neris@minerd.gob.do>; Freysy Vicente D´Oleo <freysy.vicente@minerd.gob.do>; Eddy Manuel Reyes Reyes <eddy.reyes@minerd.gob.do>
Asunto: RE: Solicitud de datos estadísticos

Buen día estimada Natsumi,

Estaremos enviándole las bases de datos de pruebas nacionales antes del 2016 y después del 2016, solo que no identificamos a los estudiantes por privacidad.
Algo personal, tengo curiosidad de ¿cómo medirá el impacto de una ordenanza?

Estoy copiando a la encargada de Estadística y parte de su equipo para que le den respuesta.

Cualquier inquietud quedamos atentos,

Yanile

De: Natsumi Then Shimazaki <thenshimazakin@mymail.shawnee.edu>
Enviado el: domingo, 1 de octubre de 2023 5:51 p. m.
Para: Yanile Altagracia Valenzuela Calderon <yanile.valenzuela@minerd.gob.do>
Asunto: Solicitud de datos estadísticos

Buenos días Directora,

Espero este correo la encuentre bien.

Mi nombre es Natsu Then Shimazaki y soy estudiante de Maestría en Ciencias en Matemáticas en Shawnee State University. Actualmente resido en Punta Cana y laboro como instructora de secundaria de matemáticas en Cap Cana Heritage School. También, pertenezco a la Escuela de Matemáticas de la Universidad Autónoma de Santo Domingo como Profesor Ayudante.

Le escribo porque estoy llevando a cabo una investigación para mi Maestría sobre cómo la Ordenanza 2-2016 referente a la evaluación de estudiantes en la República Dominicana ha impactado el rendimiento estudiantil, medido a través de las Pruebas Nacionales en Matemáticas.

Para llevar a cabo mi estudio, necesito acceso a ciertos datos específicos que estimo estarían disponibles a través del MINERD. Estos datos incluirían información sobre la población (estudiantes dominicanos) con variables como:

(1) Tipo de escuela (pública/privada)
(2) Puntuaciones en las Pruebas Nacionales (Matemáticas)
(3) Región (geográfica o las 18 oficinas regionales establecidas)
(4) Algún resultado base de años anteriores (resultado de diagnósticos o pruebas nacionales de 8vo pre-2016, etc.)
(5) Sugerencias de variables que usted considere apropiadas para un estudio con el enfoque dado

Años: antes de 2016 y después del 2016, todos los años que estén a su alcance.

Cantidad de datos por año (estudiantes): la mayor cantidad posible para lograr un estudio más preciso y riguroso

Debo hacer hincapié en que los datos que necesito para mi análisis tienen que corresponder a estudiantes dominicanos (no es necesaria su identificación). Dígase, no puede ser una nota promedio de centro educativo, regional, o nacional, como está actualmente publicamente disponible en la página del MINERD.

Agradecería mucho si pudiera proporcionarme acceso a estos datos o, si no está directamente en su alcance, si pudiera orientarme o ponerme en contacto con la persona adecuada que pueda facilitar esta información. Estoy dispuesta a desplazarme hasta Santo Domingo si fuera necesario para llevar a cabo esta investigación de manera eficiente.

Le agradezco de antemano su consideración y colaboración en este proyecto. Espero con interés su respuesta.

Atentamente,

Natsu Then Shimazaki
B.S. Mathematics
Correos electrónicos: thenshimazakin@mymail.shawnee.edu | natsushimazaki@pm.me
Teléfono: 809 258 3549

Appendix D: IRB Exempt Review

Institutional Review Board (IRB) Exempt Review

RE: IRB Inquiry

Brian Richards(2) <brichards2@shawnee.edu>
Tue 10/24/2023 1:53 PM
To:Natsumi Then Shimazaki <thenshimazakin@mymail.shawnee.edu>
Cc:Douglas Darbro <ddarbro@shawnee.edu>

Hi Natsumi,

Thanks for reaching out and being so conscientious! I was looking around for a low-jargon website that explained exceptions to the IRB review requirements, and found a good explainer on the University of Rhode Island website.

"If the project does not include any interaction or intervention with human subjects or include any access to identifiable private information, then the project does not require IRB review. If even one of the above categories are met (intervention, intervention [sic], access to identifiable private information), an IRB application is required."

Notably, interaction would involve even anonymous online surveys. However, as I understand it, you are essentially getting archived data, so you did not interact with any of the participants.

