PINTEREST CURATION AND STUDENT ACHIEVEMENT

The Effects of Elementary Mathematics Resources on Students' Learning over Time

ABSTRACT

In an era of social media, and amid the coronavirus pandemic, teachers' curation of instructional resources stands as an opportunity to observe teachers' planning and conceptualization of their practice in real time. This work explores the resources teachers curate, their rigor, and the effects on students' learning across years. Merging big data from Pinterest, a prominent social media platform, and administrative data from the Indiana Department of Education on 10,383 fourth- through sixth-grade students across 2010–2017, this study employed three-level hierarchical linear models to identify relationships between the inherent cognitive rigor in teachers' curated instructional tasks and students' achievement. Results indicate teachers curating resources focused on basic memorization and remembering negatively affected students' learning, whereas higher-level tasks focused on understanding and applying had a positive impact on achievement. Identified effects were comparable to those related to student and teacher attributes, signaling the importance of teachers' curation.

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AT the time of this writing, teachers in elementary schools nationwide are grappling with a new world of online schooling. The coronavirus pandemic has shifted engagement in both workplace and school from face-to-face to online with emergent expediency. States and districts worked to reorient online learning plans; however, many teachers were left to independently find resources online (Turner et al., 2020). Little is known regarding the resources teachers acquire and share online, how they permeate the classroom, and their relationship to students' learning.

As professionals responsible for the work in a fundamental social institution, teachers use social media just as do other members of society (Opfer et al., 2016). Nationwide, more than 79% of people engage with social media (Clement, 2020). Critically, teachers' use of social media affords them the opportunity to create, generate, and curate their own content in coordination with a professional community. The knowledge and practices acquired from virtual resource pools, those spaces in which teachers may access a large array of instructional resources, may be observed in classroom teaching and planning (Torphy Knake et al., 2021). In fact, preliminary research on teachers' planning as reflected within social media found the quality of instructional resources significantly related to teachers' quality of mathematics instruction in classrooms (Torphy Knake et al., 2021). As education policy makers, researchers, and school leaders attempt to better understand and support the mechanisms that drive student achievement, it is worth considering how resources accessed online contribute to classroom instruction and academic success. Given increasing demands for online resources and cohesive curricular units for online learning, it may be useful to examine variation in resource quality and its relative effects on students' growth.

Understanding how teachers behave within social media may be a window into their conceptualization of teaching practice and instruction. As educational leaders and teacher educators attempt to support elementary teachers and learners through the new demands of teaching in a pandemic, these understandings will contribute to foundational knowledge of the current landscape. Their professional reflections, accessed resources, and networks may allow for a more complete vision of twenty-first-century teaching, at scale.

This work advances the state of the field by pairing new forms of educational data within social media (e.g., Pinterest) to administrative state educational data. Using interdisciplinary methods to access and interpret information within social media, it connects human behavior at broad scale and in real time to summative assessments of student learning. This will allow an examination of the relationships between teachers' instructional planning, mathematics instruction, and their students' academic growth over time.

The Role of Teachers in Students' Achievement

Educational leaders since the common schooling movement have long sought to identify the most important components of schooling (e.g., Lawrence-Lightfoot, 2008; Mann, 1872; Mann & Massachusetts, 1849; Rivkin et al., 2005). Students' success hinges on their own family background (Hanushek, 2016), their unique disposition, and their education. The role of the teacher remains the leading lever in positive change for students' schooling success (Rivkin et al., 2005; Rowan et al., 1997; Sanders, 1997).

Teachers' work is embedded in multiple layers (Barr & Dreeben, 1977; Honig et al., 2010). Teachers must consider the subject content, resources available, school and teacher accountability pressure, district reform, and community engagement (Coburn, 2004; Creemers & Kyriakides, 2007; Lowyck, 1980; Penuel et al., 2013). Though teachers' academic aptitude and orientation to students' propensity to learn relates to their educational effectiveness, overall research indicates that teachers struggle with similar problems (Dweck, 2007; Lortie, 1975).

Teachers encounter problems of practice and make decisions as their beliefs and teaching evolve and respond to student behavior. The resources they leverage represent an integral component of their plans (Kennedy, 2016; Lampert, 2001; McNeill & Krajcik, 2008). Teachers connecting with colleagues within their school and districts evolve professionally as their capacity to integrate competing demands and sensemake across intended and designated curriculum builds (Borko & Livingston, 1989).

Teacher Beliefs, Teacher Practices, and Student Behavior

How teachers consider instruction and their students' needs relates to their effectiveness in the classroom (Clark & Peterson, 1986; Palardy & Rumberger, 2008). Multiple researchers have found that teachers who conveyed messages of growth, belonging, purpose, and affirmation saw greater gains in their students' standardized math test scores than did other teachers (Baker & Yoon, 2010; Dweck, 2007; Hennessey, 2018).

Teacher autonomy is regarded as an important factor that mediates the relationship of teaching practices and student learning. Changes in instructional behavior frequently develop out of voluntary, internal commitment that is achieved through self-reflection (Baker & Yoon, 2010). Today, collaboration within socialized knowledge communities (SKCs) across virtual resource pools creates an avenue for elementary teachers to voluntarily and autonomously engage with instructional tools in efforts to improve student learning (Torphy & Drake, 2019). SKCs allow teachers to exchange and follow one another's stories and advice, improving their practice (Hu et al., 2018). Similarly, informal exchanges within social media and virtual space provide collective wisdom and locally based knowledge (Frank et al., 2010; Granovetter, 1983; Zhao & Frank, 2003).

Mathematical Thinking and Curriculum

Teachers must interpret priorities and make decisions on what is best practice (Remillard & Heck, 2014). Within mathematics, challenging problems that focus on students' thinking and reasoning have been found to relate to higher cognitive demand tasks and higher student outcomes. Students with practice in higher cognitive demand problems were better able to problem solve, engage in mathematical argumentation, and develop conceptual understanding in mathematical topics (Boston & Wolf, 2006).

