ABSTRACT

DANKS, AMANDA ELIZABETH. Impact of a Digitally Focused Districtwide Turnaround Model: Lessons From a North Carolina District. (Under the Direction of Dr. Stephen Porter).

North Carolina provides a unique context in which to study the effect of a digitally focused district turnaround model given the historical state support for school connectivity through statewide infrastructure investments. Rowan-Salisbury is a rural district in western North Carolina that independently implemented a one-to-one student-to-device turnaround model in the 2014-15 school year, in concert with a variety of other policy components, all aimed at improving student outcomes. New leadership took note of the historical underperforming student outcomes and seized the opportunity to implement a swift districtwide turnaround model. Qualitative data are used to describe the turnaround model and informs this quantitative case study. This study uses a difference-in-differences model to understand how Rowan student and teacher outcomes compare to a group of schools that are similar to the treated sample on observable characteristics. Most outcomes are rendered inconclusive due to a lack of parallel trends between Rowan and the weighted comparison group in the pretreatment period. Statistically significant negative effects are observed on teachers' perception of *Professional Development* when comparing pretreatment to posttreatment; however, those effects become null when analyzing each posttreatment year. All other outcomes that exhibit parallel trends are associated with null effects in the posttreatment period. The limitations described, and potential future research offered here can help contextualize these findings and point to new research opportunities.

Impact of a Digitally Focused Districtwide Turnaround Model: Lessons From a North Carolina District

by
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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Educational Leadership, Policy, and Human Development

Raleigh, North Carolina

2021

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DEDICATION

This dissertation is dedicated to my family and friends who supported, encouraged, and celebrated with me throughout this process. My parents instilled in me a love of learning and reminded me throughout all my schooling endeavors that learning never ends. My husband, the greatest partner anyone could ask for, cheered me on every minute and encouraged me to celebrate every milestone. My children always reminded me to take care of myself and brought coffee and water as I spent countless hours at the computer. I am grateful for their support, encouragement, and motivational artwork. Completing a dissertation during a pandemic brought additional challenges but being able to work on this alongside my children as they completed their schoolwork was a blessing in disguise.

BIOGRAPHY

Amanda came to education through an alternative teaching certification program in Baltimore City, Maryland. Her teaching experience included supporting students with high incidence disabilities, and her administrative experience focused on students with significant cognitive disabilities. While working at a separate public day school, Amanda was recruited to testify for the U.S. Senate Committee on Health, Education, Labor, and Pension about the legislation of appropriate assessments for students with significant cognitive disabilities. After a decade of work with students in west Baltimore, she transitioned to a state-level position at the North Carolina Department of Public Instruction. There, she managed the policies and guidance for students with disabilities and English learners in the statewide assessment program while attending the North Carolina State University in pursuit of a PhD in Educational Evaluation and Policy Analysis. After transitioning to a full-time student, Amanda was the project director for a study of implementation and resource allocation for the North Carolina Digital Learning Initiative in five key North Carolina districts. Amanda currently works as a researcher at the American Institutes for Research, where she focuses on economic evaluations of educational and social policies and programs. Her economic evaluation work spans from early childhood to high school and postsecondary programs at local, state, and federal levels of policy implementation.

ACKNOWLEDGMENTS

I appreciate the discussion, feedback, and time of my committee throughout this process. The opportunity to take classes at the University of North Carolina while a student at North Carolina State University provided a wealth of perspectives to apply to this dissertation and my future research. Dr. Angela Caldwell, from the University of Pittsburgh, gave me tremendous encouragement throughout the doctoral program, and I look forward to an opportunity for our research to intersect. Above all else, I want to acknowledge the incredible support, patience, and mentorship I received from Dr. Brooks Bowden and Dr. Steve Porter.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

The use of digital tools and instructional methods are increasingly the response to a need for enhanced and personalized educational experiences for students. Integrating digital learning into educational programming is often seen as imperative to preparing students for the array of postsecondary options available. Initiatives that provide every student and teacher with a digital device are rolling out across the country to meet the evolving needs of students and teachers. In the context of the coronavirus disease 2019 (COVID-19) pandemic, digital learning takes on a whole new meaning. What used to be an option for some districts or students has now possibly become a fixture for students' short- and potentially long-term educational experiences. It is essential for decision makers and practitioners to understand the impact of digital learning policies on student outcomes and teacher satisfaction.

Digital learning is thought to be an important educational component in preparing students to enter our dynamic global economy. Digital tools allow teachers to analyze student performance in new and more fine-grained ways, and students have access to a wider array of content and experiences. Digital teaching and learning are often seen as a pathway to enhanced student engagement, parent involvement, and increased access to a broader base of resources (Bando et al., 2017; Banerjee et al., 2007; Bergman & Sams, 2012; Best & Dunlap, 2012). However, much of the literature focuses on the impact of a single program or application on student performance, and the impacts of a systemwide digital learning policy are scarce in the literature (Fago et al., 2013; Hull & Duch, 2019). More research is needed on the impact of system-level implementation of a digitally focused policy.

Empirical evidence is needed to guide decision making at all levels of educational governance regarding the implementation of digital learning policies and programs. However, evidence of the impact of districtwide one-to-one digital learning polices on student achievement is scarce in the literature (Bailey et al., 2018). Schools, districts, and states are investing in digital learning in a variety of ways without solid evidence of impact or an understanding of the necessary policy components. Evidence is needed to support decision makers in determining how to incorporate devices into their existing educational structures and what types of outcomes they can expect to shift.

Understanding the impacts of educational programming and policy investments on student outcomes is important to avoid the scattering of scarce resources. Large-scale digital learning polices are implemented with great intentions and enthusiasm, yet strong evidence about the effectiveness of policy implementation is lacking in the literature (Milligan & Griffin, 2016; Vigdor et al., 2014). Without a full understanding of the impact of a digitally focused districtwide turnaround, such as the turnaround implemented in the Rowan-Salisbury Public School District (hereafter referred to as Rowan) in western North Carolina, it is difficult to determine how best to allocate resources to improve student outcomes and teacher satisfaction. Work to precisely estimate those impacts will support decision makers in determining the most efficient use of resources with similar policies aimed at improving student and teacher outcomes.

Several districts across the country have embraced one-to-one digital learning policies aimed at improving student achievement and teacher satisfaction. One such district is Rowan, which implemented a paradigm shift regarding the use of digital tools for teaching and learning using district-based innovation. The district’s exceptional implementation of a digitally focused turnaround provides a critical opportunity to analyze the impacts that a districtwide one-to-one digital learning program has on student and teacher outcomes.

Purpose

The North Carolina context provides an opportunity for researchers to focus on the impact of systematic digital learning initiatives with the essential infrastructure and supports already in place. However, there are few evaluations of the impact of digital learning on student outcomes within the North Carolina context (Hull & Duch, 2019). Given the enormity of investments North Carolina has made and continues to make in digital learning infrastructure, support, training, and devices, it is essential that decision makers understand the impact on student performance. Furthermore, other districts and states considering similar digital learning policies will benefit from understanding how students were impacted by a digitally focused district turnaround model within the North Carolina context.

The evaluation of educational policies supports informed decision making about future investments and programmatic choices. Broad policy changes must be rigorously evaluated using evidence to ensure the intended purposes were achieved and inform future policy adjustments. The digitally focused turnaround model in Rowan included a combination of sweeping changes. The swift timeline and districtwide role out of the Rowan model provides a unique opportunity to study the impact of such a policy This work aims to exploit this natural experiment to estimate the effect on student and teacher outcomes by answering the following questions:

1. What was the overall effect of the Rowan digitally focused districtwide turnaround on student achievement and teacher satisfaction?
2. What was the effect of the Rowan digitally focused districtwide turnaround on student achievement and teacher satisfaction in each posttreatment year?

This dissertation contributes to the literature by leveraging qualitative data to first understand the digitally focused turnaround model and its intended goals from the district perspective. The on-the-ground implementation of a turnaround model is an important piece to understand when planning a rigorous evaluation of the policy's effectiveness. As the literature will show, research must move beyond evaluating the mere presence of digital tools in the classroom and progress toward evaluating the digital policy as a unit. An in-depth understanding of the districtwide turnaround in Rowan supports a thoughtful quantitative evaluation of the policy. The quantitative analysis in this work estimates the impacts of a districtwide one-to-one digital learning policy implemented within the greater North Carolina context. Specifically, this work estimates the overall effect of the district policy implementation and the observed impact in each of the posttreatment years. This study contributes to the literature by analyzing how a districtwide digital initiative impacts student and teacher outcomes.

This introduction chapter provides an overview of the methods and outcomes of this study, and Chapter 2, Policy, includes a comprehensive description of the digitally focused districtwide turnaround model in Rowan. In addition, the policy chapter includes an overview of digital learning in North Carolina and, more specifically, Rowan's interactions with the state context after the turnaround model was implemented. The rich legislative and policy history of digital learning in the broader North Carolina context is also fully described in the policy chapter. Extant literature (Chapter 3, Literature Review) is used to understand what other researchers previously studied related to district turnaround models and digitally enhanced instruction. The data and methods employed in this work are briefly described in this introduction chapter and are then more fully described in Chapter 4, Methods. Chapter 5, Results, describes the estimated treatment effects on student and teacher outcomes, and Chapter 6, Discussion, applies findings to the current context, identifies limitations, and suggests future research. The whole of this work is intended to highlight the importance of estimating the impacts of districtwide turnaround models, particularly those models with a digital focus.

Background

North Carolina made significant investments in digital learning to enhance statewide connectivity infrastructure, provide devices for students and teachers, and train staff to use technologically enhanced instruction (An Act Directing the State Board of Education to Develop and Implement Digital Teaching and Learning Standards for Teachers and School Administrators, 2013; North Carolina House Bill 44, 2013; 2016 Appropriations Act, 2016). The state conceptualizes digital learning as a tool to increase personalized learning and improve postsecondary preparation (Elementary and Secondary Education Act of 1965, as amended by the Every Student Succeeds Act Consolidated State Plan, North Carolina 2018). Policies and legislation support and encourage the adoption of digital learning programs across the state; however, the state affords each district the autonomy to determine its own digital learning pathway. As a result, districts use a variety of models to implement digital programs for their students and teachers. For example, some districts had a digital learning focus prior to the state's legislation and policies that encouraged digitally enhanced instruction. Those districts used the state's support to enhance their digital learning environments and become nationally recognized models. Other districts opt to use very little technology in teaching and learning and prefer more traditional methods. The effects on student and teacher outcomes associated with individual district decisions offer an important opportunity to understand digital learning at the level at which most programmatic decisions are made. Districtwide decisions require district-level impact evidence to make informed choices about future policy implementation.

North Carolina investments and state educational policies set unique conditions for digital learning. Whereas districts in other states may have to build connectivity networks from scratch, all districts in North Carolina have access to high-speed broadband. In addition, the state supports district-level innovation by providing training, grants, and supports for districts interested in implementing digital learning practices. By removing many of the potential obstacles experienced by districts attempting to effectively implement digital learning, the context in North Carolina provides a unique opportunity to study the impact of district-level digital turnaround policies.

Rowan welcomed several new district-level administrators in the 2013–14 school year. The administrative team began with an analysis of existing data to understand the needs of the districts. They observed that Rowan students were not performing as well as Mooresville, a nearby wealthy district. The leadership team explored opportunities and curricular options that supported their mission of improving students' educational experiences and teacher satisfaction. One opportunity that struck a chord with the team was a visit to Apple headquarters (in the spring of 2014), where they learned firsthand about the opportunities and possibilities available when digital learning is integrated into everyday instruction. The team immediately began questioning how they could bring high-quality digital learning experiences to all the students in the Rowan district and what other policy and operational changes they could make to move the needle on student achievement.

As the cornerstone of their turnaround model, the district leadership in Rowan decided to fast track the adoption of a one-to-one digital learning program across the district. Leadership worked with support staff and technology advocates in the district to make a plan that included student devices, professional development, and continuous improvement. After a summer of focused preparation, the 2014–15 school year opened with devices for every student, digitally enhanced instructional methods, and specialized training in digital learning for teachers and administrators. The comprehensive turnaround model was fully implemented at the start of the

2014-15 school year. Although other North Carolina districts have a one-to-one student-to-device ratio, the expedited timeline and equal implementation across all schools in the district is what sets Rowan apart. This swift implementation draws a clear line between Rowan's educational program with and without the turnaround policy, thus creating a unique quasi-experimental opportunity to study the impact of such a policy.

Methods

It is important that policy shifts are rigorously evaluated to understand the impacts of social investments on student outcomes. Although a randomized controlled trial is considered the "gold standard" when evaluating interventions, opportunities for employing a randomized controlled trial are not always possible in educational settings. This is especially true with district turnaround models, such as the model implemented in Rowan. The changes in Rowan were enacted swiftly and uniformly across the district to address local needs and goals, leaving no opportunity for prospective evaluation or randomized design. The inherent nature of a responsive district turnaround model is that there is no true counterfactual. There is no identical district where the turnaround model was *not* implemented that could be used to compare outcomes. However, this dissertation uses a case study approach to understand the policy and a difference-in-differences quasi-experimental methodology to estimate the treatment effect of Rowan's turnaround policy.

Data. Qualitative data for this dissertation were derived from extant data collection and research about Rowan's digital learning model (Bowden & Danks, 2020). Interview and site visit data reveal nuanced information about turnaround policy development and implementation. The qualitative data for this work informs the comprehensive description of the turnaround policy itself and helps contextualize the findings. This dissertation leverages publicly available data for quantitative analyses. The North Carolina Department of Public Instruction (NCDPI) publishes yearly reports that include student outcomes, along with student and teacher characteristics. Biannually, the NCDPI conducts a survey of school staff to understand teacher perceptions. Additional public data from the Public School Forum and the Common Core of Data are used to account for school and district characteristics in the analytical models. The following paragraphs briefly describe the quantitative data for sample identification, outcome variables, and covariates.

Sample**.** The sample for this study includes traditional public schools in North Carolina. The treatment group is all schools in the Rowan system. The comparison group for this work is created by first eliminating all nonrural schools to establish a set of schools that are similar to Rowan in locale, according to the Common Core of Data. Next, inverse propensity score weighting is used to limit the comparison sample to a set of schools that is similar to Rowan on observable school and district characteristics. The remaining comparison schools are then weighted in the analytical models to estimate the average treatment effect on the treated schools.

Dependent Variables**.** This study leverages publicly available data to estimate the overall effect of the turnaround model and the effect in each posttreatment year. Both teachers and students have measurable outcomes that may have been impacted by the implementation of the districtwide turnaround model. This study uses student performance on the North Carolina End-of-Grade (EOG) Tests in Grades 5 and 8 as measures of student achievement. In those grades, North Carolina gives summative assessments (the results of which are publicly reported at the school level) in English language arts (ELA) and reading and science.[1] For high school achievement, the ACT™ school-level composite score is used to represent the effect of the

[1] End-of-Grade math assessments are not used in this work due to a lack of required publicly available data to transform raw scores from one edition of the assessment (used in 2010 through 2012) to the edition used in 2013 through at least 2021.

turnaround on high school students. Teacher perceptions in North Carolina are measured by the biannual North Carolina Teacher Working Conditions Survey (TWCS). The anonymous electronic survey asks teachers and school staff about a variety of factors that impact their job satisfaction and overall effectiveness. Given the components of Rowan's districtwide turnaround, this study includes only certain questions from the five TWCS domains as outcomes: Facilities and Resources, Community Support and Involvement, Teacher Leadership, School Leadership, and Professional Development. Analyses included here estimate the treatment effect on each of these individual domains and across all these relevant domains.

***Covariates*.** School-level characteristics, including both student and teacher information, are publicly reported by the NCDPI. This study uses this information to account for changes over time and student and teacher composition. Student characteristics include race, gender, economically disadvantaged status, academically and intellectually gifted status, English learner status, and disability status. The state reports the numbers of students tested in each subgroup, as well as the total number of students tested. The subgroup numbers were divided by the total to calculate the percentage of students in each subgroup that compose the whole school population. These student-level covariates were used to estimate the treatment effects for both students and teachers. The NCDPI also publicly reports data about teacher qualifications and years of experience. Teacher experience, advanced degree status, turnover rate at the school level, and with school size are also accounted for in the analyses of student and teacher outcomes.

Estimation. The first model in this study calculates the naïve estimate of the treatment effect on student (Grades 5 and 8 EOG assessments, ACT) and teacher (satisfaction on the TWCS) outcomes. School fixed effects are included to control for school-level characteristics that are constant over time but vary between districts. Year fixed effects are also included to control for things that vary year to year but have a constant effect over all units. Indicator variables for each year are also included. The treatment variable, which represents being a Rowan school in the treatment period, is the coefficient of interest in this first model, because it estimates the overall average treatment effect of Rowan's districtwide turnaround. The second model adds school-level student and teacher characteristics as covariates to control for school-level compositional changes and the treatment variable remains the coefficient of interest.

The third model in this work analyzes the leads and lags of student and teacher outcomes. Using an indicator variable for each year before the treatment period, I examine the existence of parallel trends. The inclusion of indicator variables for each treatment year isolates the effect of the turnaround model in *each* posttreatment year. The more granular information is important for potential policy adopters to understand what can be expected after implementation.

Results

Overall, this work shows that the Rowan turnaround model is associated with statistically inconclusive results for the selected student and teacher outcomes due to a lack of pretreatment parallel trends with the weighted comparison group. The following sections explain, in more detail, the effects of the Rowan model.

Student Outcomes. Models with and without covariates are inconclusive for Grades 5 and 8 due to a lack of parallel trends. Parallel trends do exist for the ACT; however, models with and without covariates that examine the overall observed differences, as well as the model that examines year-by-year changes, show null effect on school-level ACT scores.

Teacher Outcomes. The model that analyzes the overall effect with covariates shows a statistically significant negative effect on teachers' perceptions of *Professional Development*; however, the year-by-year analysis shows null results for this component in the posttreatment period. Results were inconclusive for *Facilities* and *Community Involvement and Support* due to a lack of parallel trends, while the observed differences for teachers' perceptions of *Teacher Leaders, School Leaders,* and *Overall* were indistinguishable from zero.

Parallel Trends. The year-by-year analysis allows for statistical hypothesis testing to determine if the pretreatment outcome trends are different from zero with statistical significance. Findings show that parallel trends do exist for the ACT and some teacher outcomes (*Teacher Leaders, School Leaders, Professional Development, and Overall*). This information gives weight to the findings in the areas where parallel trends are observed; however, findings associated with those outcomes for which there are no parallel trends are inconclusive and should be interpreted with caution.

Discussion

This work provides information to the field about a digitally focused districtwide turnaround model that developed organically in a struggling district with new leaders. Although this work has many inconclusive results, districts considering a similar turnaround model and states considering support of such models can learn from this research. Districts and states can also learn from the limitations of this work as they consider support for turnaround models like that in Rowan. A discussion of future research provides next steps for this work as well as future research that can be done with additional data.

Implications. The contrast in the overall versus year-by-year findings is important for policymakers to consider when interpreting results of this study or any retrospective longitudinal study. Although the overall treatment effects may signal an ineffective policy, the year-by-year effects may signal to policymakers the need for targeted supports or adjustments to a model like the one in Rowan. The use of pilot studies related to individual components of the Rowan model may help isolate those components that are most beneficial for students or uncover which components are most beneficial for certain student subgroups. North Carolina considers Rowan a regional and national model of implementing digital learning (as defined by the North Carolina Digital Learning Initiative (NCDLI) Plan). The state endorsement of such a model warrants additional study on student and teacher outcomes. Given the lack of parallel trends for all outcomes in this study, results here should be interpreted with caution by a decision making audience.

Limitations. A discussion of the limitations of this study helps contextualize the findings. The complexity of the Rowan model makes it difficult to know which components impacted student and teacher outcomes or the fidelity with which teachers implemented each component at the classroom level. Although qualitative data from Rowan leadership indicate that the model was similarly implemented in each classroom across the district, there are no quantitative data to support that claim.

The comparison group in this model was created using publicly available school- and district-level data; however, the comparison group could be refined with additional data. Student- or teacher-level data, in addition to data about district capacity to implement a model with similar digital components, could create a more reliable comparison. This study includes qualitative data from interviews and site visits with district and school leaders in Rowan used to describe the policy itself. However, that breadth of information is not currently available for all districts in the state and, therefore, cannot be included in a model to isolate schools that are similar to Rowan.

Outcome data for this work include a summative state-made assessment for students and a state-made survey of teachers that is administered every other year. These outcomes were not the primary focus of the turnaround model; however, these measures are frequently used as indicators of school quality and district success. The study of more granular, formative, or long-term outcomes is not possible with the publicly available data used in this work. The outcomes studied in this work limit the ability for findings to speak to other components of student achievement and engagement. The time frame of outcomes is another limitation of this work. The only way to observe some outcomes is through the passage of time. For example, college-going and future earnings may be impacted by the Rowan model, but public data and the time frame used in this work do not allow for such analyses. It is also possible that additional years of publicly available posttreatment data could produce additional findings that may inform policy decisions at the district or state levels.