Here is the URI website: https://web.uri.edu/research-admin/office-of-research-integrity/human-subjects-protections/does-my-research-need-irb-review/#:~:text=If%20the%20project%20does%20not%20include%20any%20interaction%20or%20intervention,does%20not%20require%20IRB%20review.

This site explains these issues so well (except for the micro typo in the above quote , lol) that it might be worth **forwarding** to rest of your classmates.

Thank you for doing your research at SSU!

Best, Brian

From: Natsumi Then Shimazaki <thenshimazakin@mymail.shawnee.edu>
Sent: Monday, October 23, 2023 6:13 PM
To: Brian Richards(2) <brichards2@shawnee.edu>
Cc: Douglas Darbro <ddarbro@shawnee.edu>
Subject: IRB Inquiry

Hello Dr. Richards,

My name is Natsu Then Shimazaki and I was one of the attendees in yesterday's meeting about IRB led by Dr. Darbro for the Applied Research course reuqired in the M.S. Mathematics. Thank you for the useful information you provided last night.

I wanted to confirm that the type of data I currently have access to does not require IRB approval. My data constitutes data that is
"Publically available data does not include data received from a school district/organization unless the data is available to anyone who requests access. "

In fact, I just happened to receive an official document (in Spanish, but I can translate, if needed) that stresses exactly the fact that access to this data is compliant with Ley General de Libre Acceso a la Información Pública No. 200-24 (akin to the US Freedom of Information Act). Admittedly, I got more thorough and specific data (still properly de-identified) than the one they are suggesting I got, but I will have to inquire with them if that was not some special treatment given to me or something.

Either way, please let me know if this is sufficient or do I still need to go through an Exempt Review just to be safe?