The Revised Bloom's Taxonomy

Bloom's (1956) taxonomy developed an approach to evaluating the rigor of instructional problems across subjects. Bloom identified six levels within the cognitive domain in which instruction and cognitive development interplay. That is, there is a potential cognitive demand and an enacted cognitive demand, as a teacher's enactment of a particular lesson relates to the cognitive rigor. In 2001, Anderson and Krathwohl released a revised Bloom's taxonomy. Their revision allowed for the evaluation of instructional resources, as research shows increasing complexity in cognitive demand is related to greater student learning (McNeill & Krajcik; Stein et al., 2007).

The six levels presented in the revised Bloom's taxonomy framework move from basic to abstract and include remembering, understanding, applying, analyzing, evaluating, and creating (Hess et al., 2009; Hu et al., 2018). Though knowledge is acquired through a continuous and dynamic process, the revised Bloom's taxonomy may allow one to compare the potential cognitive demand inherent within instructional tasks (see validity work, e.g., Igbaria, 2013; Razmjoo & Kazempourfard, 2012; Riazi & Mosalaejad, 2010).

Cognitive Demand. The revised Bloom's taxonomy framework has six levels and may be described in consideration to mathematics cognition:

- **Remember (Level 1).** Recall mathematical facts and basic mathematical concepts.
- **Understand (Level 2).** Make observations of mathematical ideas, constructing mathematical meaning from oral, written, and representational forms.
- **Apply (Level 3).** Carry out procedures in a given situation.
- **Analyze (Level 4).** Use mathematics knowledge to analyze the components in a new situation/context.
- **Evaluate (Level 5).** Justify a mathematical stance and decision by providing mathematical evidence.
- **Create (Level 6).** Create a new mathematics pattern or structure by reorganizing, generating, and planning the components of a mathematical pattern or structure.

In Table 1, we present the full rubric from Hess and colleagues (2009) detailing the revised Bloom's taxonomy and an additional measure for cognitive rigor, the Depth of Knowledge.

Understanding the challenge inherent in instructional tasks may support a better understanding of a teacher's approach to addressing the problems of practice they confront within their teaching (Hu et al., 2020).

Teacher Planning in the Twenty-First Century

Teaching and learning has often centered around the school as a space in which teachers construct their profession. Teachers' exchange with students and enactment of content both take on an individual and socialized nature as they work within a school community (e.g., Coburn, 2001; Loewenberg Ball & Forzani, 2009; Spillane & Jennings, 1997). School community shades how curricular enactment and instructional materials diffuse into classroom teaching, resulting in intended and unintended consequences (Remillard & Heck, 2014). Outside the classroom, access to a wide array of resources within online social media extend an outlet for teachers to access expertise and lessons from peers across geographic bounds (Torphy et al., 2020).

Teachers choose instructional resources to address a variety of challenges. Teaching, students' learning, and social complexities contribute to the milieu of the classroom (Lampert, 2001). The teacher is, by active engagement, a component within this context, with their decisions interacting with the students' experiences and outcomes.

Within the virtual world, teachers seek out relevant information and decide those instructional resources worth accessing. Whereas face-to-face connections in primary schools can be limited to a small number of colleagues teaching the same grade or subjects (Frank, Lo, et al., 2018; Frank & Zhao, 2005; Spillane et al., 2012), online, new information and connections are numerous (Torphy & Drake, 2019).

Teachers collectively may form SKCs within social media, exchanging best practices and curating resources from collegial peers (Hu et al., 2018). The SKCs may allow teachers to address challenges across the problems of teaching they encounter (Kennedy, 2016). Historically, teachers have had collegial support within their school to receive advice and information and generate new professional knowledge (Bidwell & Yasumoto, 1999; Coburn et al., 2012). Face-to-face networks have also allowed teachers to collectively sense-make reform and education change (e.g., Coburn et al., 2013; Frank et al., 2004; Sun et al., 2013). However, teachers' social media engagement poses the potential to disrupt and change patterns of knowledge and resource seeking (Torphy et al., 2020; Torphy & Drake, 2019).

The context in which teachers teach relates to the resources they choose to curate. Teachers' selection and curation of instructional tasks is one component of lesson planning that frames what students will do within the classroom (Borko & Livingston, 1989; Leinhardt, 1993; Livingston & Borko, 1990). Teachers from the same district tend to curate similarly as compared with those from other districts; this holds true for same-school pairs of teachers as well (Torphy et al., 2020). In recent research, Torphy and colleagues (2020) found that even more significant than school or district influence on teachers' online curation was grade level taught, with teachers from the same grade curating more similarly. Other influential contextual factors related to teachers' curation were level of experience and teaching disposition (Torphy et al., 2020).

The instructional resources teachers choose may provide a window into their thought processes regarding instruction. Understanding teachers' planning processes has been a priority long before social media. "As teachers' thoughts and mental planning significantly direct their actions, it is necessary for innovations in the context, practices and technology of teaching to be mediated through the minds of motives of teachers" (National Institute of Education, 1975, p. 1).

Research shows a significant amount of teachers' planning is done mentally (Clark & Peterson, 1986). Though teachers' thoughts are unobservable, their behavior may reflect an "observable phenomenon" mirroring their thinking (Clark & Peterson, 1986).

How teachers curate worthwhile instructional content, plan lessons, present content, and react to students relates to their individual theories of education, teaching, and learning (Clark & Peterson, 1986). Though teachers may go online and find resources incidentally or purposely (Hu et al., 2018), each curated resource combines into a composite professional road map for teaching. As teachers are confronted by problems of practice across students' participation, thinking, classroom community, and instruction, the decisions they make present an "integrated portrait" of their work (Kennedy, 2009, p. 13). Teachers' solutions may come from an SKC of virtual colleagues (Hu et al., 2020).