Future Research. The limitations of this work warrant further investigation to understand how this model, which is upheld by the state as a model of digital learning, impacts student and teacher outcomes. Some future research opportunities fall within the scope of this dissertation, while other opportunities require additional expertise. One opportunity that is within the scope of this work is the use of more longitudinal data. Additional years of outcome data would also reflect the training and support provided by the NCDLI, which was unavailable to Rowan in the first year of its policy implementation. Rowan was the first district to include the digital components (one-to-one student devices and a full-time instructional technology facilitator at each school); however, other districts have since implemented similar digital policy components with the support of the NCDLI Plan. The support provided by the state through the NCDLI could be another component to consider in the Rowan model and in other schools in the comparison.

Another opportunity within the scope of this work is to revisit the comparison sample. District innovations and shifts in policy occur in response to local context, including student need, community demand, and teacher capacity. These types of turnaround policies are unique to the districts in which they are implemented and are unable to be implemented in the exact same fashion in any other district. The unique nature of the treatment in this study is that only schools in Rowan received it, and it cannot be replicated in other districts. Comparing Rowan to itself with and without the turnaround model across a single time frame would be an ideal way to truly understand the impact of the treatment but presents a missing data problem (i.e., Rowan cannot receive and also not receive the treatment in the same time period). Innovations in data analysis present the opportunity to quantitatively produce a synthetic Rowan as a control against which the observed outcomes in Rowan could be compared. The use of a synthetic control could help the field understand what would have happened in Rowan without the turnaround model and how that compares to what did occur in the district for students and teachers.

Additional expertise could be added to this work to explore the response to the COVID-19 pandemic in Rowan. Given Rowan's existing digital program and student, teacher, and parent comfort with the use of devices for instruction, it could be that Rowan shifted to remote learning differently than other districts that lack such digital components. Rowan also received additional autonomy at the district level through the North Carolina Renewal Program in 2018, which grants charter-like flexibility to the entire district. The intersection of increased flexibility, existing digital capacity, and forced remote learning due to the pandemic may be important phenomena to study and inform the field.

During interviews and informal discussions with Rowan district and school leaders, the leadership in Rowan, specifically the leadership qualities of the superintendence Dr. Lynn

Moody, were often credited with the implementation of the Rowan model. However, the study of leadership and how it connects to student outcomes is outside the scope of this study. Expertise in leadership models, characteristics, and functions could provide information to the state about what types of training, supports, and flexibility are most beneficial to current superintendents. This information could also support local school boards as they recruit and hire new superintendents for potential turnaround models.

CHAPTER 2. POLICY

During the 2014–15 school year, district leadership in Rowan public schools implemented a technology-focused districtwide turnaround model to address historic achievement deficits. The leadership team sought to provide high-quality educational experiences to the students that mirrored those experiences provided to students in neighboring wealthier districts. The changes in Rowan sought to infuse technology enhanced learning opportunities into every classroom and build technology infrastructure and staffing support. Professional development and efforts to hire and retain staff focused on innovation and embraced a continuous improvement mindset. With technology as the backbone for districtwide change, leadership focused on increasing internet and technology access for all students by engaging the community.

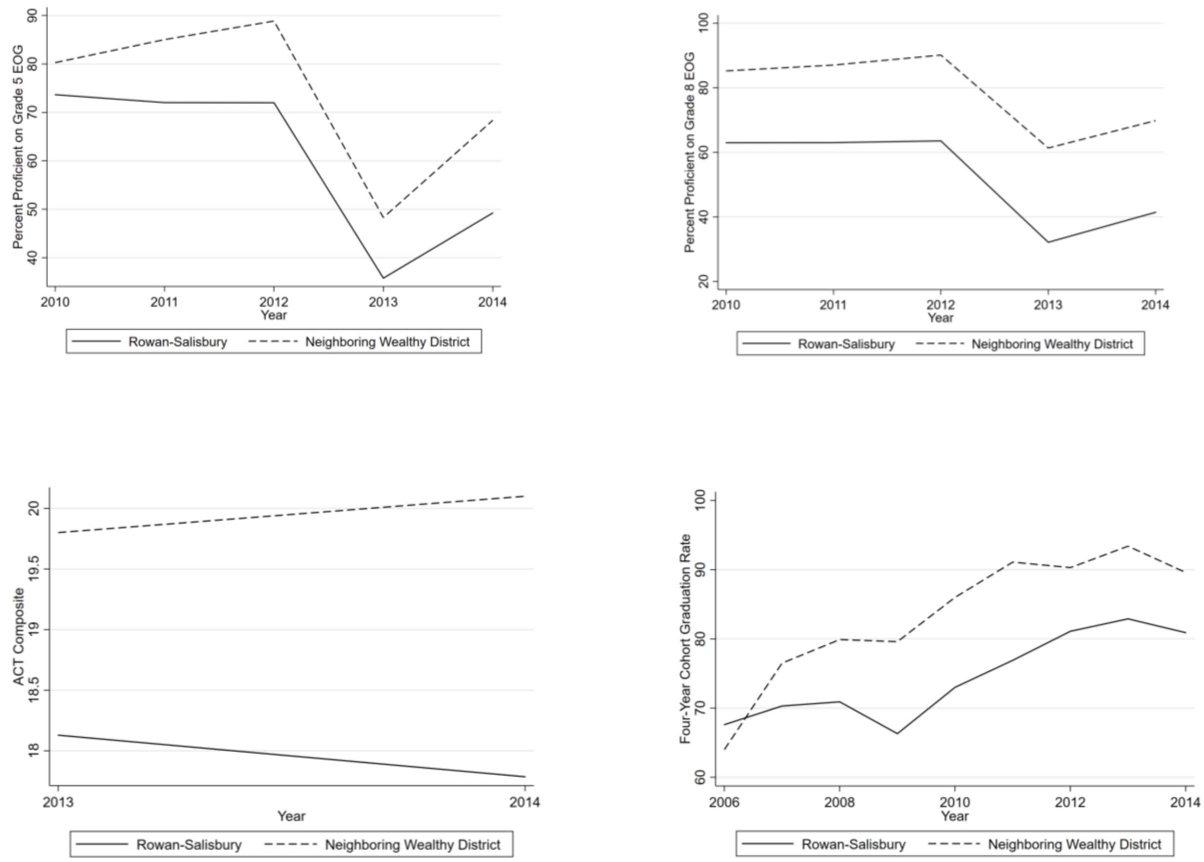
Lynch (2006) warns against the simple “input → output” model of analyzing the impact of technology on student learning (p. 32). Lynch, instead, encourages a comprehensive and holistic study of technology that emphasizes the “how” rather than simply the “what” of a technology-enriched educational program. In the following sections, I heed this advice and comprehensively describe the “how” of the Rowan district change. The sum of the programmatic changes and individual components of the Rowan district turnaround is the focus of this dissertation. The systematic change in Rowan was not simply the allocation of devices or the professional development for teachers related to digital learning in the classroom. Instead, the systematic change was a constellation of programmatic and systemic changes that occurred within a statewide context of growing digital innovation.

As with any evaluation of educational phenomena, it is important to fully describe all components of the individual case. Interview and site visit data (Bowden & Danks, 2020), along with extant policy and state initiative data, were leveraged to create a comprehensive description of the package of changes implemented in Rowan. This chapter chronicles the technology-focused district turnaround policy, beginning with the changes in Rowan leadership that paved the way for the implementation of new ideas. Although not fully developed during the planning and initial implementation period, the Rowan theory of change is clear with hindsight, which this chapter illustrates. Finally, given the technology focus of the policy changes in Rowan, this chapter describes broader context of North Carolina's digital infrastructure as the backdrop for Rowan's innovation.

District Turnaround in Rowan

In the 2013–14 school year, there were several newcomers to the Rowan district administrative team. Dr. Lynn Moody was in her first year of Rowan superintendency, with a new assistant superintendent and chief financial officer. The team was troubled by Rowan students' performance and how the students' educational experiences compared to students' experiences in Mooresville, a neighboring wealthy district (Figure 2.1). Although the mode of action was unclear at the start, the team members reported their commitment to making the most of their moment as new district leaders. The team talked through a variety of curricula choices and supplemental programs that aimed to improve student outcomes. However, the team did not determine that any single curricular program would address the global issues faced by Rowan students.

Figure 2.1. Rowan Student Achievement Compared to Mooresville

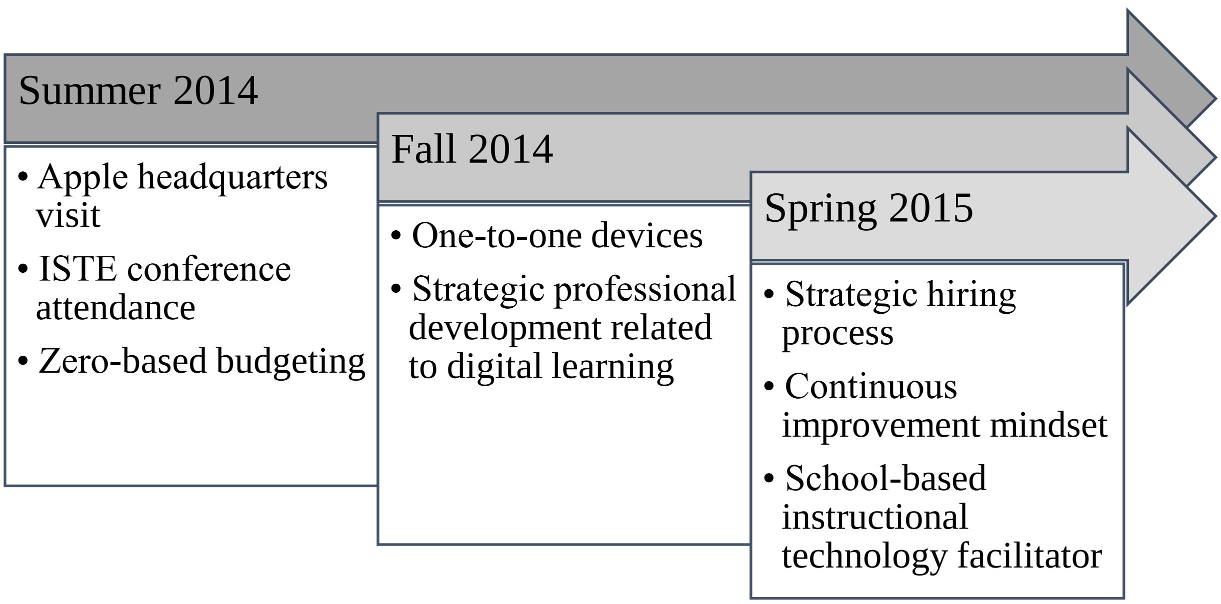


The team talked with curriculum companies and researched a variety of instructional models to understand the options available to improve student outcomes. One of those research endeavors included the use of technology in instruction. In April 2014, the administrative team visited the Apple headquarters to learn more about technology used in education and its purported impact on student learning. Team members left those informational sessions with a vision to implement comprehensive changes in the district, with one-to-one device allocation and purposeful digitally enhanced learning experiences as the cornerstones. The district leaders leveraged their status as newcomers to make significant changes to district policies to incorporate a digital learning program. Rowan leadership decided to implement sweeping changes, including infrastructure, devices, and training at the start of the 2014–15 school year.

District Turnaround Components

Rowan's district turnaround began in the summer of 2014 and was fully implemented by the spring of 2015, thereby encompassing the 2014–15 school year. The district continued to refine and make improvements in each subsequent school year. The timing of all the major components in the initial implementation year is shown in Figure 2.2. The following sections describe each component of Rowan's digitally focused districtwide turnaround model in more detail.

Figure 2.2. Timeline and Implementation Components of Rowan's District Turnaround Model



ISTE Conference Attendance. To build the knowledge needed to purchase devices and digital content, the district took 167 teachers to the International Society for Technology in Education (ISTE) conference during the summer of 2014. The ISTE conference consisted of expert speakers and panelists sharing information about the latest in digital teaching and learning. Vendors of state-of-the-art software and devices were also in attendance to give demonstrations and answer questions. The district leveraged Title II funds and a restructured budget (described below) to prioritize a one-to-one initiative (i.e., the provision of a device to each student). The district asked teachers to collect and organize findings about the information gained, and products encountered to support the district's decisions and increase teacher buy-in. As of 2019, the district continues to take approximately 200 teachers and administrators to the annual ISTE conference to learn more about the capabilities of digitally enhanced instruction.

Zero-Based Budgeting. While teachers worked to understand how technology could be used in instruction, district leadership worked behind the scenes in the summer of 2014 to create a sustainability plan to ensure a one-to-one program could be maintained over time. District leadership spoke of other districts that purchased devices without a sustainability plan and were not successful in maintaining the initial digital learning environment for students over time. This cautionary tale was the driver behind many of the budgeting decisions. The chief financial officer led the group through a zero-based budgeting process, which meant that the budget was cleared of all items, even those historically ordered items thought to be essential. Thoughtful discussions ensued, and items were added back to the budget, one at a time, with digital learning as the top priority. This budget-planning group described the process as considering every component of instruction, "down to glue sticks and paper," as a way to demonstrate that a sustainable system for digital learning was the top priority.

As a part of the budgeting process, district leaders decided to lease devices as opposed to outright purchasing them. The theory behind this decision was that leasing the devices enabled students to consistently have the latest technology and freed the district from needing to respond to device breakage or allocate staff to handle complex device issues. From a school finance perspective, the leasing program created a predictable budget item that provided high-quality devices to every student and helped avoid costly big-ticket repairs during potentially lean financial years.

One-to-One Devices. A small technology team worked throughout the summer in 2014 to procure devices, develop processes for device deployment, and ensure that all schools were equipped with necessary connectivity and supports to be successful at the start of the school year. This included wireless access points in every school, systems to report connectivity outages, and planning for regular device maintenance and updates. The district repurposed a warehouse facility, historically used for textbooks, as a place to keep devices during the summer months and perform basic maintenance, along with any necessary upgrades to keep devices at peak performance. All students in Grades K–4 received a tablet, and students in all other grades received a laptop. Students in Grades 6 through 12 were encouraged to take their devices home, and the younger grades kept their devices at school.[2]

Gaining Stakeholder Support. The exceptional timeline to implement these policy changes required a districtwide unified effort. District leadership reported that each faction of district leadership (i.e., superintendent, school board, technology experts, financial officer) had to strategically coordinate to successfully move this initiative forward. The leadership explained that achieving that type of buy-in from *all* stakeholders was an essential, but challenging, task. Stakeholders included administration, teachers, teaching assistants, families, and community members.

Dr. Moody and district leadership provided informational sessions for the school board, during which they described the utility of 1:1 in teaching and learning. As a more conservative rural community, there were naysayers who worried about the impact of the availability of

[2] The description of device allocation presented here represents conditions prior to COVID-19. Meeting students' needs during school closures may have altered the provision of devices.

digital devices on students, schools, and the greater community. For example, the school board voiced concern about potential access to inappropriate content for students. Dr. Moody assured the school board that access to inappropriate content will occur with or without school-provided digital devices and that the benefits of school-provided devices far outweighed the risks. Furthermore, she described the content filters that would be used and the process for responsibly handing issues as they arose. Another example involved local law enforcement's concern about a potential uptick in theft, given the availability of expensive devices in schools. Again, Dr. Moody and her team were able to describe security procedures while emphasizing the benefits of using digital tools for learning beyond the classroom.

Another issue that arose in the planning process was broadband access for students outside of school hours. The district worked with the community (i.e., local businesses, local governance) to establish free Wi-Fi spots throughout the district, which included some fire stations, churches, parks, and participating businesses. These opportunities to connect to the internet free of charge gave students the chance to access additional content outside of school hours to broaden their interests. In addition, according to district leaders, establishing these Wi-Fi spots was a tangible way for the local community to show support for the students' education.

North Carolina has lower than average home computer and internet access (KewalRamani et al., 2018). In some homes, heads of households considered broadband access essential; yet, many other homes had no connectivity. A lack of connectivity in the home can be due to financial constraints, geographic availability, or personal preference. The district listened to families to find solutions for connectivity issues and expand policy buy-in. One solution was the requirement that no assigned homework could require the use of connectivity in order to be completed. Instead, students had to download the materials or content needed to complete homework while in school and then complete assignments using those downloaded materials at home. Thus, connectivity to complete homework was removed as a barrier for students without connectivity in their homes.

Strategic Professional Development Related to Digital Learning. The district created a system of professional development opportunities for teachers beginning in the 2014–15 school year. The chief technology officer was tasked with creating a professional development plan for teachers, and a highly regarded veteran Rowan teacher was hired as a digital innovation coach. Together, these individuals created training and support systems for teachers that focused on what a blended learning environment does for students, how it looks, and what it should feel like (from the students' perspectives).[3] This training included an emphasis on device use as a supplemental tool for instruction. The message pushed in training sessions was that digital tools enhance, not replace, existing best teaching practices.

In the years following the implementation of the policy shift, teachers continued to expand their capacity in the use of technology in the classroom. For example, teachers attended state-facilitated professional development opportunities and brought back innovative ideas to share with the rest of the teaching staff. In weekly professional learning community meetings, teachers shared ideas and knowledge about how to improve instruction using technology. Teachers were encouraged to try new techniques and share their successes and struggles with fellow teachers so that all could learn from each other's experiences. As of 2019, the district continues to offer broad technology-based professional development and support teachers in developing these skills.

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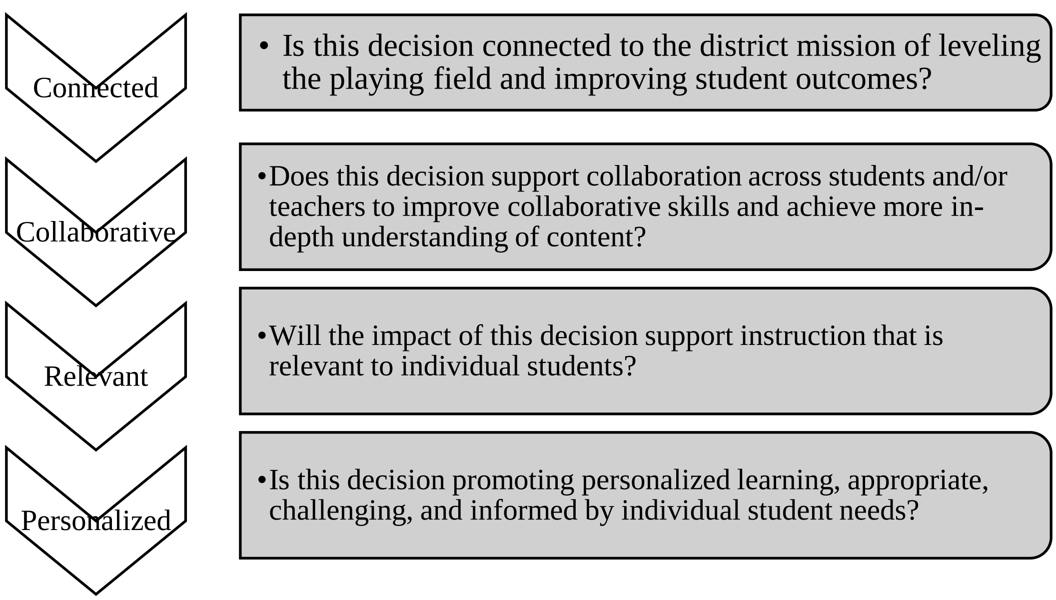
[3] For general information about the technology supports and professional development available, see https://rsstech.freshservice.com/support/home.

Continuous Improvement. Rowan approached digital learning as a vehicle to improve student outcomes and “level the playing field” for Rowan students. As an important component of digital learning, the district made intentional continuous improvement (Powell et al., 2015) a central component of the turnaround model. For example, district leaders and teachers were encouraged to determine whether decisions are connected, collaborative, relevant, and personalized (CCRP) for students. This model turned into a question asked of teachers and district leaders when making instructional, programmatic, and budget decisions. “Is it CCRP?” was a frequently asked question during professional learning community, school board, and district leadership meetings. The mission of Rowan became ensuring all decisions made regarding instruction met the CCRP litmus test. Figure 2.3 is a theoretical model I created to capture the CCRP reflective practice described by Rowan leadership and teachers.

Figure 2.3. Rowan CCRP Reflective Model



Grand Rounds. The grand rounds process, a process in existence before and after the turnaround model was implemented, is another example of Rowan’s continuous improvement mindset. Grand rounds consist of administrative teams traveling through each classroom to observe and later discuss issues and potential solutions. This reflective process led to the realization that digital tools, in the beginning of the 2014–15 school year, were being overused. Teachers reported that devices were used for the majority of the time and students, who are always encouraged to speak up during the grand rounds process, described that, at times, devices were used "just because they were there" and did not enhance the learning experience. With this feedback, the district rolled out professional development content that encouraged teachers to evaluate the use of devices in instruction to ensure the devices were purposefully used and not crowding out other effective non-device teaching strategies. As of 2019, grand rounds continue to be a way for district- and school-level administrators to evaluate programs and practices across the district and make necessary changes after collaborative discussions.