Thank you,

Natsu Then Shimazaki

Appendix E: Map of the Regional Directorates

Map of the Regional Directorates and their Regional Locations

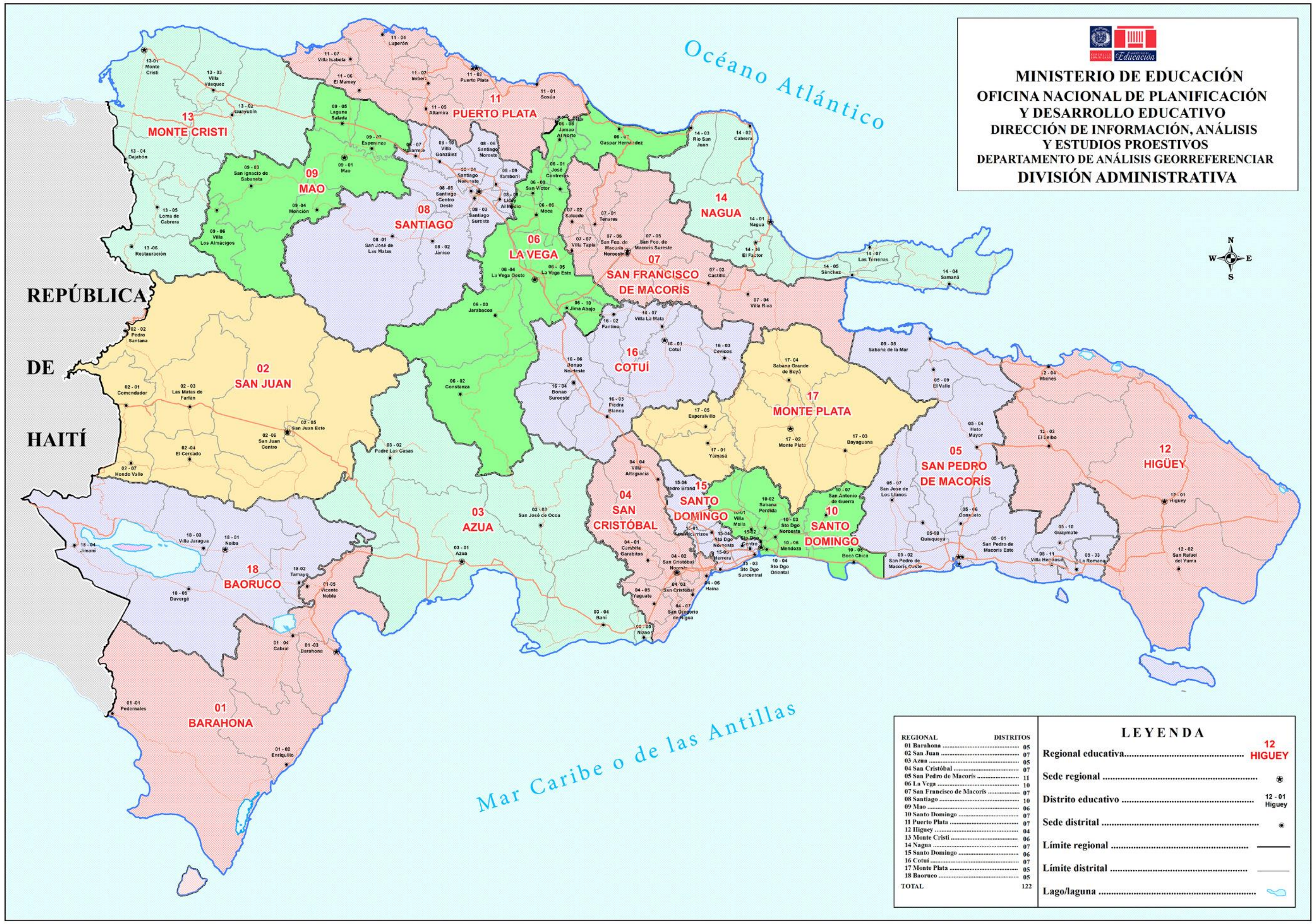

Figure 8. Administrative Division of the Dominican Republic. Reprinted from MINERD, n.d.-f.

Appendix F: Bonferroni Post Hoc Results

Bonferroni Post Hoc Results from Research Question 4

Table 14. Significant Pairwise Comparisons between Regions (Bonferroni Adjustment)

Regional Code 1	Regional Code 2	p-value
500	200	< .001
500	300	< .001
500	400	< .001
600	100	< .01
600	200	< .001
600	300	< .001
600	400	< .001
700	200	< .001
700	300	< .001
700	400	< .05
700	500	< .01
700	600	< .001
800	100	< .001
800	200	< .001
800	300	< .001
800	400	< .001
800	500	< .001
800	600	< .01
800	700	< .001
900	200	< .001
900	300	< .001
900	400	< .01
900	800	< .001
1000	200	< .001
1000	300	< .001
1000	400	< .001
1000	600	< .001
1000	800	< .001
1100	200	< .001
1100	300	< .001
1100	400	< .001
1100	800	< .001
1200	100	< .001

1200	200	< .001
1200	300	< .001
1200	400	< .001
1200	500	< .001
1200	600	< .001
1200	700	< .001
1200	900	< .001
1200	1000	< .001
1200	1100	< .001
1300	500	< .001
1300	600	< .001
1300	700	< .05
1300	800	< .001
1300	900	< .001
1300	1000	< .001
1300	1100	< .001
1300	1200	< .001
1400	100	< .01
1400	500	< .001
1400	600	< .001
1400	700	< .001
1400	800	< .001
1400	900	< .001
1400	1000	< .001
1400	1100	< .001
1400	1200	< .001
1500	100	< .001
1500	200	< .001
1500	300	< .001
1500	400	< .001
1500	500	< .001
1500	600	< .001
1500	700	< .001
1500	800	< .001
1500	900	< .001
1500	1000	< .001
1500	1100	< .001
1500	1200	< .001
1500	1300	< .001

1500	1400	< .001
1600	100	< .001
1600	500	< .001
1600	600	< .001
1600	700	< .001
1600	800	< .001
1600	900	< .001
1600	1000	< .001
1600	1100	< .001
1600	1200	< .001
1600	1500	< .001
1700	100	< .001
1700	300	< .05
1700	400	< .001
1700	500	< .001
1700	600	< .001
1700	700	< .001
1700	800	< .001
1700	900	< .001
1700	1000	< .001
1700	1100	< .001
1700	1200	< .001
1700	1500	< .001
1800	100	< .001
1800	400	< .05
1800	500	< .001
1800	600	< .001
1800	700	< .001
1800	800	< .001
1800	900	< .001
1800	1000	< .001
1800	1100	< .001
1800	1200	< .001
1800	1500	< .001

BIBLIOGRAPHY[4]

Natsumi Estefanía Then Shimazaki

Candidate for the Degree of

Master of Science Mathematics

Thesis: HOW DID THE COMPETENCY-BASED CURRICULUM, SCHOOL TYPE, AND REGIONAL LOCATION IMPACT STUDENT MATHEMATICAL PERFORMANCE IN THE DOMINICAN REPUBLIC?

Major Field: Mathematics

Education: Bachelor of Science in Mathematics

Completed the requirements for the Master of Science in Mathematics, Portsmouth, Ohio in July 2024.

ADVISER'S APPROVAL: Dr. Douglas Darbro

7/29/2024