Table 1. Revised Bloom's Taxonomy and Depth of Knowledge

Bloom's Revised Taxonomy of Cognitive Process Dimensions	Webb's Depth-of-Knowledge Levels Level 1 Recall and Reproduction	Level 2 Skills and Concepts	Level 3 Strategic Thinking/Reasoning	Level 4 Extended Thinking
Remember: Retrieve knowledge from long-term memory, recognize, recall, locate, identify	Recall, recognize, locate basic facts, ideas, principles Recall or identify conversions between units of measure Identify facts/details in texts			
Understand: Construct meaning, clarify, paraphrase, represent, translate, illustrate, give examples, classify, categorize, summarize, generalize, infer a logical conclusion, predict, compare/contrast, match like ideas, explain, construct models	Compose/decompose numbers Evaluate an expression Locate points on a grid Symbolize math relationships Write simple sentences Describe/explain how or why	Specify and explain relationships Give nonexamples/examples Make and record observations Summarize results, concepts, ideas Infer or predict from data or texts Identify main ideas	Explain, generalize, or connect ideas using supporting evidence Explain phenomena in terms of concepts Write full composition to meet specific purpose Identify themes	Explain how concepts or ideas specifically relate to other content domains or concepts Develop generalizations of the results obtained or strategies used and apply them to new problem situations
Apply: Carry out or use a procedure in a given situation: carry out (apply to a familiar task) or use (apply to an unfamiliar task)	Follow simple/routine procedures Solve a one-step problem Calculate, measure, apply a rule Apply an algorithm or formula Represent in words or diagrams a concept or relationship Apply rules or use resources to edit spelling and grammar	Select a procedure according to task needed and perform it Solve a routine problem applying multiple concepts or decision points Retrieve information from a graph and use it solve a multistep problem Use models to represent concepts Write paragraph using appropriate organization, text structure	Use concepts to solve nonroutine problems Design investigation for a specific purpose or research question Conduct a designed investigation Use reasoning, planning, and evidence Revise final draft for meaning or progression of ideas	Select or devise an approach among many alternatives to solve a novel problem Conduct a project that specifies a problem, identifies solution paths, solves the problem, and reports results Illustrate how multiple themes (historical, geographic, social) may be interrelated

Analyze: Break into constituent parts, determine how parts relate, differentiate between relevant/irrelevant, distinguish, focus, select, organize, outline, find coherence, deconstruct (e.g., for bias or point of view)	Retrieve information from a table or graph to answer a question Identify or locate specific information contained in maps, charts, tables, graphs, or diagrams	Categorize, classify materials Compare/contrast figures or data Select appropriate display data Extend a pattern Identify use of literary devices Identify text structure of paragraph	Compare information within or across data sets or texts Analyze and draw conclusions Generalize a pattern Organize/interpret data Analyze author's craft or viewpoint	Analyze multiple sources of evidence or multiple works by the same author or across genres Analyze complex/abstract themes Gather, analyze, and organize information Analyze discourse styles
Evaluate: Make judgments based on criteria, check, detect inconsistencies or fallacies, judge, critique			Cite evidence and develop a logical argument for concepts Describe, compare, and contrast solution methods Verify reasonableness of results Justify conclusions made	Gather, analyze, and evaluate relevancy and accuracy Draw and justify conclusions Apply understanding in a novel way, provide argument or justification for the application
Create: Reorganize elements into new patterns/structures, generate, hypothesize, design, plan, construct, produce	Brainstorm ideas, concepts, or perspectives related to a topic or concept	Generate conjectures or hypotheses based on observations or prior knowledge	Synthesize information within one source or text Formulate an original problem Develop a complex model for a given situation	Synthesize information across multiple sources or texts Design a model to inform and solve a real-world, complex, or abstract situation

Social Media in Education

Social media permeates education through teacher and students (Krutka et al., 2019). Similar to broader contexts, within education, it facilitates both social networks and instructional resources (Carpenter & Krutka, 2014; Torphy et al., 2020; Trust et al., 2016). A majority of teachers use social media for professional purposes (Frank & Torphy, 2019), with 87% of elementary teachers reporting use of Pinterest (Opfer et al., 2016). Pinterest allows teachers to comment, save resources (pin), and archive information across individually created and organized spaces (boards). The networks within Pinterest connect to other virtual spaces in which unique content is created, such as virtual resource pools (Torphy & Drake, 2019; Torphy et al., 2020).

Teachers may curate instructional resources to provide supplemental practice (Torphy et al., 2020). In one case study, Hu and colleagues (2020) described a suburban Indiana elementary classroom teacher—Amelia Gonzalez[1]—who turned to social media to provide additional support to her students. Ms. Gonzalez noticed students' difficulty with addition and subtraction with money. As a fourth-year teacher in a district with a relatively flexible curriculum, she routinely sought out and procured instructional resources online. "I pull from TeachersPayTeachers.com. I pull activities and adapt them to my kiddos" (Ms. Gonzalez as cited in Hu et al., 2020). Concurrently, Ms. Gonzalez considered her district-provided curriculum, students' mastery of content standards, and their engagement during the lesson. The resources she chose reflected a teaching strategy to enact. Teachers often curate resources related to teaching strategies, aspirational professional goals or ideas, and lessons for students (Shelton & Archambault, 2019).

Curating Resources in Social Media

Curation allows teachers to collect, combine, and present ideas from across the virtual universe into a succinct presentation on a particular subject or topic (Bhaskar, 2016; Frank & Torphy, 2019). In doing so, these collections combine into archives available to both the creator and other teacher consumers (Hu et al., 2018; Hu & Torphy, in press). Curated archives connected through social media may act as a heuristic for teachers upon which to rely as they confront millions of potential online resources (Torphy & Drake, 2019). This hastens teachers' ability to incorporate new information into their professional schema (Timperley & Robinson, 2001), make sense of it, and relate it to their work. During a pandemic and emergent reorientations to online schooling, archived professional resources may increase in demand. In fact, Pinterest found educational resources for kids rose to one of the top three searched items within their platform (personal communication, April 1, 2020).

Traditionally, educational change and curriculum adoption must go through multiple layers of checks and balance before adoption (Frank et al., 2011). Online, teachers may simply click and access resources for the next day's lesson (Hu et al., 2020). Virtual connection offers teachers the ability to flexibly meet their unique students' demands. However, more tailored instruction has potential for a greater degree of variation—in instructional resources within the classroom and student learning.