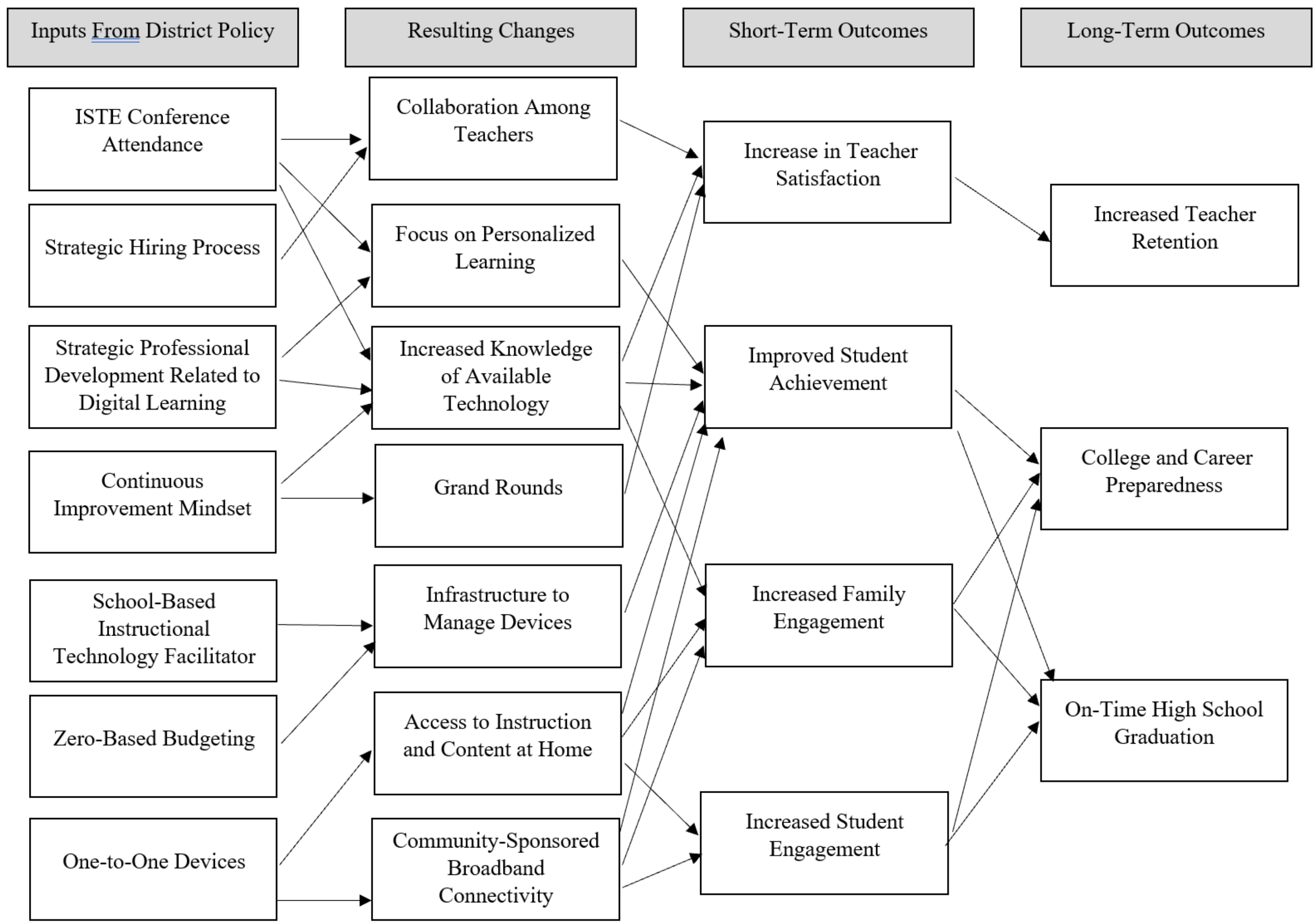
School-Based Instructional Technology Facilitator. The district responded to a variety of needs described by teachers and students during the first year of implementation. For example, during the instructional day, as simple technology issues arose, schools needed rapid response to avoid lengthy disruptions to instruction. Teachers also wanted additional support and guidance on how to integrate technology into daily instruction. Teachers wanted a school-based staff member to support teachers as they integrated technology into the classroom. To address these concerns, the district restructured some school and district positions to provide an instructional technology facilitator (ITF) in every school. This individual provided targeted classroom-based professional development and support for teachers.

The district also saw the value in collaboration among students and wanted to build those collaborative skills that would benefit students in postsecondary scenarios. The ITFs worked to revamp school spaces to foster collaboration among students and teachers. They used *Make Space* (Doorley & Witthoft, 2012) as a guide to create spaces for learning in all areas of the school. ITFs encouraged teachers and other school-based staff to evolve their perceptions of school spaces. For example, classrooms were no longer where learning happened and the hallways a way to move between those spaces. Instead, the hallways, media centers, cafeteria, and other underutilized spaces in the school were outfitted with furniture that promoted collaborative workspace for a variety of educational tasks. The ITFs played a critical role in setting up collaborative spaces and supporting teachers in making use of these spaces with technology-based instruction.

Strategic Hiring Process. Teachers who were especially enthusiastic about incorporating technology into the classroom were called upon by district leadership to help shape the recruitment and hiring process to ensure that newly hired teachers were able to contribute to the district dynamic. In response, several teachers created a video that described the technology-rich environment they sought to provide for every student. The video talked about the culture of teaching in Rowan, the supports available, and the ways in which technology was used. Viewing this video became a requirement for applicants prior to an official interview in the district. Through this process, all potential new teachers became aware of the digital dynamic in the district, and current staff had some assurance that incoming teachers were well suited to add to the existing culture.

Theory of Change. The turnaround in Rowan included an array of policy decisions that all focused on increasing student outcomes using technology-enhanced instruction. District leadership focused on the inputs they could provide in the form of district policies and programs and how those policies were expected to change student and teacher experiences and outcomes. Figure 2.4 illustrates how I conceptualize the theory of change that motivated and directed districtwide policy decision making, along with the theorized changes administrators expected from each policy lever.

Figure 2.4. Rowan Digitally Focused District Turnaround Theory of Change



State Context

Prior to Rowan deciding to implement a technology-focused district turnaround model, the state of North Carolina built the connectivity infrastructure and support to incorporate digital learning tools. Although not an explicit component of Rowan's policy shift, the broader context of North Carolina's digital learning infrastructure and support was essential to the successful implementation of Rowan's policy model. North Carolina is often held as an exemplar of digital learning policy, funding, and implementation (Acree & Fox, 2015; Fox et al., 2017; Gemin et al., 2015; Plummer, 2012). North Carolina played an integral role in the development of infrastructure and support systems necessary for Rowan's achievement of a one-to-one technology environment. This section describes those developments and supports.

State Connectivity Infrastructure. North Carolina made significant investments in digital learning to enhance statewide connectivity infrastructure, provide devices for students and teachers, and train staff to use technologically enhanced instruction (An Act Directing the State Board of Education to Develop and Implement Digital Teaching and Learning Standards for Teachers and School Administrators, 2013; North Carolina House Bill 44, 2013; 2016 Appropriations Act, 2016). The state generally conceptualizes digital learning as a tool to personalize learning and improve postsecondary preparation (Elementary and Secondary Education Act of 1965, as amended by the Every Student Succeeds Act Consolidated State Plan, North Carolina 2018). Policies and legislation support and encourage the adoption of digital learning programs across the state; however, the state affords each district the autonomy to determine its own digital learning pathway. As a result, districts use a variety of models to implement digital learning. Rowan aimed to respond to its students' needs, community's concerns, and staff strengths when implementing a districtwide one-to-one digital learning policy, yet Rowan's process was not mandated by the state.

Without adequate and reliable connectivity at the classroom level, digital instructional tools cannot be fully utilized. It is important to understand the infrastructure supports that were in place prior to Rowan's adoption of the one-to-one digital learning policy. As far back as 2002, the North Carolina General Assembly and State Board of Education encouraged the development of technology infrastructure and support systems to provide internet access to all students (North Carolina Senate Bill 1115, 2001). Beginning in 2007, the North Carolina General Assembly charged the NCDPI with the task of providing equitable technology access for schools across the state as a part of the School Connectivity Initiative and provided more than $24 million dollars annually to support the initiative (E-NC Connectivity Incentives Funds, 2007).

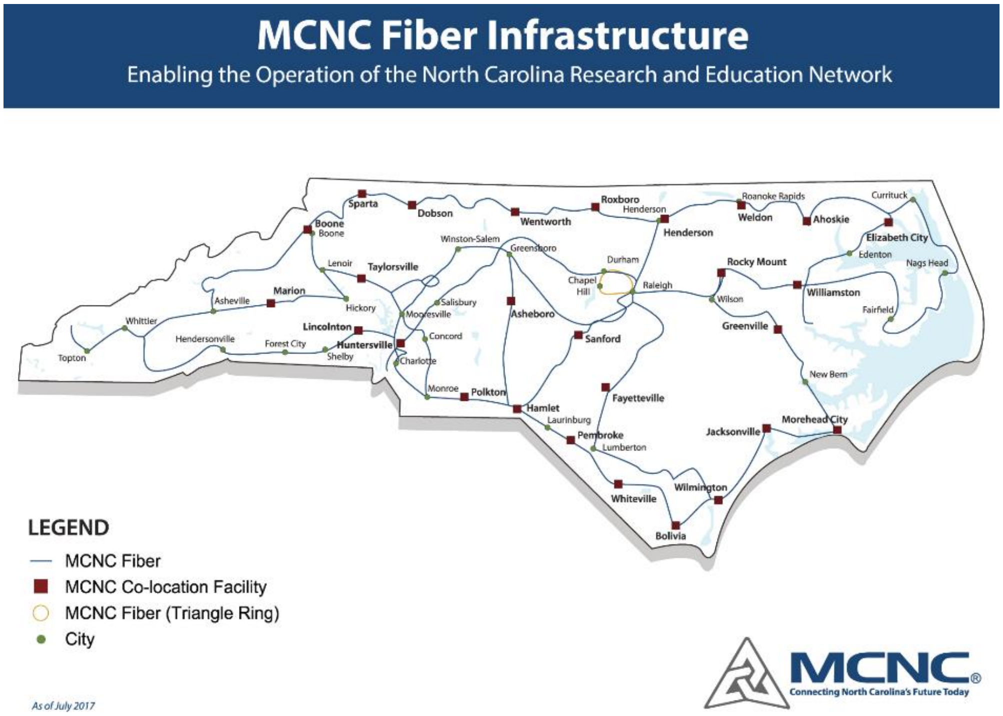
Connectivity for schools is provided through the North Carolina Research and Education Network (NCREN). The NCREN is a nationally recognized education and research network that provides "future-proof" technology to support innovation in K–12 and higher education systems. As the operator and sole provider of the NCREN, MCNC oversees the bandwidth and connectivity of the NCREN to every district in the state. Using specialized analyses and automated programming, MCNC ensures that every district has enough broadband capacity to meet its digital learning and infrastructure needs on a daily basis.[4] To accomplish this goal, MCNC continually monitors the bandwidth usage at the district level. When a district uses more than 60% of its present broadband level, MCNC increases the district's bandwidth to the next level, ensuring enough capacity to manage the district's broadband needs[5] (North Carolina

[4] For more information, visit www.mcnc.org
[5] For monthly broadband usage information for each county, visit https://www2.mcnc.org/ncren/portal/reporting/ncren_utilization_map.

Department of Public Instruction, 2017). This automatic increase is important because it allows teachers, for example, teachers in Rowan, to focus on instructional strategies and digital content that meet students' needs without concern about sufficient broadband capacity to support their decisions.

Historically, rural areas struggle to prioritize funding to improve connectivity, which exacerbated the lag in technology throughout the years. To support districts with lagging technology infrastructure, recurring funds were allocated at the state level to provide every school in the state with access to the NCREN. These investments in connectivity were especially important for the rural and economically disadvantaged regions of North Carolina, including Rowan. Figure 2.5 illustrates the NCREN infrastructure operated by MCNC. In addition to Rowan receiving funding from the General Assembly, in 2010, the Golden LEAF North Carolina Rural Broadband Initiative (NCRBI) provided nearly $24 million in matching cash funds to expand connectivity infrastructure across the state, with a focus on rural areas. Rowan was able to innovate at the district level using improved broadband connectivity infrastructure supported by the state and the NCRBI.

Figure 2.5. NCREN Infrastructure Operated by MCNC



North Carolina also provides grant support for districts aiming to integrate digital learning. In 2017–18, the North Carolina State Board of Education and the Friday Institute for Educational Innovation developed a system of grants to support districts at varying stages of digital learning implementation (2016 Appropriations Act, 2016). Grants differed in amounts and duration across four categories: Planning, Implementation, Showcase, and Innovation. Rowan received a Showcase grant totaling $46,718 for the 2017–18 school year. The purpose of the Showcase grant was to provide districts with support to become regional examples of high-quality digital learning implementation (as defined by the NCDLI). The district welcomed visitors from the region to witness how digital learning was operationalized in the district. Rowan recently received an Innovation grant from the state, which is intended to support districts in becoming a state and national example of effective digital learning. This grant, totaling $199,774, was intended to be disbursed during the 2019–20 and 2020–21 school years.[6] Along with this grant, Rowan will receive the support of a coordinator to manage visits from interested decision makers across the country. Although the subsequent grants won by Rowan were not part of the initial one-to-one digital learning initiative treatment that is the focus of this study, it is important to understand the context in which this study exists. The one-to-one digital learning program in Rowan officially began in 2014–15 and has continued to gain momentum, as evidenced by Rowan's recent grant winnings.

Evaluating Rowan's Reform

Rowan implemented a package of changes beginning in the 2014–15 school year. The dynamic leaders seized their opportunity as newcomers to make sweeping policy changes in an effort to improve student outcomes. The theory of change leveraged district policy inputs to prompt changes for both students and teachers. The goal was for these changes to lead to both short- and long-term outcomes. This study focuses on the impact on student achievement (as measured by North Carolina EOG assessments and the ACT) and teacher perceptions (as measured by the TWCS). The policy shift implemented in Rowan is unique because of the multiple components and the swift timeline during which districtwide changes were implemented. This chapter fully describes those components, and the next chapter reviews extant literature about district turnaround and technology in education.

[6] At the time of writing this dissertation, it is unclear how COVID-19 affected the dispersion of the grant or the related district requirements.

CHAPTER 3. LITERATURE REVIEW

In the 2014–15 school year, Rowan public schools implemented a unique package of changes aimed at improving student achievement. The implementation is unique in its timing (swift implementation), components (multifaceted approach), and leadership composition (majority of district leaders new to the district). At the same time, North Carolina was developing policies and supports to increase student access to technology-enhanced educational opportunities. It is impossible to know if leadership changes, state policy, or a mix of both led the district change. Yin (1994) describes case studies as appropriate for scenarios where "the boundaries between phenomenon and context are not clearly evident" (p. 13). When studying something that is complex but not yet fully operationalized to the point of scalability, a case study approach is appropriate (Creswell, 2003). A case study approach allows a researcher to understand both the qualitative nature and the quantitative impact of a policy, as I do with this Rowan study.

Rowan's turnaround model was not prescribed by the state nor developed by an expert educational body. Instead, a group of leaders was called to action to support student achievement. Adelman and Taylor (2011) urge researchers to analyze various types of turnaround and their associated impacts to inform the field about ways to improve student achievement. This work answers that call using a case study approach to first define the policy (treatment) of interest in Rowan and then analyze the quantitative impact of the policy using a difference-in-differences methodology. While Chapter 2 describes the turnaround policy and its implementation in Rowan, using interview and extant policy data, this chapter uses extant literature to describe what is known about district turnaround models and educational technology as they relate to student achievement and teacher satisfaction.

District Turnaround

Identifying a districtwide turnaround is the first step in studying the impacts of the turnaround. At what point does a constellation of changes qualify as a district turnaround model? When a districtwide vision is operationalized as distinct policy decisions that are carried out with fidelity in each school and classroom, the district is described as having a throughline (Bonda & Mitchell, 2015). This throughline is a clear marker of district turnaround. Rowan's turnaround model started at the district level as a set of decisions related to connectivity, access, and teacher training. Further operationalization of Rowan's districtwide turnaround is evidenced by the provision of devices to every student and the allocation of ITF staff in each school. Interviews revealed that consistent changes across all classrooms were made as a result of the district policy adoption. This congruity between Rowan's district decisions and implementation with reported fidelity across all classrooms is a hallmark of a districtwide turnaround throughline.

The turnaround model concept is largely taken from the business sector, which is vastly different than the public education sector (Adelman & Taylor, 2011). There are many unknowns related to implementing a district turnaround, including what the initial system changes need to be and how to effectively integrate strategic continuous improvement. The size and locale (i.e., urbanicity and rurality) of districts can be another factor that impact turnaround implementation. There is evidence that turnaround models of any scale may be more feasible in rural areas, given the typically stronger pre-existing communal connections (Mette, 2014). For example, rural communities are typically smaller, close-knit, and engaged in community activities, all of which support implementation of districtwide turnaround models.

As opposed to efforts to promote incremental improvements for teachers and students, with a focus on the school as the unit of change, the idea of district turnaround typically refers to a swift change aimed at substantial improvement for groups of lower achieving schools (Hewitt & Reitzug, 2015). Although the district is typically the decision-making body and key change instrument for school improvement, there is an unfortunate dearth of research about how districtwide turnaround models impact student achievement and teacher satisfaction (Daly & Finnigan, 2016; Heissel & Ladd, 2016; Strunk et al., 2016).

Digitally Focused District Turnaround. The adoption of technology is a common strategy included in districts' efforts to improve student achievement. A survey of 480 school administrators found that 96% of schools that received federal School Improvement Grants adopted practices that increased technology and computer access for teachers and students (Herrmann et al., 2014). In fact, schools that receive additional funding from any source for school improvement often select an increase in instructional technology as a key component of their instructional reform (Herrmann et al., 2014). A meta-analysis by Corry & Carlson-Bancroft (2014) searched extant literature for evidence of benefits of online learning used to change direction for low-performing schools. They found that online learning (both synchronous and asynchronous virtual environments) can broaden access for all students, increase student motivation and engagement with self-paced learning options, and personalize learning to meet students' strengths and interests.

Policymakers often see the provision of individual devices as the *cause* and changed education as the *effect*. However, policymakers should think about technology as tools that enable improved educational experiences and not as evidence of educational innovation (Weston & Bain, 2010). Hess and Thomas (2011) explain that the shift needs to move from *schools* to *schooling* and from *teachers* to *teaching*. When digital learning tools are used in a classroom, students no longer need to rely solely on the instruction of the teacher or capacity of the school to meet their educational needs and goals. Instead, digital learning tools and programs can connect students to content and experiences that go far outside the scope of teacher expertise and the confines of the school. When a student is given an individual laptop, the machine becomes a tool that can advance the existing capabilities of the student and teacher (Bransford et al., 2000; Weston & Bain, 2010). This cognitive tool replaces many of the traditional educational tools to improve instruction. Rural teachers new to incorporating technology into instruction emphasize how the process transforms many facets of the classroom, including engagement, use of time, and expectations (Kellerer, 2014). Rowan teachers and administrators reported the use of devices to fundamentally change the way students are engaged in learning.

Critics of digital learning believe that solid evidence is lacking regarding the positive impact of technology on student outcomes (Cuban, 2006; Cuban & Usdan, 2003;). Weston and Bain (2010) argue that most educational advancements, including accountability, increasing academic rigor, and comprehensive school reform, show little evidence of impact on teaching and learning. When compared to more complex initiatives and policies that aim to improve education, the “techno-critic” has a tangible target (and price tag) in a one-to-one device initiative, making device initiatives an easier target for scrutiny (Cuban, 1990; Weston & Bain, 2010). There are also growing concerns about the privacy protections for online educational activities, especially for our most vulnerable populations (Stahl & Karger, 2016). However, proponents of digital learning believe that digital learning can positively impact student achievement. All scholars, however, do not agree about how to make that impact. Existing literature stresses the idea that educators and policymakers cannot merely inject technology into classrooms and expect a change in student performance and later outcomes (Mayer, 2010; OECD 2000; OECD 2010; OECD 2012; Selwyn, 2010). Instead, Istance and Kools (2013) urge educators to consider the learning environment as the place for change. Integrating technology into a school's daily functioning requires a holistic approach that impacts all learning environments available to a student (i.e., classrooms, hallways, common areas, home, community). Information about this type of district implementation is missing from the literature.

Defining Digital Learning

The term *digital learning* encompasses various components and can be implemented in a variety of ways. Digital learning can broadly be described as "any instructional practice in or out of school that uses digital technology to strengthen a student's learning experience and improve educational outcomes" (Gemin et al., 2015, p. 5). The recent adoption of the Every Student Succeeds Act (ESSA) in 2015 responded to the growing use of technology in classrooms by including specific language related to what digital learning is and how digital learning is used in the classroom. The ESSA of 2015 states that digital learning is "any instructional practice that effectively uses technology to strengthen a student's learning experience and encompasses a wide spectrum of tools and practices" (ESSA 2015, p. 1,969). Digital learning can include the use of online tools in the classroom, the sole use of online learning experiences, or a hybrid of in-person and digital learning activities. Digital learning programs can provide broader access to online information sources and create an interactive learning experience for students. Digital tools can also encompass computer-based assessments to understand student progress (ESSA, 2015). These descriptions of digital learning, outlined in ESSA, demonstrate the depth and breadth of digital learning in classrooms across the country. As is true in North Carolina and across the country, this multifaceted educational tool can be implemented in a variety of ways.

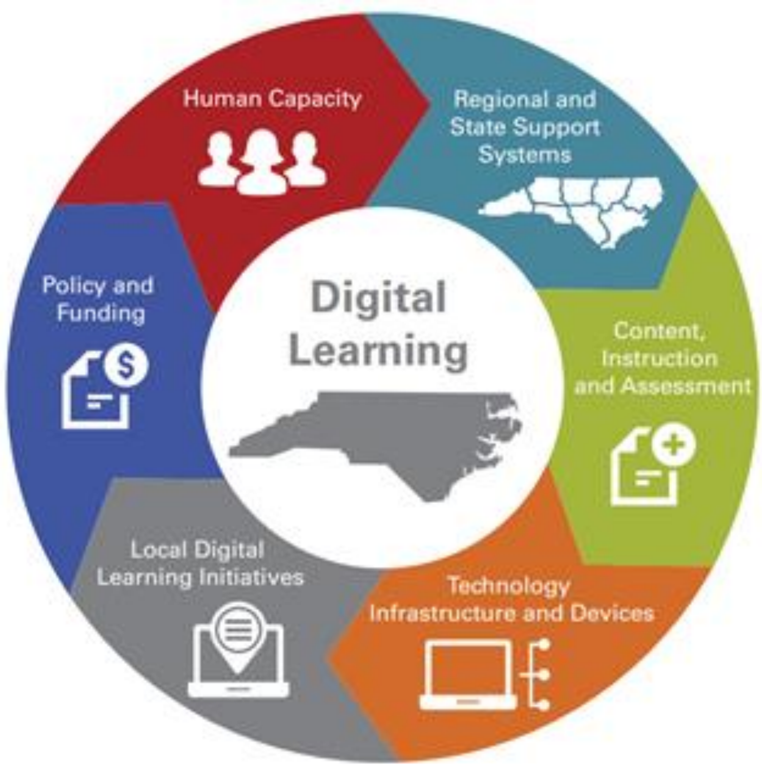
Digital learning has its roots in providing differentiated instruction and content opportunities for students at the extreme of the performance spectrum (i.e., students with disabilities and students pursuing advanced placement courses; Gemin et al., 2015; Pearson et al., 2005). Online learning opportunities, particularly for students in rural areas where the teacher workforce may not meet the needs of all students, is another example of digital learning implementation. In these circumstances, courses are delivered in whole or in part online from a remote location. Online learning opportunities are also considered a way to offer students from all locales more advanced or specialized courses when personnel to teach those courses are not locally available (Berry & Wintle, 2009; Farkas, 2003; Pearson et al., 2005; Stahl & Karger, 2016). Most recently, the pandemic has forced online learning to be the “new normal” for many students across the globe.

Digital Learning Defined in North Carolina. North Carolina is at the forefront of digital learning in the K–12 space because of statewide initiatives and supports. The state investments in connectivity infrastructure, training, and hardware to support digital learning environments are unlike any other state. The intent of digital learning in North Carolina is to use digital tools to enhance instruction and personalize learning experiences in an effort to improve student outcomes (Elementary and Secondary Education Act of 1965, as amended by the Every Student Succeeds Act Consolidated State Plan, 2018).

With major infrastructure in place, North Carolina allows districts to make their own decisions regarding digital learning implementation, including curriculum, training, and device provision. This autonomy allows district leadership to respond to local needs of students and families. The NCDLI Plan (Friday Institute for Educational Innovation, 2015) lays out the guiding principles that define how North Carolina conceptualizes digital learning. The NCDLI Plan describes digital learning through six key components: Human Capacity; Regional and State Support Systems; Content, Instruction, and Assessment; Technology Infrastructure and Devices;

Local Digital Learning Initiatives; and Policy and Funding (Figure 3.1). Districts and schools seeking to digitize their curriculum and meaningfully integrate technology must provide training and support related to the technical components while aiming to integrate technology into the culture of the schools. Without the cultural shift among teachers, leaders, and families, implementation of a technology-focused model is unlikely to be successful (Mette & Stanoch, 2016). According to the NCDLI Plan, districts must address digital learning through all facets of their teaching and learning framework to truly alter the learning environment. Although this model and associated guidance were not released until 2015, retrospective qualitative (interviews and classroom observations) and quantitative (receipt of NCDLI grants in Rowan) data show that Rowan addressed each component of the NCDLI Plan framework in its initial 2014–15 turnaround implementation.

Figure 3.1. Key Components of North Carolina's Digital Learning Initiative



Source: Friday Institute for Educational Innovation (2015). NCDLI Detailed Plan.

Evidence of the Impact of Digital Learning

There are a variety of ways in which technology affects the student experience and the teacher's ability to provide instruction. Concurrently, specific digital learning tools and programs can be used in many ways. Although there is ample research that focuses on single software programs or computer-based interventions (Léger et al., 2019; Murray et al., 2018; Nicholas et al., 2017; Steiner et al., 2015; Tärning, 2018), the literature is less robust when analyzing the impact of a districtwide digitally focused turnaround model. The following sections explore evidence regarding the broad use of technology in education. The impact of digital learning programs on student academic and cognitive processes are reviewed. The relationship between student engagement and the use of technology is then surveyed. Finally, because postsecondary success is a prime focus of K–12 education, the impact of digital learning on postsecondary preparation is described.

Academic Performance. Learning experiences that cater to a student's individual learning preferences lead to significantly improved outcomes when compared to traditional class wide instructional approach (Farkas, 2003). Across the country, the average classroom size ranges from 17 to 27 students (National Center for Education Statistics, n.d.), leaving teachers with the important task of creating learning activities and instructional modules that meet the unique needs of a group of students. Included in these 17–27 individual students are individual learning differences, needs, and strengths. Technology can be an important tool that allows educators to personalize instruction by providing each student with appropriately challenging material (Farkas, 2003). Some states, such as North Carolina, have even gone so far as to describe digital learning as an essential component in the personalization of learning experiences for all students (Elementary and Secondary Education Act of 1965, as amended by the Every Student Succeeds Act Consolidated State Plan of North Carolina).

The ability for a computer-based program to scaffold instructional activities is key in reaching an individual student, especially students who are struggling. Positive trending results in student reading and math achievement, although not statistically significant, were found by Shapley et al. (2011) in a study that analyzed the impact of a technology immersion initiative for middle school students.[7] Hull and Duch (2019) analyzed a districtwide one-to-one technology program and found that, although statistically insignificant, short- and medium-term math scores increased by 0.13 standard deviations. Blended learning, in which part of the content is delivered in a face-to-face format and part is delivered using a virtual platform, led to higher scores on the Measures of Academic Progress (MAP) for Texas Students ($M = 11.12$, $SD = 7.88$) when compared to a fully face-to-face model ($M = 8.84$, $SD = 7.40$, $t(411) = 3.02$, $p < .01$; Fazal & Bryant, 2019). Additionally, the blended model was associated with greater academic growth than solely face-to-face learning experiences based on student performance on the MAP and the STAAR (State of Texas Assessments of Academic Readiness).

Some digital learning programs, such as the Rowan program, include the provision of individual devices as a core tenet. When students are given an individual device, for example, a laptop, to use for instruction, their academic achievement is significantly higher than those students without a laptop. Students with an individual laptop taking the California norm-referenced test performed 16 points better on math and 13 points higher on ELA ($p < .05$ across two different cohorts; Gulek & Demirtas, 2005). Rosen and Beck-Hill (2012) also found significant positive effects of one-to-one technology on student performance on the TAKS for

[7] Shapley et al. (2011) analyzed student performance on the Texas Assessment of Knowledge and Skills (TAKS) in reading and math and found a positive trend that replicated across student cohorts.

fourth graders (Math *SD* = 2.7, $p < .01$; Reading *SD* = 3.5, $p <.01$) and fifth graders (Math *SD* = 2.1, $p <.05$; Reading *SD* = 2.2, $p <.05$). Additionally, reading motivation as measured by a student survey increased for fourth graders (*SD* = 3.0, $p <.01$) and fifth graders (*SD* = 2.2, $p<.05$). One-to-one technology programs are also associated with a decrease in student disciplinary issues. Individual device allocation was associated with a 62.5% decrease in classroom disciplinary infractions compared to students without individual devices (15.4% decrease; Rosen & Beck-Hill, 2012)

Some student subgroups may benefit more from technology. For example, the overall reading ability of students from low socioeconomic backgrounds is higher with the use of a computer-based reading intervention program than the same intervention presented in a textbook-based format ($d = 0.62$, $p < .05$; Cuevas et al., 2012). English learners are another group of students for whom technology can be especially beneficial. The use of digital gaming resources resulted in more positive results for students learning English when compared to more traditional paper-and-pencil methods ($d = .681$, $p < .05$). Additionally, students were more motivated to learn English based on survey responses ($t = -3.11$, $p <.005$; Wichadee & Pattanapichet, 2018). The evidence supporting the use of technology in the classroom is not limited to instruction in the core subjects of reading and math. Research shows that the appropriate use of technology can positively impact student achievement in art (Lin & Bruce, 2013; Wang 2019) and music (Petty & Henry, 2014).

Cognitive Changes. Although there are measurable academic outcomes that the literature can link with the use of digital learning, there are also cognitive processes occurring during the learning process that can be affected using technology. Metacognition, for example, includes knowledge derived from making important connections between what a student already knows and what a student wants to know during the learning process (Channa et al., 2015). At the most basic level, metacognition can be defined as thinking about thinking (Nazarieh, 2016). Students use metacognition regardless of the subject matter, to comprehend new material. By cognitively being aware of new content students encounter, they connect new content with previously learned skills or interests. Programs that encourage students to employ metacognitive strategies can improve students' reading and comprehension skills (Channa et al., 2015). Metacognitive strategies, in general, are not the one-size-fits-all solution to effective and efficient learning. The nature of metacognition makes each individual student's metacognitive process and perception unique. However, comprehensively designed software programs can provide personalized metacognitive prompts to support skills development (Hsu et al., 2016; Warschauer & Matuchiniak, 2010).

Self-regulation is a specific metacognitive process that allows students to understand where they are on the path toward a goal and adjust as needed, based on an evaluation of their own understanding. Self-regulated learning "mediates the relations between learner characteristics, context, and performance" (Greene & Azevedo, 2007, p. 335). Students set educational goals based on their skills and environment, with or without their conscious understanding of this internal process. Within that process is an appraisal of how much time and effort to invest in each learning task (Dweck, 1986). The control students have over their learning can be a powerful tool in enhancing their efficacy in the educational process. An understanding of that control is what supports and builds effective self-regulation. Calling attention to the components of self-regulation and making the process intentional can increase student achievement (de Bruijn-Smolders et al., 2016). Computer-based learning environments support students in developing the essential self-regulation skills needed to be effective learners, both in and outside the classroom (Lai et al., 2018; Mihalca, 2014).

Engagement. *Learner engagement* can be broadly defined as the mediator between the antecedents and the outcomes of an individual student (Lam et al., 2014). Those antecedents can include a student's enjoyment of learning, classroom climate, interest in content, or even physical factors such as level of hunger or tiredness. Outcomes can include student achievement, attendance, peer interactions, and mastery of specific skills in the workplace. Technology can be used to increase comprehension and motivation and provide immediate feedback to increase student engagement in educational activities from a variety of content areas (de Jong & Bus, 2002; Doty et al., 2001; Goldberg et al., 2003). Concurrently, digital devices extend the opportunity for engagement beyond the classroom (Northey et al., 2018). For example, the Maine Learning Technology Initiative (MLTI) aims to provide each student with a device for education, both in and outside the classroom. Research on the MLTI showed that students with devices were engaged an average of 30% more of the classroom time, comprehended more instructional content ($SD = .61$), and retained taught concepts better ($SD = 1.42$) when compared to students without access to individual devices (Berry & Wintle, 2009). Another study found that engagement in postsecondary settings increases with the use of interactive digital learning platforms (Bertheussen & Myrland, 2016).

The novelty of technology can be leveraged to increase engagement and decrease disciplinary infractions. In a survey of teachers, Dudaitė & Prakapas (2019) found that students enjoy the use of new technology in the classroom. Teachers leveraged student interest in the technological tool itself to more fully engage students in learning activities and decrease the number of disciplinary infractions (Shapley et al., 2011). Such technological tools can include, for example, an interactive whiteboard, coding software with small robots, classroom survey software and tools, or multimedia to present work products. However, the impact of using technology is not always positive. Student interest can wane over time and lead to disciplinary issues in classrooms with less developed management structures (Dudaitė & Prakapas, 2019). For some students, the use of technology may be difficult to navigate or may add pressure to perform (Farnsworth et al., 2002). In those cases, a student's attitude about learning may be negatively impacted, leading to decreased engagement or academic performance.

Preparation for Postsecondary. A primary goal in education is to academically prepare students for postsecondary options (ESSA, 2015). Along with the academic preparations needed for postsecondary options are the cognitive processes that also need developed. Digital learning as a broad body of instructional decisions is purported to be an important component for the preparation of students for the variety of postsecondary options available to them, which can range from college and career readiness to immediate job placement success after high school (Johnson et al., 2010; Project Tomorrow, 2014; Schmid et al., 2014). High-quality experiences with technology-enhanced instruction in the K–12 setting can prepare students for later learning experiences that require technology to be successful.

As learning opportunities in the postsecondary realm evolve to more technology-based delivery models (Yasinski, 2014), it is important that students are prepared to thrive in those environments. In the workforce, programs offered virtually allow employees to progress through training at their own pace and give employees the flexibility to balance personal and professional demands. The success in a self-directed learning scenario is directly related to an individual's competency in instructional technology (Shinkareva & Benson, 2007). Online learning experiences often blend synchronous and asynchronous activities to provide students with a hybrid model of instruction. This balance, not always perfectly achieved, is important for students to navigate successfully to learn the content and meet required milestones to advance in coursework (Reese, 2015).

As industries change and work demands evolve, it becomes more important for individuals to be able to effectively collaborate and solve complex problems. The ability for students to collaborate, share ideas, and work together to solve issues is imperative to their success in any postsecondary setting (DuFour & Marzano, 2016). Technology can be integrated into classrooms to help address some of the social goals of education, such as learning collaboration (Rosen, 2017; Rosen & Rimor, 2009). Online collaborative opportunities allow students to engage with one another and hone the collaborative skills needed to be successful in the postsecondary realm (Northey et al., 2018).

The use of technology in instruction and student activities makes possible the use of electronic portfolios, or e-portfolios, to compile and analyze a student's work over time. These types of student portfolios allow teachers to understand strengths and weaknesses in process, not just product, then curtail instruction in a way that supports a student's individual development. The use of electronic portfolios may have a particularly positive impact on students with special needs or students struggling to meet required benchmarks (Rhodes, 2011). For those individuals seeking sheltered employment or apprenticeship-based employment straight out of high school, a digital portfolio provides access for employers to important information about a student's skill set. Access to such a portfolio can ease the transition from the classroom into a community college or local employment training program (Rhodes, 2011).

Teachers and Administrators. Teachers and administrators are the gatekeepers for technology in the classrooms, as well as the stewards for academic content and progress toward meeting standards. The influx of technology used in education altered the ways in which teachers and administrators have historically operated within schools. For example, principals have increased their acceptance of mobile device use in school for educational purposes from 2010 to 2013 (Project Tomorrow, 2014). Administrators report that the utility of mobile devices as instructional tools outweighs the potential for them to be distractions in the classroom (Project Tomorrow, 2014). Teachers' perspectives have also changed as technology usage increases. Teachers report their instructional styles and understanding of content delivery has transformed after the introduction of technology in the classroom, which included new ideas about instructional decisions, classroom physical space reorganization, and time allocation for technology-based activities. For example, in one study analyzing the impact of technology on first-grade Chicago teacher behaviors, 89% of technology-rich classrooms used small-group designs during literacy instruction (compared to only 11% of the nontechnology classrooms; Blachowicz et al., 2009). One teacher said, "[I] always just thought stuff like this was games and things, but I could see that the students were really learning something," and another teacher said, "I get farther faster now," when talking about lesson pacing (Blachowicz et al., 2009 p. 399). Teachers report that devices provide a way to personalize instruction and give students added autonomy and ownership over learning progress (Project Tomorrow, 2014).

There is growing literature that points to factors of school climate, such as teacher satisfaction, being leading indicators of successful turnaround implementation (May & Sanders, 2013). Whereas, academic outcomes may lag far after implementation, the first sign of improvement may be observed in how teachers report their job satisfaction. Teachers feel more empowered and supported with the use of technological tools that allow them to quickly, easily, and appropriately differentiate instruction to meet student needs (Rosen & Beck-Hill, 2012) using timely, granular information about student performance (Stahl & Karger, 2016). The use of technology in classrooms gives teachers data beyond the end-of-year summative assessments required by law. Instead, teachers (and students) can use multiple opportunities each day to formatively monitor student progress (Stahl & Karger, 2016). Technology also provides opportunities for teachers to utilize formative data and capitalize on opportunities to shape student behavior and increase outcomes. Using a randomized controlled trial approach, a 3-year longitudinal study examined the use of a classroom technology intervention coupled with strategic professional development for teachers. Findings showed that teachers were able to provide more in-the-moment targeted feedback for students. This feedback led to a large statistically significant improvement in student algebra achievement ($ES = 0.19$, $p < .05$; Irving et al., 2016).

Conclusion

The literature presented in this chapter (summarized in Table 3.1) sets the stage for the present study. There is no single national definition for digital learning, and there are many variations for how digital learning can be implemented in schools and districts, although the NCDLI provides a framework that is used in this study to identify components of digital learning in Rowan retrospectively. Analyzing an initiative of this complexity requires an astute understanding of its implementation and the anticipated outcomes. Prior research that focuses on how digital learning tools, software, and programmatic decisions impact student achievement were explored in this chapter. The impact of cognitive processes was also discussed as an additional point of impact for digital learning and a critical part of the educational process. Student engagement, an essential component to effective educational programming, was defined, and the effect produced by digital learning is generally positive across the literature. Preparation for postsecondary opportunities was described as both the driver and result of effective digital learning policies. Finally, the role of teachers and administrators must also evolve as digital teaching and learning become standard parts of the classroom experiences. Digital learning shifts the need for professional development so that teachers are able to smoothly integrate technology in the classroom while maximizing the utility of such devices and programs.

Table 3.1. Summary of Impact Evidence for Technology in Education

Author	Study focus	Change	Findings
Berry & Wintle, 2009	Student laptops	Positive	On-task behavior increased 30%; comprehended more (*ES* = .61); retained concepts (*ES* = 1.42)
Blachowicz et al., 2009	Teacher perceptions	Positive	Increase in small-group instructional design with technology-rich classrooms (qualitative study)
Cuevas et al., 2012	ELA software	Positive	Total reading ability increased 0.62 *SD**
Farkas, 2003	Individualized instruction	Positive	Overall achievement (*SD* = 1.1)***
Fazal & Bryant, 2019	Blended learning	Positive	Math growth increased 0.30 *SD***
Gulek & Demirtas, 2005	One-to-one program	Positive	Math (*F* = 13.89)***; language (*F* = 9.84)**; overall GPA Years 1 and 2 (*F* = 12.65 to 14.47)**; overall GPA Year 3 (*F* = 2.13)
Hull & Duch, 2019	One-to-one program	Positive	Math achievement increased 0.13 *SD*
Irving et al., 2016	Connected classroom technology for algebra	Positive	Algebra achievement (*ES* = .19)*

Table 3.1. (continued)

Lin & Bruce, 2013	Digitally mediated arts education	Positive	Connects individuals and communities (qualitative)
Northey et al., 2018	Asynchronous learning	Positive	Perceived engagement increased ($t(115) = -3.09$)**
Rosen & Beck-Hill, 2012	One-to-one program	Positive	Math (*SD* = 2.7)**; reading *SD* = 2.2)**; fourth-grade reading motivation (*SD* = 3.0)**; fifth-grade motivation (*SD* = 2.2)*; classroom disciplinary infractions (15.4% to 62.5%)
Shapley et al., 2011	Technology immersion	Positive	Reading growth (Gamma = .39); math growth (Gamma = .71)†
Wichadee & Pattanapichet, 2018	English learners and technology	Mixed	Learning motivation (*SD* = .44)**

*$p < .05$. **$p < .01$. ***$p < .001$. $^{\dagger}p < .10$.

The majority of studies summarized in Table 3.1 support the hypothesis that technology in education has statistically significant positive impacts on student outcomes, and no significant negative impacts were discovered in the review of literature. These findings may very well indicate a publication bias. These findings could also mean that initial implementation of technology in education could consistently result in improved outcomes. There is also cautionary research describing the oversimplification of digital learning in schools and the associated research. Some researchers view digital learning as merely the latest school reform fad and worry that, like other large-scale reforms of the past, digital learning will lead to little or no change in the long-run outcomes for students. The intersection in the literature of positive outcomes and digital learning skeptics prompts future research in this area.

There is a need for more robust research that expands beyond understanding whether a specific program works or how small-scale educational technology programs impact student and teacher outcomes (Cavanaugh et al., 2015; Watson et al., 2014). The present study analyzes the impact of a digitally focused districtwide turnaround model in the Rowan school district. However, evaluating Rowan's policy change presents a missing data issue. We do not have an additional Rowan district to which I can compare school-level outcomes in the post period. To accommodate the missing data, I employ a difference-in-differences approach to compare Rowan schools to other NC traditional public schools that are similar on observable characteristics.[8]

[8] Heckman et al. (1997) recommend the difference-in-differences approach over matching due to the inherent bias that can exist when using a matching approach.