Conceptual Framework

As teachers online mediate between class and cloud—that virtual space in which individuals around the world meet, interact, and share—teachers autonomously direct the trajectory of their classroom curriculum (Torphy et al., 2020). We present a conceptual framework that situates teachers as active problem solvers. Teachers, planning comprehensively, curate instructional resources to meet both immediate and overarching needs (Clark & Peterson, 1986; Hu et al., 2020; Lampert, 2001). However, planning takes place within teachers' social world, local context, and, in many cases, as part of an SKC (Hu et al., 2018, 2020). Teachers' curation of resources generates an artifact to reflect their "understanding of the rapid flow of continuing social events [and] . . . rich store of general knowledge of objects, people, events, and their characteristic relationship" (Nisbett & Ross, 1980, p. 28). Recent research has found that teachers online curate instructional resources to specifically address students' needs unmet by district-promoted curriculum (Hu et al., 2020). We adapted a conceptual framework of teachers' thoughts and actions as presented in Clark and Peterson (1986) to a twenty-first-century view of teachers' professional engagement from face-to-face to virtual space. Figure 1 presents the opportunities and constraints teachers encounter as they curate and enact instructional resources for their classroom.

Opportunities and Constraints in Twenty-First-Century Teaching

Teachers' curation and actions are a cyclical process through which action and effect occur iteratively and build upon one another, seen in Figure 1. Curation is affected by teachers' thought processes, planning, and schemas, whereas teachers' actions are affected by their past behavior, their students' past behavior and learning, and their students' achievement. Historically, the notion teachers act out their beliefs has been evidenced in instruction. "What teachers do is directed in no small measure by what they think . . . it will be necessary for any innovations in the context, practices, and technology of teaching to be mediated through the minds and motives of teachers" (National Institute of Education, 1975, p. 1).

Recent research has examined teachers' use of social media as it permeates from cloud to class. Hu and colleagues (2020) followed curriculum planning and enactment of early career teachers across several midwestern school districts and found they largely supplemented resources to address lacking or incomplete learning activities within the official district curriculum. Through interviews and observations, authors learned how teachers incorporated virtual instructional resources and enacted them within their classrooms. The flow of these resources and teachers' sensemaking of the lessons occurred within SKCs. "Even in districts where there was a strict [curriculum] requirement . . . we observed teachers supplementing the textbook by using virtual resources" (Hu et al., 2020, p. 29). For teachers in districts with greater autonomy, virtual resources intermixed with the district's official curriculum in nuanced ways, making it difficult to differentiate institutional and virtual influence (Hu et al., 2020). We connected the opportunities and constraints teachers face to data across virtual and physical space to examine effects of curation over time (see Fig. 1).

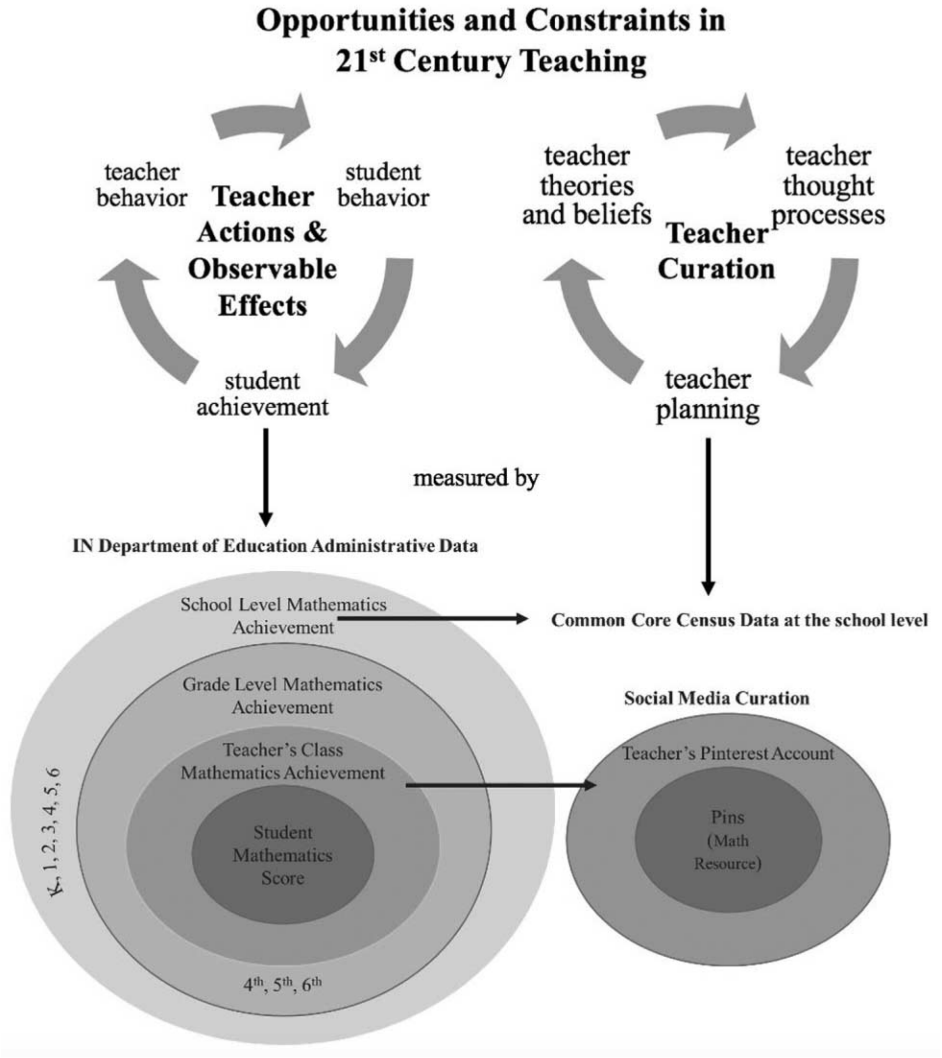


Figure 1. The opportunities and constraints of instructional planning and teaching.

Research Questions

Combining rich social media data and analytic techniques, we seek to explore relationships between instructional planning, teaching, and academic growth over time. Leveraging the instructional resource archives teachers curate as artifacts representing their professional practices and teaching demands, we sought to identify the relationship between the quality of resources (proxied by cognitive demand within a mathematics resource) and students' learning.

We focused our analysis on mathematics instruction, a required subject within all elementary school classrooms, with consistent standards delineated by the Common Core State Standards. Resource quality was proxied by the inherent cognitive demand within a particular task, as research has found positive returns to more complex instruction requiring students to actively construct knowledge. Students' learning was measured by the statewide department of education annual assessment. Given research showing significant variance in teachers' curation patterns across district, school, and grade level, we incorporated contextual factors including district- and school-level variables.