CHAPTER 4. METHODS

This study aims to understand the impact of a digitally focused districtwide turnaround model on school-level student achievement and teacher satisfaction in Rowan. A comparison sample is created by first focusing on schools in a locale similar to Rowan, then using inverse propensity weighting to establish a set of comparison schools that is similar to Rowan on observable pretreatment characteristics and weighting them accordingly in the analytical models. This analysis addresses the question of how Rowan's policy decisions in 2014–15 affected student and teacher outcomes. Specifically, this work addresses the following research questions:

1. What was the overall effect of the Rowan digitally focused districtwide turnaround on student achievement and teacher satisfaction?
2. What was the effect of the Rowan digitally focused districtwide turnaround model on student achievement and teacher satisfaction in each posttreatment year?

This chapter first describes the sample used to understand the impact of the Rowan model, then an explanation of the outcome and covariate data is provided. Lastly, the three models used for analysis are described.

Sample

North Carolina has 115 school districts that span major metropolitan areas with high levels of wealth to remote rural areas with extreme poverty. Given this variety of locale and wealth, it is important to ensure that Rowan schools are being compared to schools that are similar and to first remove those schools that are drastically different on observable characteristics, for example, school locale. Table 4.1 summarizes the number of schools that fall into each federally defined broad locale category. A look at the distribution of schools across locale types shows that the majority of schools in North Carolina were located in rural areas in

2010. Given that 1,199 schools were in a rural area, like Rowan, the first stage of creating a comparison is to match on locale and eliminate all schools that were not considered rural in 2010. This ensures that the starting comparison sample is similar to Rowan in locale and eliminates larger urban and suburban districts.

Table 4.1. Summary of Schools That Represent Each Locale Category in 2010

Locale	North Carolina schools	Rowan	Total
Rural	1,199	35	1,234
Town	198	0	198
Suburb	188	0	188
City	757	0	757
Total	2,342	35	2,377

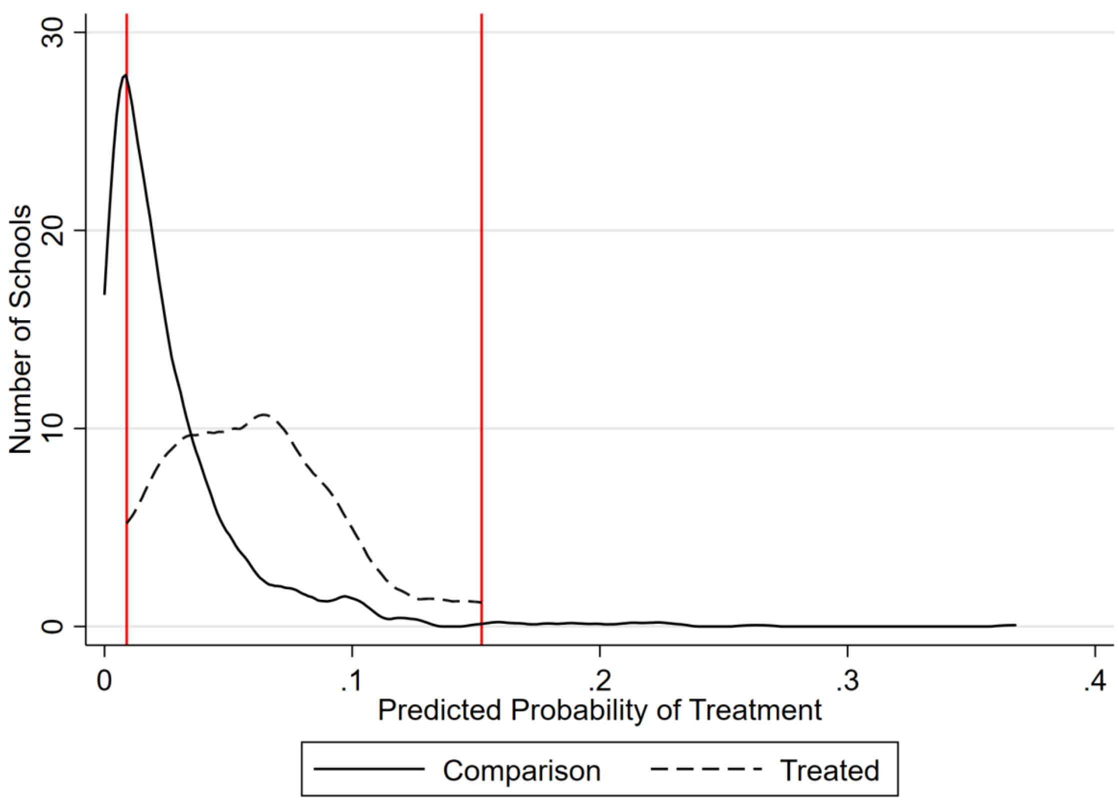
After nonrural schools were removed, the next step in creating the comparison sample was to determine the propensity for each rural school to be in Rowan using a theoretical logistical regression. Covariates in the propensity weighting included those characteristics that are observable in public data that could be used to produce a set of schools that were most similar to Rowan (Table 4.2). School-level student and teacher characteristics were used to identify schools with similar composition across the state. District characteristics, such as median household income and per-student spending, along with school-level average daily membership (ADM), were also used to determine the propensity of schools to receive treatment (i.e., be a school in Rowan). Table 4.2 lists all covariates used in the propensity and weighting models.

Table 4.2 Covariates for Inverse Propensity Weighting

Student characteristics	Teacher characteristics	District characteristics
Race	Years of experience	Median household income
Gender	Advanced degree	Per-student spending
Economically disadvantaged (EDS)	Teacher turnover rate	School-level ADM
Students with disabilities		
English learners (EL)		
Academically and intellectually gifted (AIG)		

The results from the logistic regression were then plotted to visually understand the area of overlap, or common support, between Rowan schools and other rural North Carolina schools. Figure 4.1 illustrates where the propensity to be Rowan overlaps.

Figure 4.1. Area of Common Support for Schools in Rowan and Other Rural Districts



Next, the inverse propensity was calculated, producing an average treatment on the treated (ATT) weight for each school in the rural sample. This weight reflects how similar each school is to schools in Rowan. Schools with a higher propensity to be Rowan (i.e., more similar to Rowan schools) receive a higher weight, while schools with a lower propensity to be Rowan are given a smaller weight. The raw and standardized differences between Rowan and the rural sample and the weighted rural sample (Table 4.3) demonstrate that the weighting substantially decreased the differences between Rowan and the comparison sample.

Table 4.3. Baseline Variable Differences Between Rowan and Comparison Sample

	Rowan	Rural Schools	Raw Difference	Standardized Difference	Weighted Rural Schools	Raw Difference	Standardized Difference
Students							
% Native American or Pacific Islander	0.01	0.03	-0.02	-0.25	0.01	0.00	0.00
% AIG	0.12	0.13	-0.01	-0.23	0.12	0.00	0.00
% Asian	0.02	0.02	0.00	0.10	0.02	0.00	-0.01
% Black	0.23	0.26	-0.03	-0.14	0.23	0.00	0.01
% EDS	0.61	0.58	0.03	0.15	0.61	0.00	-0.01
% Female	0.49	0.50	-0.01	-0.16	0.49	0.00	0.01
% Hispanic	0.11	0.12	-0.01	-0.11	0.11	0.00	0.00
% EL	0.08	0.08	0.01	0.10	0.08	0.00	-0.02
% Male	0.52	0.52	-0.01	-0.10	0.52	0.00	0.00
% Two or More Races	0.05	0.05	0.00	0.06	0.05	0.00	-0.02
% Students with a Disabilities	0.14	0.15	-0.01	-0.12	0.14	0.00	-0.01
% White	0.64	0.60	0.04	0.15	0.64	0.00	0.00
Teachers							
% with 0-3 years of experience	0.18	0.19	-0.01	-0.11	0.18	0.00	0.02
% with 10+ years of experience	0.53	0.52	0.02	0.14	0.54	0.00	-0.03
% with 4-9 years of experience	0.29	0.30	-0.01	-0.06	0.29	0.00	0.02
% with Advanced Degree	0.22	0.25	-0.04	-0.39	0.22	0.00	0.00
Turnover Rate	0.10	0.13	-0.03	-0.36	0.10	0.00	0.01
District							
School-Level ADM	606	543	63	0.22	601	4.49	0.02
Per-Student Spending	$ 1,776	$ 1,793	$ -17	-0.04	$ 1,781	$ -5	-0.01
Median Income	$ 44,022	$ 42,221	$ 1,801	0.30	$ 44,123	$ -101	-0.02
Average Standardized Difference				0.15			0.01

Data

This work uses publicly available data from the NCDPI, North Carolina Education Research Data Center, the Public School Forum, and the Common Core of Data. Student outcome data include student achievement, as measured by the EOG North Carolina state assessment in Grades 5 and 8 and the ACT taken in Grade 11 by all North Carolina students. To understand teacher perceptions, this study uses data from the biannual TWCS. This study also includes school-level student and teacher descriptive data from NCDPI, as controls. District locale and median income, from the Common Core of Data, along with per-student spending from the Public School Forum are used to calculate inverse propensity weights. The following paragraphs describe all data used for this study.

Dependent Variables. The EOG assessments are given each year for students in grade 3-8, while the ACT is required each year for students in Grade 11. The TWCS is a voluntary anonymous online staff survey and is only given every other year. Table 4.4 summarizes the years and outcomes across the study period.

Table 4.4. Summary of Study Period and Dependent Variables

School year	Dependent variables
Pretreatment	
2009–10	Student achievement and teacher satisfaction
2010–11	Student achievement
2011–12	Student achievement and teacher satisfaction
2012–13	Student achievement
2013–14	Student achievement and teacher satisfaction
Treatment	
2014–15	Student achievement
2015–16	Student achievement and teacher satisfaction
2016–17	Student achievement
2017–18	Student achievement and teacher satisfaction

Student Achievement. To understand the impact on student achievement, this study focuses on demonstrated proficiency in Grades 5 and 8 in reading and ELA and science as measured by the North Carolina EOG assessments at the school level. For high school students (i.e., Grade 11), this study uses the ACT assessment and focuses on the average school-level composite score.

North Carolina EOG Assessments. North Carolina administers annual EOG assessments to satisfy both state and federal accountability requirements. Students in Grades 3–8 and 10 take annual assessments, either in an online or paper-and-pencil version, in reading and ELA and math[9]. In Grades 5 and 8, students also take a science EOG assessment. All EOG assessments are given during the last 10 days of the school year and are a summative assessment of a subset of standards that were taught during the year. The NCDPI publicly annually reports student

[9] The high school EOG assessments are taken when a student completes the required course on which the assessment is based. Most students take the summative state assessments in Grade 10; however, some students take the required courses in other high school years. For more information about the North Carolina required assessments, visit https://www.dpi.nc.gov/districts-schools/testing-and-school-accountability.

achievement at the school level. Additionally, student achievement data are reported at the school level by student subgroup (i.e., race, ethnicity, disability status, English learner status, economically disadvantaged status). In 2013, the NCDPI began using a new edition of the EOGs. Therefore, a concordance table is used to bring all scores from 2010 through 2012 to the same scale as those from 2013 and beyond. After intensive investigation and contacting the NCDPI directly, the required concordance tables were *only* available for reading and science. Unfortunately, the required math concordance table needed to put scores across the study period on the same scale was not available. Therefore, math EOG scores are not used in this analysis of student outcomes for grade 5 or 8.

ACT. In North Carolina, the ACT is taken by all Grade 11 students by the end of March each year. Publicly available school- and district-level scores for the ACT include subtest scores on English, math, reading, science, and writing, as well as average composite scores. The average composite ACT score is the focus of this study.

Teacher Satisfaction. The biannual TWCS was used to understand the impact of treatment on teacher satisfaction. Every 2 years since 2002, North Carolina administers the TWCS.[10] All licensed school-based teachers, including itinerant and part-time teachers, anonymously provide electronic responses to the survey, and results are made publicly available after the 4-week survey window closes. For each topic area, teachers are asked to answer a set of questions to help state decision makers understand the experience of teachers and inform policy decisions.

The district turnaround policy in Rowan focused on digital accessibility, professional development, and collaboration among teachers, families, and the community. The TWCS asks several direct questions in each of these areas, and response categories range from *strongly*

[10] For more information about the TWCS, visit https://ncteachingconditions.org/about.

disagree to *strongly agree*. Table 4.2 summarizes the survey questions that are used to understand teachers' perceptions as they relate to components of this district turnaround model.[11]

[11] The North Carolina Education Research Data Center provided the TWCS data for this dissertation.

Table 4.5. Summary of TWCS Data to Understand District Turnaround

Survey domain	Survey items
Facilities and Resources	Teachers have sufficient access to instructional technology, including computers, devices, printers, software, and internet access. Teachers have access to reliable communication technology, including phones, faces, and email.
Community Support and Involvement	This school maintains clear, two-way communication with the community. This school does a good job of encouraging parent/guardian involvement. Teachers provide parents/guardians with useful information about student learning. Community members support teachers, contributing to their success with students.
Teacher Leadership	Teachers are recognized as educational experts. The faculty has an effective process for making group decisions to solve problems.
School Leadership	The school leadership makes a sustained effort to address teacher concerns about: Professional development Community support and involvement Instructional practices and support
Professional Development	Teachers have sufficient training to fully utilize instructional technology. Teachers are encouraged to try new things to improve instruction. Teacher collaborate to achieve consistency on how student work is assessed.

Covariates

Covariates are added to the analyses to control for school-level compositional changes over time that could potentially be correlated with the treatment and outcomes (students and teachers).

School-Level Student Characteristics. For each summative assessment, the state collects the total number of students who participated at the school level for each grade and content area assessment (e.g., reading and science). In addition, the number of tested students in each of the following subgroups is reported: race, gender, economically disadvantaged status, academically and intellectually gifted status, English learner status, and disability status. Race is reported as American Indian/Alaska Native, Asian, Black, Hispanic/Latino of any race, Native Hawaiian/Other Pacific Islander, White, or two or more races. Gender is reported as binary (i.e., male or female), and indicators are used to represent if a student is economically disadvantaged based on family income and number of people in the household. Based on district procedures, students are designated as academically and intellectually gifted, and state-level English proficiency standards are imposed to assign an indicator variable for students lacking sufficient English language skills. Students identified as having a disability according to federal IDEA (Individuals with Disabilities Education Act) standards and state guidance are represented by a disability indicator variable.[12]

The NCDPI summative assessment performance data for all subgroups are reported by grade and content area assessment (e.g., reading and science) for every school in the state. In addition, NCDPI reports the total number of tested students for each grade and content area

[12] The proportion of students with a Section 504 plan are not represented in this analyses as those data are not publicly available.

assessment. Using the subgroup and total counts at the school level, the percentages of students who represent each subgroup were calculated and used as control covariates in this work.

School-Level Teacher Characteristics. The NCDPI maintains publicly available data about teacher qualifications. Data include the percentage of teachers with advanced degrees (e.g., master's degree, doctorate) and the percentage of teachers with 0–3 years, 4–10 years, or more than 10 years of experience in the classroom. The teacher turnover rate is also publicly reported on an annual basis. These data are used as controls in both student and teacher outcome models.

District-Level Characteristics. Locale and median household income, both from the Common Core of data, school size (from the NCDPI) and per-student spending (from the Public School Forum) are used in the inverse propensity weighting model to create the comparison sample. The average daily membership (ADM) is used as a school-size covariate in the analytical models.

Summary of Variables

The dependent variables in this work (student performance and teacher satisfaction), along with relevant covariates, illuminate the impact of treatment. Table 4.3 summarizes all variables that are used in this work.

Table 4.6. Summary of Control and Outcome Variables

Variable	Description
Control variables	
Race	Proportion of students who are of a particular race within each school. Indicator variables are included for the percentage of students who identify as the following: Asian, Alaska Native/Native American/Pacific Islander, Black, Hispanic, White, and two or more races.
Gender	Proportion of students who identify as male or female within each school.
Economically disadvantaged	Proportion of students within each school who are identified as being economically disadvantaged.
Students with disabilities	Proportion of students who are identified as having a disability within each school.
English learners	Proportion of students who are identified as having limited English learning proficiency within each school.
Academically and intellectually gifted	Proportion of students who are identified as academically and intellectually gifted within each school.
Teacher experience	Proportion of teachers with 0–3 years, 4–10 years, or 10 or more years of experience.
Teacher advanced degree	Percentage of teachers in a school who have a master's degree or a doctorate.
Teacher turnover	Annual rate of teacher turnover at the school level.

Table 4.6. (continued)

Median Income	Median income in the district.
School Size	Number of students served in each school.
Per student spending	Total spending per student, including the district portion and the state supplements for low-wealth and small districts.
Outcome variables	
EOG reading achievement	School-level achievement for students in Grades 5 and 8 for reading and ELA.
EOG science achievement	School-level achievement for students in Grades 5 and 8 for science.
ACT composite	School-level ACT composite score for Grade 11 students.
TWCS response	Teachers' responses on the TWCS domains for the Facilities and Resources, Community Support and Involvement, Teacher Leadership, School Leadership, Professional Development, and Instructional Practices and Support.

Note. According to the NCDPI rules of public data sharing, student counts and percentages that are above and below certain thresholds are omitted from public reporting. Counts that are too low to be included will be coded as zeros, and percentages that are too high to be publicly available will be coded as 100%.

Estimation

Model 1. This study uses a difference-in-differences approach to estimate the impact of Rowan's digitally focused district turnaround model on student and teacher outcomes as compared to the outcomes in traditional public schools that are similar to Rowan across the state.

$$Y_{st} = \alpha_s + \lambda_t + \beta D_{st} + \varepsilon_{st} \tag{1}$$

This equation represents the outcome for school *s* at time *t*. The coefficient of interest is the treatment variable (βD_{st}) of being a Rowan school in the treatment period. The value of this coefficient is the overall impact of the model across all posttreatment years (Murnane & Willett 2010). School fixed effects (α_s) are included in the model to control for school characteristics that are constant over time but vary between districts. These characteristics can include things like wealth in a particular area or a school's locale. Year fixed effects (λ_t) control for things that vary year to year but have a constant effect over all units. Examples could be statewide policy changes for teacher credentials or adaptations in state academic standards. Model 1 weights each school in the comparison group depending on its likeness to Rowan schools.

Model 2. The naïve estimates in Model 1 show the effect of Rowan's turnaround policy. However, Model 1 lacks data about school characteristics. The characteristics of students and teachers in each school are included in Model 2.

$$Y_{st} = \alpha_s + \lambda_t + \beta X_{st} + \beta D_{st} + \varepsilon_{st} \tag{2}$$

This equation represents the outcome for school *s* at time *t* while controlling for school-level characteristics (*X*). School-level characteristics include student composition and teacher experience, education, turnover rate and school size. School (α_s) and year (λ_t) fixed effects are also included along with school weighting. Again, the coefficient of interest is the treatment variable (βD_{st}) for Rowan schools in the treatment period.

Model 3. Examining the lead and lagged outcomes provides more context regarding the impacts estimated in Models 1 and 2. Although a visual inspection is employed to investigate the presence of pretreatment parallel trends (Figures A1 through A4), an estimate of those pretreatment outcomes is calculated by including an interaction of the pretreatment years (i.e., 2010–2014) and treatment variable. The lagged effects in each of the years following the implementation of Rowan's turnaround model allow me to examine how student achievement and teacher perceptions changed in each year after implementation. This estimate gives granular detail about what can be expected in the years following the adoption of a similar policy. The interaction of the treatment variable and each year pre and posttreatment will be the coefficients of interest.

$$Y_{st} = \alpha_s + \lambda_t + \sum_{j=-m}^{q} \beta_j D_{st+j} + \beta_{2+1} + \beta X_{st} + \varepsilon_{st} \tag{3}$$

This equation represents the outcome for school *s* at time *t* while controlling for school (α_s) and year (λ_t) fixed effects, as well as school-level characteristics (*X*). D_{st} is now an indicator for whether the treatment was turned on in year *t*. This estimates *q* leads and *m* lags of the treatment, where the leads should all be zero if the parallel trends assumption holds. The year-by-year coefficients for the pretreatment years (2010-2013) will allow me to evaluate outcome pre-trends. The year-by-year coefficients for treatment years (2015-2017) will estimate impact on student and teacher outcomes in *each* treatment year.

CHAPTER 5. RESULTS

Introduction

The difference-in-differences approach compares the changes in the treated group to the changes in the comparison group to estimate the effect of treatment. In this study, the treated group consists of all schools in Rowan, and the comparison sample consists of rural schools with similar observable characteristics as Rowan at the beginning of the study period. This study uses three models to measure the impact of Rowan's digitally focused districtwide turnround model on student and teacher outcomes. Inverse propensity weights are used in each model to weight control schools according to how similar they are to Rowan on observable characteristics. The first model uses school and year fixed effects to estimate the overall treatment effect of Rowan's digital turnaround model. The second model adds school-level characteristics to control for covariates, such as student composition, teacher experience, and school size, that change over time and may be correlated with outcomes. The coefficient of interest in the first two models was the treatment variable. The third model includes school and year fixed effects, school- and district-level covariates, and indicators to represent the leads and lags for each student and teacher measure of interest. The coefficients of interest in the third model are the interactions of each year and the treatment variable. The coefficients for the posttreatment years isolate the treatment effect for each posttreatment year included in the data (i.e., 2014-15 through 2016–17), while the pretreatment coefficients for each year (i.e., 2010-11 through 2012–13) allow me to statistically test for parallel trends prior to treatment.

Analysis

This section describes the results from the analytical models with and without covariates along with an examination of the year-by-year observed differences. Finally, this section includes a description of how the presence of parallel trends was evaluated and where they exist.

Overall Observed Effects. Model 1 and Model 2 estimate the overall average treatment effect for all posttreatment years (2015, 2016, and 2017). The coefficient of interest in Models 1 and 2 is the treatment variable, shown in Table 5.4, for all outcomes in the study.[13] Model 1 includes school fixed effects to control for school characteristics that are constant over time but vary between districts, and year fixed effects control for factors that varied year to year but have a constant effect over all schools in the state. Model 2 adds school-level characteristics as covariates to control for things that may be correlated with the outcome. These covariates include the percentage of students in each school who identify as male or female and the percentage of students who are determined to be an English learner (EL), a student with a disability, a student who is academically and intellectually gifted (AIG), or a student who is economically disadvantaged (EDS). The racial and ethnic composition of schools, which includes the percentage of students who are Asian, Black, Hispanic Native American or Pacific Islander, White, or identify as two or more races, is also incorporated in Model 2. The per-student spending and school-level ADM are also used in Model 2. Covariates also include the percentage of teachers in each school with 0–3, 4–9, and 10 or more years of experience and of teachers with an advanced degree and the school-level teacher turnover rate.[14]

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[13] Tables A1 and A2 in the Appendix also includes coefficients for the year fixed effects in Model 1.
[14] Tables A3 and A4 in the Appendix also includes coefficients for year fixed effects and all covariates in Model 2.

Estimates from Model 1 and 2 show inconclusive results for Grade 5 and 8 and teachers' perceptions of *Facilities* and *Community Involvement and Support* (due to a lack of parallel trends which are discussed later in this chapter). Results are statistically indistinguishable from zero for the ACT and the *Teacher Leadership, School Leadership,* and *Overall* components of the TWCS. Statistically significant negative results are observed the *Professional Development* component of the TWCS in models both with and without covariates. Because the raw scores are used here, it is helpful to think about this difference in relation to the standard deviation for the distribution of scores. For example, the standard deviation for the *Professional Development* component for the TWCS across the study period is approximately .27. This means that the statistically significant -.12 difference is equivalent to approximately -.44 standard deviations. Models 1 and 2 along with the existence of parallel trends are summarized in Table 5.1.

Table 5.1. Observed Effect on School-Level Student and Teacher Outcomes, With and Without Covariates

Outcomes	Model 1 (no covariates)	Model 2 (with covariates)	Parallel trends
Grade 5 Outcomes (schools = 449 observations = 3,465)			
Reading	-0.28	-0.23	No
	(0.29)	(0.24)	
Science	-1.25**	-1.56***	No
	(0.38)	(0.31)	
Grade 8 Outcomes (schools = 216 observations = 1,651)			
Reading	-2.71***	-2.59***	No
	(0.53)	(0.49)	
Science	-1.51**	-1.89***	No
	(0.47)	(0.44)	
High School Outcomes (schools = 167 observations = 820)			
ACT Composite	-0.20	-0.11	Yes
	(0.18)	(0.10)	
Teacher Outcomes (schools = 805 observations = 3,190)			
Facilities	0.27***	0.27***	No
	(0.04)	(0.04)	
Community Involvement and Support	-0.02	-0.04	No
	(0.04)	(0.03)	
Teacher Leaders	0.00	-0.01	Yes
	(0.06)	(0.05)	
School Leaders	0.01	0.01	Yes
	(0.04)	(0.04)	
Professional Development	-0.11*	-0.12*	Yes
	(0.06)	(0.06)	
Overall	0.03	0.02	Yes
	(0.04)	(0.04)	

Note. All models include year and school fixed effects. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Overall, Models 1 and 2 showed similar results. Without parallel trends, the observed impact on all Grade 5 and 8 subject areas and teacher perceptions of *Facilities* and *Community Involvement and Support* are inconclusive, regardless of observed magnitude or statistical significance. Where parallel trends do exist, results are indistinguishable from zero, with the exception of *Professional Development* where a statistically significant negative difference is observed.

Year-by-Year Treatment Effect. Model 3 includes the year and school fixed effects and the school-level characteristics as covariates. Additionally, Model 3 has indicators for treated and comparison schools in each pre- and post-treatment year. The coefficients of interest in this model are the indicators for treatment within *each* year. Estimates of student and teacher outcomes using school and year fixed effects, along with covariates in each year, is of interest for two reasons. First, the estimated treatment effect in each posttreatment year isolates the impact of the turnaround model in each treatment year. This information helps contextualize the findings from Models 1 and 2. Models 1 and 2 cluster all posttreatment years together (Rowan and the weighted comparison, respectively) and contrasts that with the clustered pretreatment years. This broad comparison of pretreatment and posttreatment may amplify the observed effects more than the year-by-year outcomes, which instead isolate the observed effect of Rowan compared to the comparison within each year. Secondly, the pretreatment outcomes show the pretreatment trends between Rowan and the comparison sample. Using statistical testing, I demonstrate that parallel trends only exist for the ACT and the *Teacher Leaders, School Leaders, Professional Development,* and *Overall* components of the TWCS. All other outcomes do not exhibit parallel trends (more discussion about parallel trends in a section that follows). Table 5.2 summarizes the interaction of treatment and time for each year of the study period and again shows the existence of parallel trends.[15]

[15] Tables A5 and A6 in the Appendix includes coefficients for all years and all covariates.

Posttreatment Outcomes. The interaction of each study year and being a treated school (i.e., a school in Rowan) provides opportunity to investigate each posttreatment year, as opposed to the clustered pre- and posttreatment year effects shown in Models 1 and 2. The lack of parallel trends renders the observed effects on all subject areas in Grade 5 and 8 and *Facilities* and *Community Involvement and Support* inconclusive. For those outcomes with parallel trends, all observed results in this year-by-year analysis are indistinguishable from zero. Although Models 1 and 2 showed statistically significant outcomes for the *Professional Development* component of the TWCS, those effects are not observed in the year-by-year analysis. The results from each pretreatment and posttreatment year are summarized in Table 5.2.

Table 5.2. Estimated Effect on School-Level Student and Teacher Outcomes in Each Year

Outcome	Pretreatment				Posttreatment			Parallel trends
	2010	2011	2012	2013	2015	2016	2017	
Grade 5 Outcomes (schools = 449 observations = 3,465)								
Reading	1.46***	0.90*	0.51	-0.17	0.09	0.55	0.33	No
	(0.44)	(0.44)	(0.48)	(0.48)	(0.36)	(0.36)	(0.38)	
Science	0.57	0.49	0.90	-0.46	-1.61*	-0.79	-1.36	No
	(0.58)	(0.64)	(0.47)	(0.58)	(0.67)	(0.86)	(0.79)	
Grade 8 Outcomes (schools = 216 observations = 1,651)								
Reading	2.87***	2.71***	2.12**	1.21*	-1.64*	0.11	-0.81	No
	(0.72)	(0.78)	(0.72)	(0.51)	(0.74)	(0.75)	(0.84)	
Science	1.61**	1.47	1.70***	0.95	0.14	-1.73*	-1.00	No
	(0.52)	(0.76)	(0.42)	(0.63)	(0.73)	(0.74)	(0.66)	
High School Outcomes (schools = 167 observations = 820)								
ACT Composite				0.34	0.08	-0.15	0.21	Yes
				(0.26)	(0.08)	(0.16)	(0.24)	
Teacher Outcomes (schools = 805 observations = 3,190)								
Facilities	-0.02		0.13***			0.30***		No
	(0.05)		(0.04)			(0.04)		
Community Involvement and Support	0.08**		0.09**			0.02		No
	(0.03)		(0.03)			(0.04)		
Teacher Leaders	0.03		0.07			0.02		Yes
	(0.06)		(0.06)			(0.06)		
School Leaders	0.02		0.06			0.03		Yes
	(0.04)		(0.04)			(0.04)		
Professional Development	-0.03		0.06			-0.11		Yes
	(0.06)		(0.04)			(0.06)		
Overall	0.02		0.08*			0.05		Yes
	(0.04)		(0.04)			(0.04)		

*p < .05. **p < .01. ***p < .001. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

Testing for Parallel Trends

The following basic assumptions need to be met for a difference-in-differences approach:

- The intervention cannot be related to the outcome at baseline.
- The treated and comparison groups are stable over time.
- There no spillover effects of treatment to comparison units.
- The treatment and comparison groups have parallel outcome trends prior to treatment.

Rowan was the only district in North Carolina to implement a digitally focused districtwide turnaround in the treatment year, as evidenced by data showing the student-to-device ratio and allocation of an ITF.[16] This package of changes was not assigned to other districts with similar levels of achievement and teacher satisfaction. Instead, it was a district-specific decision to make significant changes in school policy. The schools in Rowan and the schools in the comparison sample remain in their respective groups throughout the study period, and there is no observable or theoretical evidence of spillover effects to comparison districts from Rowan. The one difference-in-differences assumption that cannot be defended using the information provided in the Policy chapter (Chapter 2) is the assumption of parallel trends. Evidence of pretreatment parallel trends in this case will come from student and teacher outcomes between 2010 and 2013.

To investigate the existence of parallel trends, I analyze the outcomes from 2010 through 2013 for Grades 5 and 8 EOGs, from 2013 for the ACT, and from 2010 and 2012 for teacher satisfaction. The results in Table 5.2 (above) and Figures 5.1 through 5.4 (below) show that many outcomes in this study have trends that diverge from each other during the pretreatment period. The outcomes in the respective pretreatment years are tested to see if there is a

[16] The Annual Media and Technology Report (AMTR) and Digital Learning and Media Inventory (DLMI) are tools used by the NCDPI to capture the number of devices and allocation of ITFs. These data provide evidence that Rowan was the only district with one-to-one devices and a full-time ITF in each school.

statistically significant difference. The null hypothesis here is that the trends in Rowan and the comparison sample do not differ in the pretreatment years. If they do not differ with statistical significance, I fail to reject the null hypothesis and assume that there are parallel trends. If the trends are different with statistical significance, then I reject the null hypothesis and assume that outcomes do not have parallel trends. Table 5.3 shows the *p* value for the joint hypothesis tests of pretreatment interactions and which outcomes exhibit parallel trends. Some observed outcomes in this study demonstrate parallel trends between Rowan and the comparison sample, while most do not. This is verified by both hypothesis testing (Table 5.3) and visual inspections (Figures 5.1 through 5.4). Interpretation of results where parallel trends do not exist are inconclusive and are examined in the Discussion chapter (Chapter 6).

Table 5.3. Summary Evidence of Parallel Trends

	p Value	Parallel Trends
Grade 5 Outcomes		
Reading	0.00	No
Science	0.00	No
Grade 8 Outcomes		
Reading	0.01	No
Science	0.00	No
High School Outcomes		
ACT Composite	0.20	Yes
Teacher Outcomes		
Facilities	0.00	No
Community Involvement and Support	0.01	No
Teacher Leadership	0.47	Yes
School Leadership	0.32	Yes
Professional Development	0.19	Yes
Overall	0.05	Yes

	p Value	Parallel Trends
Grade 5 Outcomes		
Reading	0.00	No
Science	0.00	No
Grade 8 Outcomes		

Table 5.3. (continued)

Reading	0.01	No
Science	0.00	No
High School Outcomes		
ACT Composite	0.20	Yes
Teacher Outcomes		
Facilities	0.00	No
Community Involvement and Support	0.01	No
Teacher Leadership	0.47	Yes
School Leadership	0.32	Yes
Professional Development	0.19	Yes
Overall	0.05	Yes

Figure 5.1. Grade 5 Reading and Science Achievement in Rowan and Weighted Comparison Sample

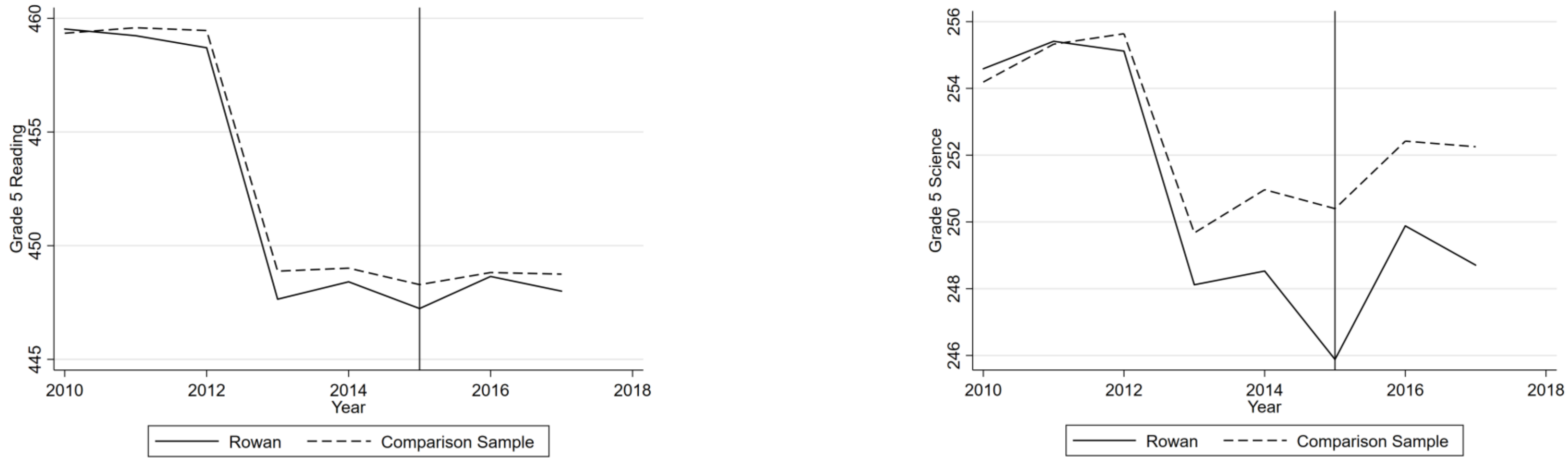


Figure 5.2. Grade 8 Reading and Science Achievement in Rowan and Weighted Comparison Sample

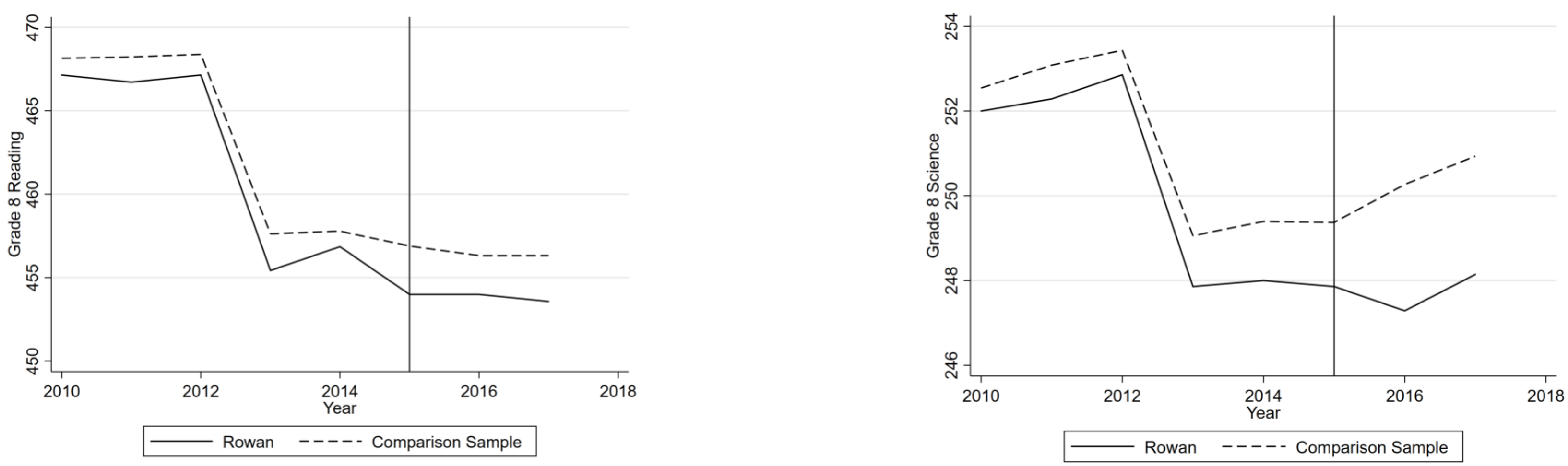


Figure 5.3. ACT Achievement in Rowan and Weighted Comparison Sample

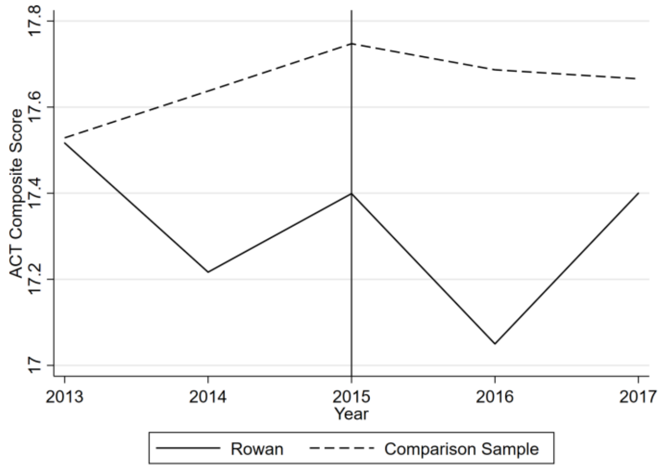
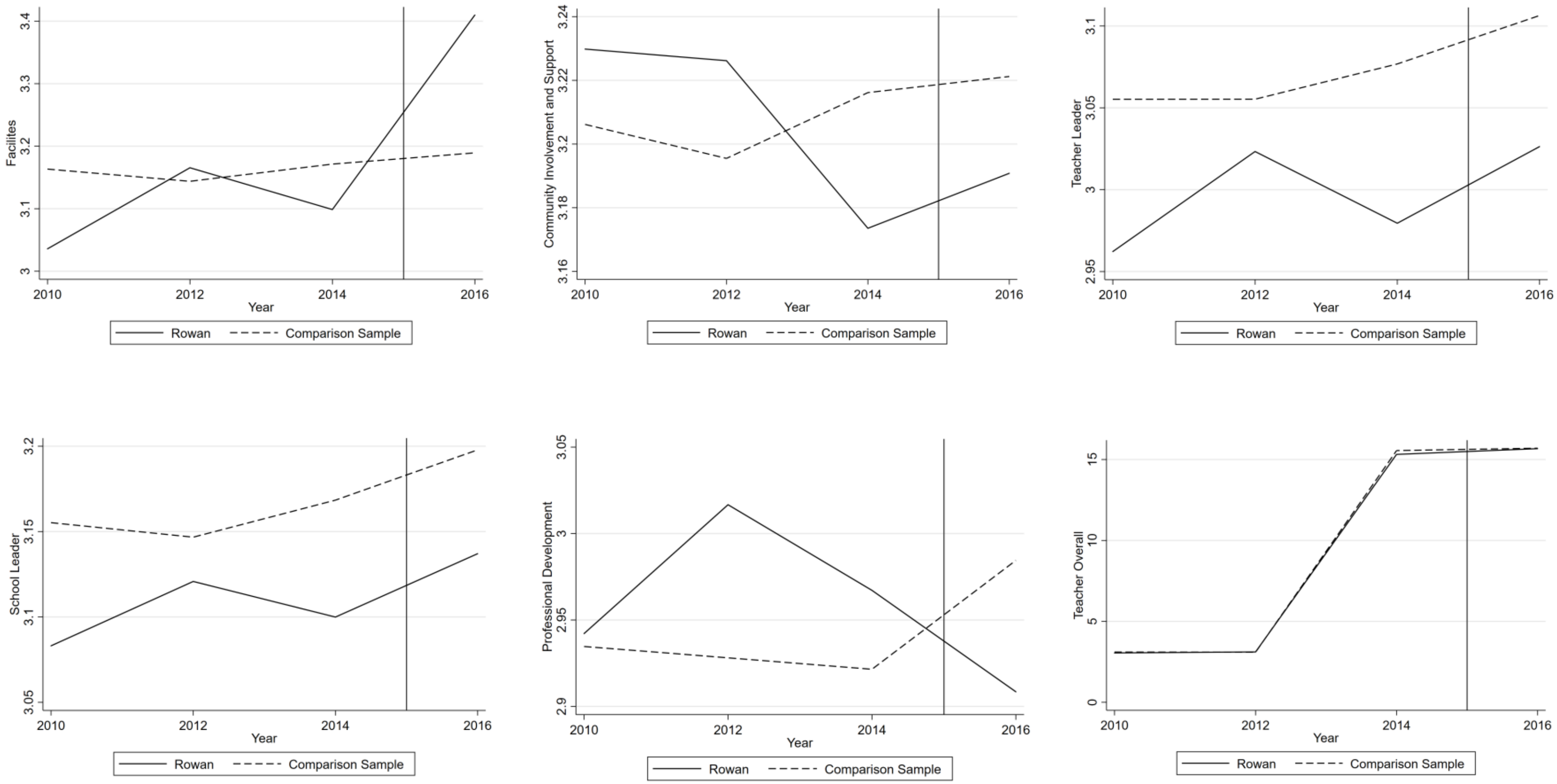


Figure 5.4. Teacher Working Conditions Survey Results in Rowan and Weighted Comparison Sample



Conclusion

Overall, these results show that the digitally focused districtwide turnaround model in Rowan is associated with largely inconclusive observed differences for students, some null differences for students and teachers, and statistically significant negative results for teachers (*Professional Development* component) when comparing pretreatment to posttreatment. Models 1 and 2 reveal statistically significant negative results after implementation of the turnaround model for *Professional Development,* while Model 3 showed null results for this same outcome.