This article examines the relationship between teaching planning within Pinterest and student outcomes. To evaluate Pinterest curation within mathematics, we use the revised Bloom's taxonomy and asked the following questions:

> R1. How do the resources teachers access online support their students' learning?
>
> R2. Does aggregate curation in the social context of the school affect student learning?

Description of Methodology

Data and Methods

As aforementioned, Pinterest is a prevalent social media platform among elementary teachers. Other social media include Twitter, Instagram, Facebook, TikTok, Snapchat, and YouTube, to name a few. The data from each platform varies, depending on its purpose, accessibility, and structure. Within Pinterest, data include teachers' pin (image), associated title, description, any potential comments, domain of origin (the virtual space a particular pin may be linked outside of Pinterest), and followers/followees. Each pin provides a time-stamped artifact of teachers' curation, reflecting their thinking and decision-making related to knowledge worth curating. Teaching pins are one of many types of resources pinned within Pinterest. Other topics of interest extend from exercise and health to home renovation to fashion.

Pinterest is a public social media space; individuals' accounts can be public or private. Although all sampled teachers' Pinterest accounts were public, we still deidentified teacher accounts and data.

Social media platforms differ in how they support teachers' professional engagement. A majority of teachers use Pinterest to acquire and share instructional resources (Frank & Torphy, 2019). Resources are "pinned" and connect users to the site in which the pin originated. Pinterest both facilitates the convergence of teachers within their social media platform and the exchange of knowledge as they connect to the larger online space. Figure 2 displays a sample teacher's Pinterest page that contains an array of resources from personal to professional.

Data Sources, Structure, and Linkage

To answer the proposed research questions, estimating the relationships between teachers' instructional planning as evidenced within social media and students' mathematics performance, this article combines three data sources outlined below. A rich social media data set from Pinterest is created for a survey-collected sample of

Figure 2. Elementary teacher’s professional resources and ideas curated across boards. Color version available as an online enhancement.

284 elementary teachers in Indiana. This sample is collected through surveys from the Study of Elementary Mathematics, funded research from the National Science Foundation. This data set presents an archive of all educational resources a particular teacher has saved (pinned) since the origin of their account and surveys of teacher attributes.

Sampled teachers are identified within the Indiana Department of Education (IDOE) through a data-sharing agreement with Notre Dame University. The IDOE data include students' attributes and achievement scores, by year, from the academic year 2010–2011 to 2016–2017. Merging sampled teachers to IDOE data, we successfully linked 277 teachers. Finally, we include Common Core census data to gather school contextual variables, such as the composition of students' ethnicity, socioeconomic status, and urbanicity.

Three data sources, teachers' Pinterest accounts, their school-level public administrative data, and their students' achievement scores are linked through numeric identification numbers of schools, teachers, and students. Together, data present in a nested structure as shown in Figure 3. In Figure 3, students' mathematics scores on the statewide assessment are situated within teachers' classrooms, grade levels, and schools. As is typical, schools are situated within districts and states. Teachers are nested within grades, schools, and districts. IDOE data, by teacher, are matched to Common Core Data, by district. Within Pinterest, teachers' pins are nested within boards and individual accounts. For this analysis, we do not attend to board level differences but focus on analyses at the pin level.

Variables

Dependent variable. Our dependent variable is students' mathematic achievement score measured by the Indiana Statewide Testing for Educational Progress Plus (ISTEP+) program. ISTEP+ requires grade 3–10 students to take assessments in mathematics, science, reading, and social science during the spring semester

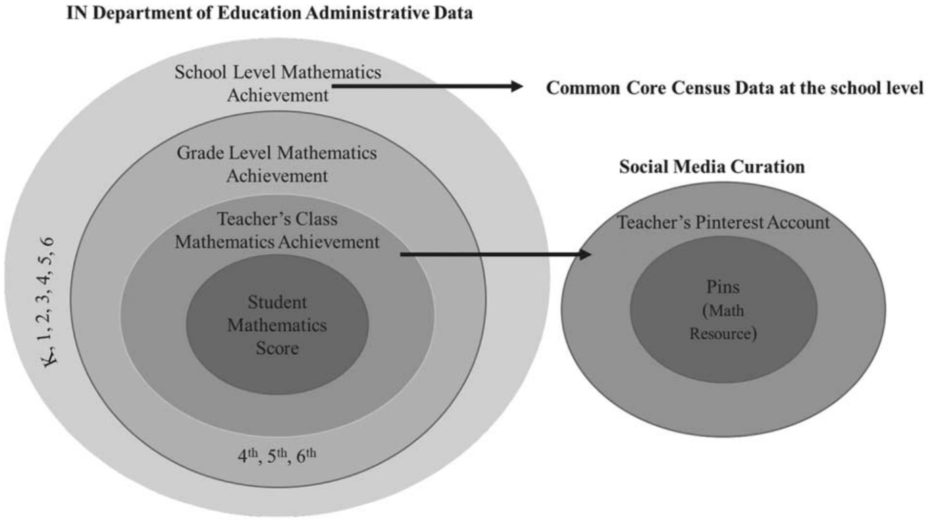
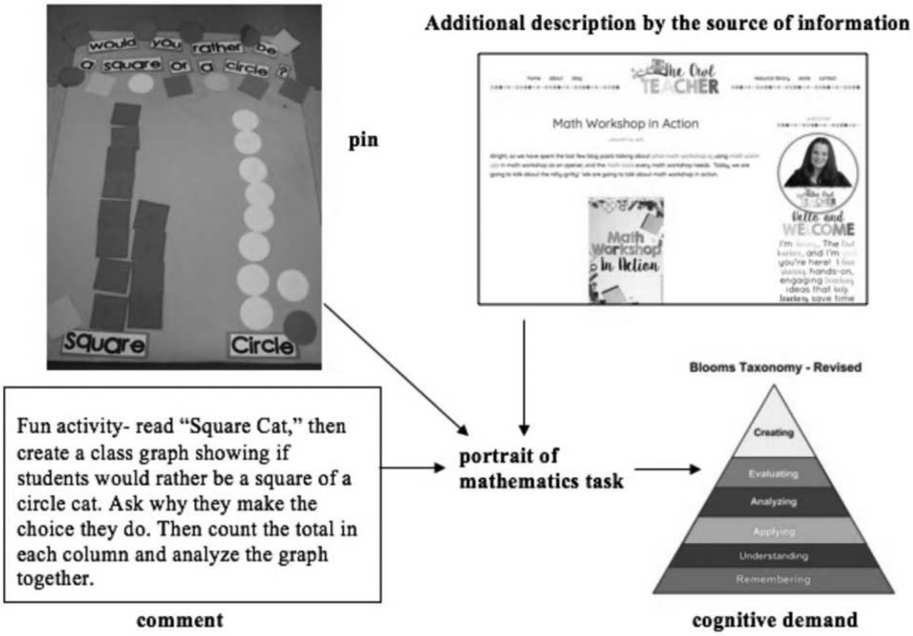