Analyses of the pretreatment years show that Rowan was already declining in student achievement prior to implementation of the turnaround model and that parallel trends exist for ACT and most teacher outcomes. The next chapter discusses the implications of these findings and limitations of this study.

CHAPTER 6. DISCUSSION

Introduction

This study used case study approach to understand the Rowan turnaround model and a difference-in-differences approach to compare Rowan schools with a group of weighted comparison schools to analyze the impact of the digitally focused districtwide turnaround model on student and teacher outcomes. Findings show overall inconclusive results for the majority of student and two teacher outcomes due to a lack of parallel trends on outcome measures in the pretreatment period. Although statistically significant in the overall effect models, both with and without covariates, the negative differences in teachers' perceptions of *Professional Development* was not observed in the year-by-year analysis. Outcomes for which there were parallel trends, but null results include the ACT, and teachers' perceptions of *Teacher Leaders, School Leaders*, and *Overall*.

Districts considering similar initiatives can learn about how Rowan implemented and sustained its digital efforts alongside these estimated impacts. Rowan used zero-based budgeting to help prioritize digital learning components in the annual budget and leased devices to provide a predictable budget item year-to-year. North Carolina considers Rowan a regional example of digital learning and recently awarded Rowan funds to become a regional and national example. These additional funds are intended to support the district in managing district visits and refine the digital components of their turnaround model.[17] The state and national spotlight on Rowan makes contextualizing findings from this work with the study limitations, and the potential future research aimed at further exploration, especially important.

[17] At the time of this dissertation study, data were unavailable about exactly how additional state funds were used at the district and school level.

This chapter begins with a description of the implications of these results on future policy decisions then explains the limitations of this work. Lastly, this chapter describes future research that can be conducted with these data and with future data and/or additional data collection.

Implications of Results on District and State Policy Decisions

The contrast of overall versus year-by-year treatment effects is important for policymakers to understand. The overall treatment effects reported here include a declining Rowan student achievement in the pre-period and compares to the overall posttreatment outcomes. The year-by-year analysis provides results in *each* posttreatment year instead of clustering all pretreatment results and all posttreatment results. It is important that district leaders monitor the effects associated with specific policy components so that they can make incremental adjustments as needed. District and state policymakers can then use that information to ensure that practices associated with positive outcomes for students and teachers are propagated, while practices associated with negative outcomes are revisited and refined.

Rowan being the first district in the state to take on this type of districtwide digital focus presents an opportunity to learn from Rowan's methods and outcomes. For example, Rowan's model was a constellation of changes (Figure 2.4), and some changes may have had more impact on student achievement and teacher perceptions than other changes. Pilot studies of individual components, specifically the digital components, given the investment needed for implementation, could illuminate specific policy levers that have a greater impact on student outcomes. Pilot studies in other districts may also help illustrate which components work best for which students.

Rowan received two state grants based on its digital learning initiatives.[18] One grant (Showcase Grant) promoted Rowan as a regional example of digital learning implementation, and the other grant (Innovation Grant) seeks to promote the district as a state and national example.[19] Given the attention that Rowan receives and the state endorsement these grants signal, it is important to situate the outcome measures used in this study within the greater body of student-level data that Rowan may have available. The North Carolina summative assessments were not the intended focus of the turnaround model; however, they are the data most often used to evaluate school quality and district success. Interviews with Rowan district leaders revealed that the district sought more granular and formative data related to student performance and leveraged technology to continually monitor growth and make instructional adjustments. The formative student-level data collected in the district may show results that justify the continuation of the turnaround model. It is also possible that students and teachers may exhibit changes in ways that are not measured by any state or district assessment, but that are valued by district leaders and the community. These changes may include student happiness, student cognitive processes, and student independence in the learning environment—all outcomes that district leadership referred to as important components of overall student growth that they hoped to improve with the turnaround model.

The overall evidence from this study shows inconclusive results. For results that exhibit parallel trends, results are that are statistically indistinguishable from zero, with the exception of teachers' perception of *Professional Development* in the overall effect models. This combination of inconclusive, null, and a statistically significant negative result for teachers in the overall

[18] More information about the NCDPI digital learning grants can be found at https://sites.google.com/dpi.nc.gov/digital-teaching-and-learning/dli-grants-overview?authuser=0.
[19] It is unknown how the COVID-19 pandemic impacted the distribution of the *Innovation* grant funds.

model renders all findings in this work subject to scrutiny. It is important that these results are interpreted in the confines of the study limitations and that future work seek to reduce limitations and increase the scope to understand other impacts of the Rowan model.

Limitations of This Study

This work contributes important information to the field about impacts of Rowan's policy shift; however, this approach has its limitations. The implementation of a complex and ever-evolving policy is challenging to qualitatively and quantitatively capture through a retrospective lens. It is possible that other comparison groups are more appropriate for this work; however, available data limit the capacity to seek an alternative. Data available for the outcomes are limiting due to the time span of this study while the lack of parallel trends for many outcomes point to inconclusive results. Each limitation is described in more detail in the sections that follow.

Policy Implementation. The complexity of the Rowan policy makes it extremely difficult to know which components or to what extent each component contributed to student or teacher outcomes. The package of changes was implemented all at once during a short period of time. A retrospective quasi-experimental study does not afford the opportunity to parse out the impacts associated with each program component. Also, there are no data regarding the fidelity of classroom implementation. Although the districtwide policy shift contained supports, guidance, and training for teachers, there are no data that allow me to observe how teachers implemented the policy components in their classrooms. District and school interviews confirm that components of the policy were well known, yet there are no data to confirm that *every* district leader and teacher implemented the policy in the same way. There are quantitative data to show that schools in Rowan did, indeed, have a one-to-one student-to-device ratio beginning in

2015 and that an ITF was allocated at each school; however, there are no data to describe how those devices and the staff time were used.

Comparison Group. The comparison group in this model was a weighted set of rural schools with overlapping propensity to be Rowan based on a set of school- and district-level characteristics. This comparison group drives all results observed in this study. Alternative comparison groups could contribute additional context to these findings. For example, the capacity for districts to adopt such a digital model (i.e., their existing digital footprint in 2010) could be a variable added to the model. The state collects data about the number of devices and wireless access points in every school across the state, along with ITF staffing allocation. Unfortunately, these data do not exist in 2010 to show the number of devices per student or the ITF staffing structures. This information could be an additional covariate to add to the weighted model to produce a more similar comparison group. Another example is the idea that schools that are geographically near Rowan may be more similar on unobservable characteristics. Isolating the comparison group to only those schools may produce different results than the results presented here. Finally, the new leadership in Rowan was reported as a major reason they were able to implement the turnaround model. Data about leadership tenure and skills, if available, could also be added as a covariate.

This study includes qualitative data about the creation, implementation, and evolution of Rowan's policy. These data include testimonials from teachers, administrators, and district leaders, along with school and classroom visits and observations. All qualitative data were used to understand and describe the policy and its implementation. At the time of this dissertation, those types of qualitative data do not exist for other districts. It could be that other districts implemented policies with similar components at about the same time. Those districts may be similar to Rowan on dimensions that are only observable through qualitative data collection. Both qualitative and quantitative evidence support the idea that the entire turnaround model started with the arrival of new leaders in a struggling district. The qualities, experience, and expertise of leaders are not represented in the quantitative analysis for Rowan or the comparison sample. The lack of this information is a limitation of this work because the skills and experience of the leaders creating and implementing policies could be important factors in understanding the resulting outcomes and finding an appropriate comparison.

Outcome Data. Another limitation of this work is the time frame of available outcome data. It is possible that a districtwide turnaround model takes more time to impact student outcomes and teacher perceptions, or perhaps students and teachers endure a period of policy shock immediately following policy implementation and take time to recover from that shock and begin making measurable gains. Additional years of data could be used to understand later treatment effects. The selection of student outcomes is another a limitation of this work. State-made summative assessments (EOGs) and surveys (TWCS) may not be the best outcomes to signal effectiveness of such a model, as they were not the intended targets of the turnaround model. Other outcomes of focus, that were mentioned as targets of the turnaround model, could include family involvement, course enrollment patterns, graduation, college going, college completion, or teacher performance evaluations. Finally, without student level-data, it is impossible to know if digital learning programs have heterogeneous effects for certain subgroups of students. Future work would benefit from investigating how particular student subgroups are affected differently by this policy shift.

Parallel Trends. For most outcomes in this study, parallel trends are not reflected in the data (i.e., all subjects in Grade 5 and Grade 8; teacher *Facilities* and *Community Involvement and*

Support). The results associated with these outcomes are inconclusive must be interpreted with caution. Additional pretreatment data may lead to an increase in the number of parallel trends observed; however, the current study cannot demonstrate parallel trends for many of the studied outcomes. There is debate among scholars about the parallel-trends assumption (Kahn-Lang & Lang, 2020; Roth, 2019). One key issue is that the parallel-trends assumption should account for the differences in composition between the treatment and the counterfactual, including factors such as demographics (Roth, 2019). In this work, I go beyond the visual inspection (Figures 5.1 through 5.4) of pretreatment data and include school-level, student, and teacher characteristics to statistically evaluate the existence of parallel trends; however, richer covariates and student-level data may help further explore the presence of parallel trends. Although skilled methodologists are working toward improving methods for evaluating parallel trends, including their presence and magnitude of violation (McKenzie, 2020a; McKenzie, 2020b), outcomes in this study without parallel trends should be interpreted with caution.

Suggested Future Research

This dissertation uses qualitative information to describe the policy and its implementation, then conducts a quantitative analysis of student and teacher outcomes; however other research questions can be explored. Findings from future research can inform the field locally (i.e., in North Carolina) and more broadly, especially in light of the pandemic and the shift to more digitally supported learning environments for students and teachers. The suggested future research discussed here is divided into work that can be completed as a follow-up to this study and more expansive work that would require additional expertise and data.

Next Steps for This Work. This research study shows overall null results associated with the Rowan turnaround model, but more opportunities exist for further exploration using these same data or minimal additional data. Additional years of outcome data and the use of existing data to employ a synthetic control model are two examples of potential next steps for this work.

Additional Data. Findings in this study are limited to the data available from 2010 through 2017; however, including subsequent years could provide more information about the impact of Rowan's model. A recent study of district and school turnaround models suggests that, although short-term outcomes (within 3 years of implementation) may be observable in student performance data, longer term outcomes should also be studied (Pham et al., 2020). A study including more student and teacher longitudinal data could demonstrate how the turnaround model impacted students and teachers in years after the study period of this dissertation. A later study may also include outcomes that can only be observed after the passage of time, such as college going, college completion, and/or earning potential.

The support for digital learning provided by the state through NCDLI after Rowan's implementation is another component that can be included in an analysis with more longitudinal data. The strategic state supports in the NCDLI did not officially begin until 2016 and strengthened in scope and breadth in the years that followed.[20] Rowan initially implemented a districtwide digital model without state supports or oversight in the first year. The supports later received by Rowan and other districts may impact the results in subsequent years. Future studies for this work could include an analysis with more longitudinal data to examine the impact on students and teachers as more training and supports with NCDLI were available across the state. Although Rowan was the first and only district in North Carolina with a one-to-one student-to-device ratio and the allocation of a full time ITF in each school in 2015, other districts more

[20] More information about the digital learning initiatives, supports, and programs with the NCDPI can be found at https://www.dpi.nc.gov/districts-schools/districts-schools-support/digital-teaching-and-learning.

recently incorporated these same observable digital components. Using data about the presence of digital components and a comparison group that narrows in on those districts that implemented similar digital components, can help further explore the Rowan model.

Synthetic Control Study. The treatment in this work is essentially *being Rowan* as only schools within Rowan experienced the district's unique turnaround model. Given how the treatment originated in the district, no other district was able to receive the same treatment. District innovations and policy shifts that occur in this way create an opportunity to learn about implementation and impacts; however, this type of natural phenomena is not in alignment with more traditional methods of statistical analysis. Ideally, we would want to compare Rowan to itself to see what the student and teacher outcomes would look like in Rowan if the treatment were never provided. As in any quasi-experimental study, we do not have the opportunity to observe Rowan both with and without the turnaround model during the same time period. However, recent developments in causal methods provide an innovative solution with the use of a synthetic control group (Grier & Maynard, 2016; Abadie et al., 2010; Abadie & Gardeazabal, 2003; Munasib & Rickman, 2015).

Student outcomes in Rowan were already declining prior to the treatment in some areas, so one question is the following: How much did the turnaround model change outcomes compared to what would have been in the absence of treatment? The use of the synthetic control method could leverage statewide school-level data to weight schools accordingly and create a statistical counterfactual against which Rowan's observed outcomes could be compared. The use of a synthetic control could be especially useful in Rowan's case, given the state's recent approval for the Renewal Program (An Act to Make Various Changes to Education Laws, 2017),[21] which affords Rowan exceptional autonomy in policy decisions to implement changes aimed at improving student outcomes.

Suggested Research for the Broader Context. There are additional research opportunities that fall outside the scope of this study or my expertise. The impact of COVID-19 on students, families, and teachers is a timely topic, and Rowan could be an ideal location to study the response of a digitally equipped district. The leadership in Rowan was largely responsible for the creation and implementation of the Rowan model. A study of the leadership qualities and skills could provide important information to North Carolina and other states looking to implement a similar model.

Studies of COVID-19 Response. The COVID-19 pandemic forced an unprecedented number of students to participate in 100% virtual instruction. Considering the unknown future impact COVID-19 may have on schools, remote learning could potentially be a part of our students' instructional model for the foreseeable future. Given Rowan's existing infrastructure and overall familiarity with digital learning, studies related to Rowan's response to the COVID-19 pandemic could inform how remote learning impacts students and teachers with an established foundation for such interactions. Given the recent autonomy afforded to Rowan (An Act to Make Various Changes to Education Laws, 2017) and Rowan's established multifaceted digital model, lessons from the district's management of the pandemic could provide other districts, particularly low-wealth rural districts, with valuable lessons and useful strategies. Comparing the experiences of teachers and students in Rowan with experiences of teachers and students from other districts may help identify components of digital learning and district

[21] More information about the North Carolina Renewal Program can be found on the district schoolboard website (https://www.rssed.org/uploaded/photos/District_News/2018_Renewal_District_announcement/Renewal_Resolution.pdf).

policies that are needed to respond to such a crisis and continue with high-quality instruction when students are learning remotely.

Studies of Leadership. Rowan organically created this policy shift with a batch of new leaders and motivated teachers. Information about the characteristics that led to implementation of this broad model may support other districts in hiring a superintendent or principals who possess the capacity to undertake a similar model. The turnaround leadership conceptual framework (Hewitt & Reitzug, 2015) highlights the interconnectivity of leadership practices, emotional intelligence, and a leader’s general disposition. Dr. Moody’s unique leadership style was described by Rowan district and school staff as essential to the implementation of the turnaround model. A portraiture method, for example, could illustrate the characteristics of district leadership in Rowan (Hewitt & Reitzug, 2015). That information could support future superintendent training programs or inform future superintendent searches for school boards across the state.

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APPENDIX: RESULTS

Table A1. Coefficients for Student Outcomes in Model 1

	Grade 5 Reading EOG	Grade 5 Science EOG	Grade 8 Reading EOG	Grade 8 Science EOG	ACT Composite
Treatment	-0.28	-1.25**	-2.71***	-1.51**	-0.20
	(0.29)	(0.38)	(0.53)	(0.47)	(0.18)
2010 Fixed Effect	10.88***	10.73***	4.77***	3.70***	
	(0.26)	(0.45)	(0.42)	(0.32)	
2011 Fixed Effect	10.87***	10.44***	5.81***	4.08***	
	(0.26)	(0.46)	(0.44)	(0.44)	
2012 Fixed Effect	10.54***	10.92***	5.76***	4.67***	
	(0.30)	(0.47)	(0.37)	(0.31)	
2013 Fixed Effect	-0.26	-0.48	-0.75**	-0.15	0.12
	(0.29)	(0.51)	(0.27)	(0.39)	(0.18)
2015 Fixed Effect	-0.65*	-0.96	0.04	0.98	0.25*
	(0.26)	(0.53)	(0.33)	(0.51)	(0.12)
2016 Fixed Effect	0.28	-1.14*	3.04***	0.86**	0.06
	(0.24)	(0.50)	(0.40)	(0.30)	(0.11)
2017 Fixed Effect	-0.08	-1.74***	2.29***	1.50***	0.22
	(0.23)	(0.34)	(0.33)	(0.30)	(0.15)
Constant	448.44***	456.17***	249.54***	247.82***	17.32***
	(0.18)	(0.36)	(0.28)	(0.26)	(0.08)
Schools	449	449	216	216	167
Observations	3465	3465	1651	1651	820

*$p < .05$. **$p < .01$. ***$p < .001$. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

Table A2. Coefficients for Teacher Outcomes in Model 1

	Facilities	Community Involvement and Support	Teacher Leaders	School Leaders	Professional Development	Overall
Treatment	0.27***	-0.02	0.00	0.01	-0.11*	0.03
	(0.04)	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)
2010 Fixed Effect	-0.04	0.02	-0.01	-0.01	-0.01	-0.01
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
2012 Fixed Effect	0.02	0.02	0.01	-0.00	0.02	0.02
	(0.02)	(0.02)	(0.04)	(0.02)	(0.02)	(0.02)
2014 Fixed Effect	0.03	0.03*	0.04	0.03*	0.06**	0.04*
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.01)
Constant	3.14***	3.19***	3.02***	3.13***	2.96***	3.09***
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Schools	805	805	805	805	805	805
Observations	3190	3190	3190	3190	3190	3190

*p < .05. **p < .01. ***p < .001. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

Table A3. Coefficients for Student Outcomes in Model 2

	Grade 5 Reading EOG	Grade 5 Science EOG	Grade 8 Reading EOG	Grade 8 Science EOG	ACT Composite
Treatment	-0.23	-1.56***	-2.59***	-1.89***	-0.11
	(0.24)	(0.31)	(0.49)	(0.44)	(0.10)
2010 Fixed Effect	10.80***	11.32***	4.54***	4.18***	
	(0.24)	(0.54)	(0.45)	(0.31)	
2011 Fixed Effect	10.82***	11.11***	5.68***	4.42***	
	(0.28)	(0.45)	(0.53)	(0.39)	
2012 Fixed Effect	10.60***	11.31***	5.73***	4.88***	
	(0.26)	(0.33)	(0.42)	(0.27)	
2013 Fixed Effect	-0.29	-0.31	-0.84**	-0.11	0.06
	(0.26)	(0.40)	(0.29)	(0.34)	(0.12)
2014 Fixed Effect	-0.48	-1.01***	0.14	0.89*	0.12
	(0.25)	(0.30)	(0.32)	(0.38)	(0.08)
2016 Fixed Effect	0.35	-1.04**	2.98***	1.08**	-0.02
	(0.33)	(0.33)	(0.47)	(0.35)	(0.08)
2017 fixed Effect	0.15	-1.39***	2.37***	1.88***	0.13
	(0.29)	(0.41)	(0.44)	(0.35)	(0.09)
% AIG	6.03***	11.36**	5.41**	7.97*	-0.45
	(1.17)	(3.53)	(1.85)	(3.44)	(1.22)
% Asian	-1.05	2.16	4.16	-4.99	-4.64
	(2.82)	(8.84)	(4.78)	(6.59)	(2.72)
% Black	0.97	-11.36***	3.84	-14.74***	-2.47
	(2.91)	(2.91)	(4.65)	(2.93)	(1.45)
% EDS	-2.37*	0.66	-1.97	0.24	-1.25*
	(1.07)	(0.76)	(1.49)	(1.04)	(0.54)
% Female	1.60	1.05	0.04	-0.92	2.50
	(2.08)	(2.17)	(3.73)	(1.86)	(1.92)
% Hispanic	-0.23	0.39	-2.49	-0.01	-4.57*

Table A3. (continued)