Figure 3. A demonstration of the linked data sources.

("Linking the Indiana ISTEP+," 2017). The mathematic assessment is designed to align with Indiana Academic Standards ("Linking the Indiana ISTEP+," 2017) and assess students' mathematics skills of number sense, computation, algebra and functions, geometry, measurement, and problem-solving (National Center for Education Statistics, n.d.). Based on performance scores, students are given an indicant of mastery, including did not pass, pass, and pass+. Each student also earns a numeric performance score. We used the numeric performance scores of individual students each year. Excluding classes of grades K–2, which are not required to take ISTEP+, our data linked 17,780 students from 621 classes of sampled teachers.

Independent variable. Teachers' curated mathematics pins are representations of teachers' conceptualization of mathematics. Torphy and colleagues developed a categorization system of the curated pins based on pins' mathematical content (Hu et al., 2018). As shown in their categorization, six types of pins are defined based on their specific mathematical tasks, including (1) art and fine motor skills, (2) visual mathematical representation, (3) concrete and manipulative, (4) kinesthetic and embodied mathematics, (5) contextual and open-ended mathematics, and (6) standard algorithm mathematics. The other three types of mathematic resources, which do not show concrete mathematical tasks, are (7) pedagogical processes, (8) physical resources, and (9) content resources. Building on this categorization (Hu et al., 2018), the current study further codes pins from the first six types with cognitive demand levels according to the revised Bloom's taxonomy (Hess et al., 2009) to understand pins' content quality. As mentioned earlier, there are six levels of cognitive demand, including (1) remembering, (2) understanding, (3) applying, (4) analyzing, (5), evaluating, and (6) creating. Figure 4 presents the process for coding teachers'



Fun activity- read "Square Cat," then create a class graph showing if students would rather be a square of a circle cat. Ask why they make the choice they do. Then count the total in each column and analyze the graph together.

Figure 4. Coding for cognitive demand within mathematics tasks. Color version available as an online enhancement.

pins for resource quality. A mathematics task depicts a student-generated graph of circles and squares reflecting students' preference to be a square or circle cat. The teams' expert mathematics raters hand-coded categories and cognitive demand of pins using both the comment accompanying the pin, and—if there was not enough information to identify cognitive demand through image and pin—following the pin's link back to the original source of information, outside Pinterest (Torphy, Hu, & Liu, 2018). For example, in the task in Figure 4, students are required to organize and interpret simple data. Therefore, the task is labeled "analyze" and given a code of 4 for potential cognitive demand.

Among the total 5,523 mathematic pins that were curated by sampled teachers, 3,853 pins were coded for cognitive demand. The first three cognitive demand levels of remembering, understanding, and applying accounted for the majority of the coded pins with 21.0%, 37.3%, and 26.4% of the total pin count, respectively. Hence, pins with cognitive demand levels of analyzing, evaluating, and creating, which fall within the upper levels of the revised Bloom's taxonomy, were combined into one category reflecting more complex thinking and higher cognitive demand pins. Pins coded in levels, 4, 5, and 6 accounted for 15.3% of the coded pins total.

The coding procedure followed an interrating reliability (IRR) design. We randomly assigned pins to six coders (including three authors of the current study) who have mathematical teaching expertise and were trained in pin coding. When a coder coded every 15–20 sampled teachers and their pins, another experienced coder would randomly sample 15 of those coded pins for a discrepancy check. There was evidence in preliminary coding training that coders were more likely to disagree on pins with higher cognitive demand level. Therefore, we oversampled higher cognitive demand pins in discrepancy checks. When there were more than three pins that coders disagreed on scoring, they would meet and discuss each discrepancy. Each IRR round completed when the coders' discrepancy rate was lower than 20%.

We computed year-accumulative proportion measures of each cognitive demand level and the other resource types of pins. For example, the understanding-level pin of a teacher curated in the first year is divided by the total curated pins. The following year (i.e., the second year), a teacher's understanding-level pin proportion is computed by summing the first and second years of understanding-level pins and dividing by the sum of the first two years of curated pins. That is, for a given year's measure, we sum over the corresponding pins that were curated in the given year and previous years. The accumulative measure is constructed to present teachers' accumulation of mathematical knowledge over the years. Moreover, the proportion measure reflects the weight of certain types of pins in teachers' conceptualization of mathematics.

Covariates. We included covariates to account for student-level, classroom-level, and school-level characteristics. The students' background covariates are individual students' ethnicity, with Black students coded as 1, and other race groups coded as 0. We do not further distinguish White from other racial groups as the other groups comprise a small amount of the student population within sampled classrooms (approximately 18%). Other student background covariates included age when taking the test, whether a student was a female (yes = 1), whether a student was an English-language learner (yes = 1), whether a student was given a primary exception for special education (yes = 1), and if a student was eligible for free or reduced-priced lunch (yes = 1), as a proxy for students' socioeconomic background. Students' grade level was also included as a fixed effect, where grades 4 and 5 were coded as dummy variables, and grade 6 was the reference group.