	(2.10)	(2.74)	(3.54)	(1.72)	(2.01)
% English Learner	2.22	-10.05*	1.97	-8.51*	6.16*
	(1.84)	(4.04)	(2.78)	(3.32)	(2.56)
% Male	0.09	2.12	-0.36	5.99	1.17
	(2.11)	(3.22)	(3.65)	(3.57)	(0.64)
% Two or More Races	2.65	4.22	3.96	-0.87	-10.61***
	(2.35)	(2.66)	(3.30)	(3.19)	(3.03)
% Native American or Pacific Islander	11.40**	7.24*	8.25	3.63	0.37
	(3.52)	(2.86)	(9.07)	(4.20)	(6.21)
% Students with a Disability	-6.30*	-1.20	-1.73	1.19	3.49
	(2.58)	(2.91)	(3.73)	(2.52)	(1.85)
% White	7.19**	-0.39	5.57	-0.27	-3.41
	(2.38)	(2.31)	(3.38)	(2.43)	(1.88)
% Teachers 0-3 yrs Experience	0.01	-4.07	-9.21	16.72	32.60
	(8.05)	(9.06)	(10.25)	(12.20)	(43.49)
% Teachers 10+ yrs Experience	1.53	-3.99	-10.22	18.00	32.80
	(8.09)	(9.64)	(10.66)	(12.53)	(43.61)
% Teachers 4-9 yrs Experience	2.63	-5.40	-6.24	15.24	29.51
	(8.04)	(9.31)	(10.70)	(12.34)	(43.50)
% Teachers with Advanced Degree	-1.01	4.15	1.63	-0.09	-0.36
	(1.42)	(2.29)	(2.38)	(1.94)	(1.05)
Turnover Rate	-0.20	-0.92	-2.19	-0.61	-1.39*
	(0.94)	(1.17)	(1.50)	(1.38)	(0.62)
ADM	-0.00*	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	445.09***	459.45***	256.04***	229.97***	-13.13
	(8.65)	(9.44)	(11.11)	(12.10)	(43.40)
Schools	449	449	216	216	167

Table A3. (continued)

Observations	3465	3465	1651	1651	820

Note. EOG = End-of-Grade Tests; AIG = Academically and Intellectually Gifted; EDS = Economically Disadvantaged. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table A4. Coefficients for Teacher Outcomes in Model 2

	Facilities	Community Involvement and Support	Teacher Leaders	School Leaders	Professional Development	Overall
Interaction	0.27***	-0.04	-0.01	0.01	-0.12*	0.02
	(0.04)	(0.03)	(0.05)	(0.04)	(0.06)	(0.04)
2010 Fixed Effect	0.00	0.00	-0.03	-0.01	0.01	-0.00
	(0.03)	(0.02)	(0.03)	(0.02)	(0.05)	(0.03)
2012 Fixed Effect	0.05*	0.01	0.02	0.00	0.05	0.03
	(0.02)	(0.02)	(0.04)	(0.02)	(0.03)	(0.02)
2016 Fixed Effect	0.09***	0.05**	0.06*	0.06**	0.10***	0.07***
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
% AIG	0.34	0.14	0.18	0.10	0.00	0.15
	(0.25)	(0.18)	(0.31)	(0.20)	(0.20)	(0.20)
% Asian	-0.10	-0.33	-0.38	-0.21	0.40	-0.12
	(0.55)	(0.48)	(1.05)	(0.72)	(0.75)	(0.63)
% Black	0.18	0.59**	0.93*	0.63*	0.19	0.50*
	(0.28)	(0.22)	(0.41)	(0.27)	(0.33)	(0.24)
% EDS	0.35	-0.02	-0.02	0.15	0.07	0.10
	(0.20)	(0.16)	(0.26)	(0.18)	(0.21)	(0.18)
% Female	-0.34	-0.52**	-1.00***	-0.54*	-0.46	-0.57**
	(0.27)	(0.18)	(0.29)	(0.22)	(0.26)	(0.19)
% Hispanic	-0.34	-0.10	0.23	0.19	-0.15	-0.03
	(0.32)	(0.23)	(0.29)	(0.27)	(0.33)	(0.24)
% English Learner	0.03	0.51	0.23	0.03	0.11	0.18
	(0.33)	(0.31)	(0.38)	(0.29)	(0.48)	(0.30)
% Male	-0.08	-0.20	0.09	-0.14	0.30	-0.00
	(0.24)	(0.18)	(0.30)	(0.20)	(0.30)	(0.19)
% Two or More Races	-0.89*	0.48*	0.32	0.11	-0.13	-0.02
	(0.39)	(0.23)	(0.37)	(0.27)	(0.34)	(0.24)

Table A4. (continued)

% Native American or Pacific Islander	-0.50	0.52	2.49***	1.84**	0.37	0.94*
	(0.53)	(0.36)	(0.58)	(0.64)	(0.57)	(0.45)
% Students with a Disability	-0.86***	-0.26	-0.41	-0.33	-0.73	-0.52*
	(0.25)	(0.22)	(0.30)	(0.27)	(0.38)	(0.25)
% White	-0.23	0.75***	0.79*	0.65*	0.06	0.40
	(0.28)	(0.22)	(0.31)	(0.26)	(0.33)	(0.22)
% Teachers 0-3 yrs Experience	1.34	12.28	0.38	1.65	-11.12	0.91
	(20.74)	(14.76)	(34.09)	(22.43)	(26.48)	(21.39)
% Teachers 10+ yrs Experience	1.27	12.53	0.41	1.82	-11.08	0.99
	(20.72)	(14.74)	(34.03)	(22.37)	(26.44)	(21.35)
% Teachers 4-9 yrs Experience	1.27	12.44	0.48	1.75	-11.22	0.94
	(20.67)	(14.71)	(33.94)	(22.31)	(26.43)	(21.29)
% Teachers with Advanced Degree	0.10	0.16	0.16	0.20	0.42	0.21
	(0.20)	(0.11)	(0.24)	(0.16)	(0.22)	(0.16)
Turnover Rate	0.29	0.18	-0.04	0.17	0.04	0.13
	(0.16)	(0.09)	(0.16)	(0.13)	(0.21)	(0.11)
ADM	-0.00**	0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	2.29	-9.63	2.36	1.00	14.14	2.03
	(20.70)	(14.74)	(34.01)	(22.37)	(26.41)	(21.33)
Schools	805	805	805	805	805	805
Observations	3190	3190	3190	3190	3190	3190

Note. EOG = End-of-Grade Tests; AIG = Academically and Intellectually Gifted; EDS = Economically Disadvantaged. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

**p* < .05. ***p* < .01. ****p* < .001.

Table A5. Coefficients for Student Outcomes in Model 3

	Grade 5 Reading EOG	Grade 5 Science EOG	Grade 8 Reading EOG	Grade 8 Science EOG	ACT Composite
Treatment & 2010	1.46***	0.57	2.87***	1.61**	
	(0.44)	(0.58)	(0.72)	(0.52)	
Treatment & 2011	0.90*	0.49	2.71***	1.47	
	(0.44)	(0.64)	(0.78)	(0.76)	
Treatment & 2012	0.51	0.90	2.12**	1.70***	
	(0.48)	(0.47)	(0.72)	(0.42)	
Treatment & 2013	-0.17	-0.46	1.21*	0.95	0.34
	(0.48)	(0.58)	(0.51)	(0.63)	(0.26)
Treatment & 2015	0.09	-1.61*	-1.64*	0.14	0.08
	(0.36)	(0.67)	(0.74)	(0.73)	(0.08)
Treatment & 2016	0.55	-0.79	0.11	-1.73*	-0.15
	(0.36)	(0.86)	(0.75)	(0.74)	(0.16)
Treatment & 2017	0.33	-1.36	-0.81	-1.00	0.21
	(0.38)	(0.79)	(0.84)	(0.66)	(0.24)
2010 Fixed Effect	9.98***	11.04***	2.97***	3.32***	
	(0.21)	(0.36)	(0.33)	(0.27)	
2011 Fixed Effect	10.32***	10.87***	4.24***	3.65***	
	(0.19)	(0.30)	(0.30)	(0.25)	
2012 Fixed Effect	10.33***	10.83***	4.62***	3.96***	
	(0.15)	(0.20)	(0.24)	(0.22)	
2013 Fixed Effect	-0.21	-0.06	-1.51***	-0.62**	-0.11
	(0.14)	(0.18)	(0.21)	(0.21)	(0.07)
2014 Fixed Effect	-0.62***	-0.99***	-0.32	-0.27	0.02
	(0.15)	(0.20)	(0.23)	(0.19)	(0.04)
2016 Fixed Effect	-0.05	-1.47***	1.57***	0.98***	-0.01
	(0.22)	(0.23)	(0.36)	(0.24)	(0.07)

Table A5. (continued)

2017 fixed Effect	-0.09	-1.50***	1.54***	1.38***	-0.01
	(0.23)	(0.29)	(0.38)	(0.27)	(0.08)
% AIG	6.62***	12.53***	7.06***	8.36*	0.15
	(1.26)	(3.24)	(2.02)	(3.27)	(1.21)
% Asian	-1.13	1.63	3.92	-5.17	-2.87
	(2.35)	(8.82)	(5.41)	(8.32)	(2.45)
% Black	1.41	-12.22***	3.42	-15.20***	-2.31
	(2.59)	(2.86)	(4.11)	(2.82)	(1.37)
% EDS	-2.14*	0.85	-1.25	-1.13	-1.36*
	(1.06)	(1.14)	(1.78)	(1.28)	(0.54)
% Female	1.77	1.36	0.69	-0.89	2.24
	(2.05)	(1.96)	(3.49)	(1.81)	(1.58)
% Hispanic	-0.08	-0.54	-2.55	-1.01	-4.51**
	(1.96)	(2.67)	(3.19)	(1.98)	(1.72)
% English Learner	3.29	-10.46*	3.38	-7.45*	6.17*
	(1.93)	(4.11)	(2.81)	(3.44)	(2.45)
% Male	0.35	2.92	0.47	6.85	1.17
	(2.13)	(3.51)	(3.24)	(3.78)	(0.65)
% Two or More Races	2.40	3.95	3.54	-2.84	-10.21**
	(2.46)	(2.83)	(3.53)	(3.27)	(3.25)
% Native American or Pacific Islander	11.01**	5.25	7.82	-0.08	-0.08
	(4.04)	(2.67)	(7.44)	(3.40)	(5.97)
% Students with a Disability	-7.03**	-0.16	-3.00	0.36	3.52*
	(2.53)	(3.26)	(3.72)	(2.80)	(1.69)
% White	7.87**	-1.45	5.85	-2.32	-3.48*
	(2.51)	(2.47)	(3.40)	(2.07)	(1.60)
% Teachers 0-3 yrs Experience	-0.19	-2.50	-9.79	18.72	41.14
	(8.00)	(7.36)	(10.76)	(11.31)	(49.79)

Table A5. (continued)

% Teachers 10+ yrs Experience	1.17	-1.88	-10.85	20.84	42.03
	(7.97)	(7.33)	(11.05)	(11.32)	(50.11)
% Teachers 4-9 yrs Experience	2.12	-3.39	-7.44	17.52	38.69
	(7.95)	(7.17)	(11.12)	(11.16)	(49.90)
% Teachers with Advanced Degree	-1.46	3.85	0.83	0.36	-0.52
	(1.42)	(1.99)	(2.47)	(1.76)	(0.94)
Turnover Rate	0.02	-0.74	-1.84	-0.13	-1.30*
	(0.90)	(1.28)	(1.42)	(1.36)	(0.59)
ADM	-0.00	-0.00	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	444.31***	457.62***	255.04***	229.24***	-22.08
	(8.54)	(7.73)	(11.29)	(11.56)	(50.02)
Schools	449	449	216	216	167
Observations	3465	3465	1651	1651	820

Note. EOG = End-of-Grade Tests; AIG = Academically and Intellectually Gifted; EDS = Economically Disadvantaged. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

**p* < .05. ***p* < .01. ****p* < .001.

Table A6. Coefficients for Teacher Outcomes in Model 3

	Facilities	Community Involvement and Support	Teacher Leaders	School Leaders	Professional Development	Overall
Treatment & 2010	-0.02	0.08**	0.03	0.02	-0.03	0.02
	(0.05)	(0.03)	(0.06)	(0.04)	(0.06)	(0.04)
Treatment & 2012	0.13***	0.09**	0.07	0.06	0.06	0.08*
	(0.04)	(0.03)	(0.06)	(0.04)	(0.04)	(0.04)
Treatment & 2016	0.30***	0.02	0.02	0.03	-0.11	0.05
	(0.04)	(0.04)	(0.06)	(0.04)	(0.06)	(0.04)
2010 Fixed Effect	0.02	-0.04*	-0.04	-0.02	0.03	-0.01
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
2012 Fixed Effect	-0.01	-0.03**	-0.02	-0.02	0.02	-0.01
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
2016 Fixed Effect	0.07***	0.02	0.04	0.05*	0.10***	0.06**
	(0.02)	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)
% AIG	0.55*	0.24	0.28	0.17	0.11	0.27
	(0.25)	(0.18)	(0.33)	(0.22)	(0.21)	(0.21)
% Asian	-0.20	-0.39	-0.44	-0.25	0.35	-0.19
	(0.55)	(0.46)	(1.03)	(0.71)	(0.74)	(0.62)
% Black	0.07	0.55**	0.88*	0.59*	0.13	0.44
	(0.27)	(0.21)	(0.39)	(0.26)	(0.33)	(0.23)
% EDS	0.33	-0.04	-0.03	0.14	0.07	0.09
	(0.20)	(0.16)	(0.26)	(0.18)	(0.21)	(0.18)
% Female	-0.28	-0.49**	-0.97***	-0.52*	-0.43	-0.54**
	(0.27)	(0.17)	(0.27)	(0.21)	(0.25)	(0.18)
% Hispanic	-0.42	-0.14	0.19	0.16	-0.19	-0.08
	(0.32)	(0.24)	(0.29)	(0.27)	(0.33)	(0.24)
% English Learner	0.01	0.57	0.25	0.05	0.09	0.19

Table A6. (continued)

	(0.31)	(0.30)	(0.37)	(0.28)	(0.45)	(0.29)
% Male	-0.01	-0.14	0.13	-0.10	0.33	0.04
	(0.22)	(0.18)	(0.29)	(0.20)	(0.30)	(0.19)
% Two or More Races	-0.80*	0.45*	0.33	0.12	-0.07	0.00
	(0.36)	(0.22)	(0.37)	(0.27)	(0.34)	(0.23)
% Native American or Pacific Islander	-0.43	0.49	2.49***	1.84**	0.41	0.96*
	(0.53)	(0.35)	(0.59)	(0.63)	(0.57)	(0.44)
% Students with a Disability	-0.85***	-0.33	-0.43	-0.35	-0.71	-0.53*
	(0.23)	(0.22)	(0.30)	(0.28)	(0.39)	(0.24)
% White	-0.33	0.70**	0.74*	0.62*	0.01	0.35
	(0.27)	(0.22)	(0.30)	(0.26)	(0.32)	(0.22)
% Teachers 0-3 yrs Experience	-1.45	9.44	-1.62	0.08	-12.22	-1.16
	(21.27)	(14.27)	(34.00)	(22.16)	(26.60)	(21.37)
% Teachers 10+ yrs Experience	-1.49	9.72	-1.57	0.27	-12.16	-1.05
	(21.25)	(14.25)	(33.94)	(22.11)	(26.56)	(21.33)
% Teachers 4-9 yrs Experience	-1.51	9.61	-1.52	0.18	-12.31	-1.11
	(21.21)	(14.22)	(33.86)	(22.05)	(26.55)	(21.28)
% Teachers with Advanced Degree	0.12	0.13	0.16	0.20	0.43	0.21
	(0.20)	(0.12)	(0.24)	(0.16)	(0.23)	(0.16)
Turnover Rate	0.29*	0.20*	-0.03	0.18	0.04	0.14
	(0.15)	(0.10)	(0.16)	(0.13)	(0.22)	(0.11)
ADM	-0.00**	0.00	-0.00	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	5.07	-6.81	4.35	2.56	15.23	4.08
	(21.24)	(14.25)	(33.92)	(22.11)	(26.53)	(21.32)
Schools	805	805	805	805	805	805
Observations	3190	3190	3190	3190	3190	3190

Table A6. (continued)

Note. EOG = End-of-Grade Tests; AIG = Academically and Intellectually Gifted; EDS = Economically Disadvantaged. Coefficients here reflect standard deviation units. Year 2014 is left out here for comparison purposes.

*$p < .05$. **$p < .01$. ***$p < .001$.

Table A7. Grade 5 Reading Score Distribution Summary of Rowan and Comparison Group

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	459.44	1.89	456	463	459.34	2.51	451	467
2011	459.05	2.28	454	464	459.59	2.53	449	466
2012	458.75	2.05	455	463	459.46	2.56	451	466
2013	447.65	3.00	442	455	448.88	3.03	439	459
2014	448.20	2.97	442	453	449.01	3.11	440	459
2015	447.35	3.00	443	452	448.29	3.41	439	459
2016	448.60	2.41	444	453	448.82	3.13	439	458
2017	448.10	2.88	442	452	448.75	3.15	438	458

Table A8. Grade 5 Science Score Distribution Summary of Rowan and Comparison Group

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	254.44	2.41	250	258	254.19	3.49	243	263
2011	255.25	3.21	248	263	255.33	3.48	240	263
2012	255.15	2.54	251	259	255.64	3.34	245	264
2013	248.15	3.48	242	256	249.67	3.94	239	261
2014	248.90	4.12	240	255	250.97	4.28	237	261
2015	246.60	3.70	240	253	250.40	4.32	238	263
2016	250.10	3.01	245	255	252.42	3.93	239	264
2017	249.20	4.14	241	256	252.25	4.07	238	265

Table A9. Grade 8 Reading Score Distribution Summary of Rowan and Comparison Group

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	466.00	3.59	458	469	468.15	2.36	460	473
2011	465.50	4.14	457	469	468.22	2.45	458	473
2012	466.13	3.48	459	470	468.38	2.21	461	474
2013	454.38	3.11	447	456	457.63	3.04	446	467
2014	455.00	5.58	442	460	457.78	3.29	446	469
2015	452.88	3.60	445	457	456.90	3.58	443	470
2016	452.88	3.52	445	457	456.32	3.46	443	468
2017	451.88	5.19	440	457	456.32	3.58	443	469

Table A10. Grade 8 Science Score Distribution Summary of Rowan and Comparison Group

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	250.75	3.92	242	254	252.54	3.29	242	259
2011	251.00	4.66	242	255	253.08	3.23	244	261
2012	251.75	3.81	244	256	253.44	3.29	242	260
2013	246.75	3.49	239	250	249.06	3.68	238	260
2014	246.50	4.87	236	252	249.40	3.91	239	259
2015	246.88	3.14	240	250	249.37	3.80	236	261
2016	245.88	4.64	236	252	250.27	4.01	237	261
2017	246.75	4.68	237	252	250.93	3.92	237	261

Table A11. ACT Distribution Summary of Rowan and Comparison Group

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2013	18.13	1.90	16	22	17.53	1.56	13	22
2014	17.79	1.65	16	21	17.64	1.61	12	23
2015	17.36	2.04	14	21	17.75	1.65	12	23
2016	17.49	1.37	16	20	17.69	1.62	13	24
2017	17.96	1.70	16	21	17.67	1.73	13	24

Table A12. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: Facilities

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	3.05	0.27	2.38372	3.58929	3.16	0.31	2.12195	3.92424
2012	3.19	0.20	2.67898	3.71053	3.14	0.29	2.04405	3.875
2014	3.13	0.25	2.70513	3.6	3.17	0.28	2.05128	3.92593
2016	3.43	0.18	3.01351	3.73889	3.19	0.28	2.07486	3.96429

Table A13. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: Community Involvement and Support

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	3.22	0.21	2.67683	3.70536	3.21	0.21	2.51923	3.83333
2012	3.22	0.17	2.7234	3.59483	3.20	0.19	2.58992	3.7875
2014	3.18	0.21	2.76667	3.73958	3.22	0.19	2.52077	3.71605
2016	3.21	0.25	2.60379	3.675	3.22	0.20	2.36074	3.79839

Table A14. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: Teacher Leadership

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	2.97	0.32	2.02439	3.78571	3.06	0.27	1.9386	3.83333
2012	3.04	0.28	2.55319	3.85	3.06	0.26	2.05682	3.74324
2014	3.00	0.36	2.05172	3.94444	3.08	0.27	2.04445	3.85294
2016	3.06	0.38	2.20496	3.9	3.11	0.26	2.26	3.85417

Table A15. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: School Leadership

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	3.09	0.23	2.41463	3.51896	3.16	0.20	2.31986	3.8254
2012	3.12	0.16	2.70922	3.51724	3.15	0.19	2.58667	3.7985
2014	3.12	0.22	2.41111	3.66667	3.17	0.20	2.26282	3.82051
2016	3.16	0.27	2.50451	3.75556	3.20	0.20	2.27177	3.8

Table A16. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: Professional Development

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	2.95	0.28	2.30303	3.42857	2.93	0.25	1.82857	3.65909
2012	3.01	0.19	2.5	3.32143	2.93	0.24	2.05	3.9
2014	2.99	0.24	2.47826	3.38095	2.92	0.24	2	3.7037
2016	2.96	0.35	2.05405	3.68421	2.98	0.24	2.08333	3.71429

Table A17. Teacher Working Conditions Survey Score Distribution Summary of Rowan and Comparison Group: Professional Development

	Rowan				Comparison			
	Mean	SD	Min	Max	Mean	SD	Min	Max
2010	3.06	0.22	2.47683	3.60558	3.10	0.20	2.4291	3.71019
2012	3.12	0.14	2.88093	3.4798	3.09	0.19	2.468	3.8197
2014	3.08	0.21	2.5359	3.54445	3.11	0.19	2.45359	3.75318
2016	3.16	0.26	2.58146	3.69945	3.14	0.19	2.35953	3.74345