Covariates accounting for teacher attributes contain whether the teacher has less than 5 years of teaching experience (i.e., an early career teacher), whether the teacher is Black and female, and whether the teacher holds a graduate education degree. These variables are coded as 1 if yes, and 0 otherwise. The classroom-level covariates measured students' composition and socioeconomic status, including the percentage of Black students, percentage of English-language learners, percentage of primary exception (students receiving special education services), and percentage of students taking free or reduced-priced lunch. The school context variables are the same. We also estimate the impact of accountability pressure on the school by tracking variance in the A–F school rating within Indiana. A school is considered a failed school and coded as 1 if it received a "D" or "F" in a given year; otherwise it is coded as 0. In addition, fixed effects of districts and years are included.

Modeling Approach

The sampled data present a nested data structure, where the students are nested within teachers, and teachers are nested within classrooms. Thus, students from the same class and/or school tend to be more like to each other as they share similar contexts and background than the students from other classes and schools (Snijders & Bosker, 2011). In this case, the independent error assumption in the conventional ordinary least squares analysis no longer holds. The current study, therefore, employs hierarchical linear modeling (HLM) to handle the dependency issue caused by the nested data structure. Three-level random intercept models are conducted, which address the research questions regarding the relationship between teachers' curated resources on students' average achievement variation, conditioning on class and school context covariates. In addition, teachers' resource curation effect on students' achievement gains or value added is estimated through concluding the prior academic year's score of students (Koedel et al., 2015; McCaffrey et al., 2004). It is a critical control, as prior instruction may have had substantial effects on future instruction. As presented below, a null model with no predictors and covariates is included, with only the prior score, to estimate the between-student and within-student error variances:

$$\text{Level 1 (Student): } Y_{ijkt} = \beta_{0jkt} + \beta_{1jkt}\text{PriorScore}_{ijk(t-1)} + \varepsilon_{ijkt},$$

$$\text{Level 2 (Class): } \beta_{0jkt} = \pi_{00kt} + \xi_{0jkt},$$

$$\text{Level 3 (School): } \pi_{00kt} = \gamma_{000t} + \eta_{00kt},$$

where i indicates an individual student, j is a classroom, k is a school, and t is an academic year. Y_{ijkt} is then the mathematic performance score of a student i from a class j and school k of the year t. The random effects of ε_{ijk}, ξ_{0jk}, and η_{00k} are all assumed to be normally distributed with a zero mean and variances of σ_i^2, σ_j^2, and σ_k^2 respectively, and to be mutually independent. Specifically, these variance components conclude two intraclass correlation coefficients (ICC) with 14.8% of the error variance accounted for at the school level and 26.0% accounted for at the class level, which are shown in Appendix B. In other words, students' average achievement across schools and classes differs considerably so that including school- and class-level attributes were needed. The following full model examined teachers' curated remembering-level pins' effects on students' average achievement, controlling for covariates of students, classes and teachers, and schools. The time subscript of *t* is omitted for simpler notations.

Level 1 (Student):

$$Y_{ijk} = \beta_{0jk} + \beta_{1jk}\text{PriorScore}_{ijk} + \boldsymbol{\beta}_{\boldsymbol{qjk}}\textbf{StudentAttr}_{\boldsymbol{ijk}} + \varepsilon_{ijk},$$

Level 2 (Class):

$$\beta_{0jk} = \pi_{00k} + \omega_{01k}\text{CogDemand1}_{jk} + \boldsymbol{\pi}_{\boldsymbol{0pk}}\textbf{ClassAttr}_{\boldsymbol{jk}} + \xi_{0jk},$$

$$\boldsymbol{\beta}_{\boldsymbol{qjk}} = \boldsymbol{\pi}_{\boldsymbol{q0k}},$$

Level 3 (School):

$$\pi_{00k} = \gamma_{000} + \boldsymbol{\gamma}_{\boldsymbol{0zk}}\textbf{SchoolAttr}_{k} + \boldsymbol{\gamma}_{\boldsymbol{0sk}}\textbf{District/Year} + \eta_{00k},$$

$$\boldsymbol{\pi}_{\boldsymbol{0pk}} = \boldsymbol{\gamma}_{\boldsymbol{p00}},$$

$$\boldsymbol{\pi}_{\boldsymbol{q0k}} = \boldsymbol{\gamma}_{\boldsymbol{q0k}},$$

and $\boldsymbol{q}, \boldsymbol{p}, \boldsymbol{z}, \boldsymbol{s} = 1, 2, \ldots, n.$

ω_{01k} reveals the different effects of remembering-level pins (i.e., CogDemand1$_{jk}$) on students' achievement compared with other types of pins. It is treated as fixed. The random effects and variance components are now treated as conditional with the inclusion of the predictors and covariates. The covariates at each level are presented by the vectors of $\textbf{StudentAttr}_{\boldsymbol{ijk}}$, $\textbf{ClassAttr}_{\boldsymbol{jk}}$, $\textbf{SchoolAttr}_{\boldsymbol{k}}$ in the model, and their corresponding coefficients of $\boldsymbol{\gamma}_{\boldsymbol{p00}}$, $\boldsymbol{\gamma}_{\boldsymbol{q0k}}$, $\boldsymbol{\gamma}_{\boldsymbol{0zk}}$ are treated as fixed. Covariates are grand-mean centered, thus, the class-level predictors of interest are net of student- and school-level effects (Raudenbush & Bryk, 2002, p. 142; see also Brincks et al., 2017). District and year effects (i.e., $\boldsymbol{\gamma}_{\boldsymbol{0sk}}$) are controlled by adding the dummy variables for each district and year. A parallel model, controlling for the same covariates, uses the remembering-level pins as the reference group and considers the other types of the pins as the predictors of interest. The corresponding class-level model yields to:

Level 2 (Class):

$$\begin{aligned}\beta_{0jk} = {} & \pi_{00k} + \omega_{02k}\text{CogDemand2}_{jk} + \omega_{03k}\text{CogDemand3}_{jk} \\ & + \omega_{04k}\text{CogDemandHigh}_{jk} + \omega_{05k}\text{678MathPin}_{jk} + \boldsymbol{\pi}_{\boldsymbol{0pk}}\textbf{ClassAttr}_{\boldsymbol{jk}} + \xi_{0jk}.\end{aligned}$$

$$\boldsymbol{\beta}_{\boldsymbol{qjk}} = \boldsymbol{\pi}_{\boldsymbol{q0k}}.$$

The coefficients of the curated pins ω_{ovk} ($v = 2, 3, 4, 5$) are correspondingly the effect of the understanding-, applying-, and high-level cognitive demand pins, comparing with the remembering-level pins and resource types of pins.

In the above models, only grade 4–6 students are modeled because grade 3 students have no prior scores. Missing flags are created for grade 4–6 students who have no prior scores. This may be due to students who either did not take the test or took an alternative test. If the prior score is missing, then it was coded as 0, and the missing flag was coded as 1. If the prior score was not missing, it remained a performance score, and the missing flag was coded as 0. Similarly, missing cases of the curated pins are coded as 0. The missing cases are due to teachers having no Pinterest or curated pins. Thus, the dummy variable indicating teachers' status of whether they have Pinterest and pins serves the missing flag for the interests (i.e., cognitive level and other resource types of pins).

Results

Descriptive Statistics

The final analysis sample contained 10,383 students nested within 375 classes and 180 schools from the academic years of 2010–2011 to 2016–2017. Table 2 reports the means and standard deviations of the variables in the employed overall sample and across the grade levels. The average achievement scores of students are increasing each year, which is true to the design of ISTEP+. Among the curated pins that are codable for cognitive demand levels, the pins are distributed relatively evenly across the levels of remembering, understanding, applying, and the three combined

Table 2. Descriptive Statistics of Important Variables of the Overall Sample, and by Grade Levels

	Overall		Grade 4		Grade 5		Grade 6	
Variable	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Current-year score	506.47	65.75	484.70	65.67	515.78	61.44	526.08	62.96
Prior-year score	459.31	117.65	438.50	109.13	465.42	115.31	482.43	128.66
Proportion of remembering-level pins	.31	.25	.36	.26	.26	.18	.32	.33
Proportion of understanding-level pins	.31	.21	.33	.22	.34	.20	.21	.20
Proportion of applying-level pins	.25	.19	.22	.19	.28	.14	.29	.24
Proportion of high-level pins	.12	.20	.09	.21	.12	.16	.18	.25
Proportion of pins of other resources	.38	.26	.36	.25	.36	.23	.50	.32
Nonpin teacher	.69	.46	.66	.47	.70	.46	.72	.45
Grade level	4.78	.75	–	–	–	–	–	–
Teacher advance degree	.29	.46	.23	.42	.41	.49	.19	.39
Early career teacher	.43	.50	.46	.50	.33	.47	.55	.50
Female teacher	.90	.30	.90	.30	.94	.24	.83	.38
Black teacher	.10	.30	.08	.30	.12	.33	.09	.29
Student age	11.03	.90	10.15	.42	11.17	.45	12.19	.48
Student eligible for FRL	.58	.49	.59	.49	.53	.50	.66	.47
ELL student	.09	.29	.09	.28	.09	.28	.09	.29
Student with primary exception	.13	.33	.12	.33	.13	.34	.13	.33
Black student	.36	.48	.36	.48	.32	.47	.45	.50
Female student	.49	.50	.48	.50	.50	.50	.48	.50

Note.—ELL = English-language learner; FRL = free and reduced lunch.

upper levels of Bloom's taxonomy. The pins that are not codable with cognitive demand levels are the other types of resources, which account for approximately 38% of the total curated resources in the overall sampled classes. A small variation shows in grade 6, where 50% of pins are the noncodable ones, although the sample from grade 6 takes only 20% of the overall sample. Approximately 70% of the teachers in a given year have either no Pinterest or no codable pins. To check if there are systematic mechanisms underlying teachers' decision on curating resources due to year and district context, we conduct ANOVA tests of the curated resources on years and districts. No significant differences are detected.

In terms of student characteristics within classes, more than 50% of students are eligible for free and reduced lunch, approximately 10% are English-language learners, 13% request a primary exception, and 36% are Black. For the sampled teachers, the majority of them are female, slightly under half of them are early career teachers who have less than 5 years of teaching experience, and approximately 30% of them have graduate or advanced degrees. Only 10% of the sampled teachers are Black.

Main Model Analysis

Table 3 summarizes the HLM analyzed effects of teachers' curated resources on students' achievement, conditioning on the student-, class-, and school-level backgrounds and fixed effects of years and districts. The first two models are the null models, which only include prior scores, the missing flag of the prior score, and a dummy variable for sampled teachers who had no mathematics pins (including both those teachers who had no Pinterest account and those with Pinterest accounts but no mathematics pins). Not surprisingly, the prior score fixed effect is significant, as students' average achievement is relatively stable across two successive years. The missing flag for the prior score is significant, with a coefficient of 316, which indicates that a student who did not take the previous year's test needs to score around 300 points higher than the average score of the current year to have an eligible current-year score. As introduced earlier, students without prior scores may relate to not passing in the previous year's test, having no test available in 2011, taking alternative exams, or undetermined. These students only account for 4% of the sample in modeling. The above findings of the prior score and its missing flag are consistent across all models. No significant effect is found for being a teacher without mathematics pins. However, the inclusion of this dummy variable (i.e., nonpin teacher) is important, as it serves to detect any critically different teacher effects on students' achievement with respect to whether a teacher curates resources and also as a missing flag for pins' types as demonstrated in the last two models. The third model examined all the covariates' effects on students' achievement, excluding the predictors of interest. See Appendix A for the full model outputs. Appendix B presents the estimated random effects. In general, the covariates and predictors explained the between-school variance substantially around 76%, and 30% of the between-class-within-school variance. The last two models further included the cognitive demand levels and other resource types of pins. We discuss their results together below. In response to research question 1 (How do the resources teachers access online support their students' learning?), we found significant effects for the curation of pins, conditioning on covariates. Moreover, the effects of teachers' curation on students' achievement

Table 3. Fixed Effects of Curated Resources

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	165.0***	162.7***	217.0***	211.1***	202.1***
	(3.053)	(3.395)	(30.27)	(29.95)	(31.12)
Prior-year score	.711***	.711***	.666***	.667***	.667***
	(.006)	(.006)	(.006)	(.006)	(.006)
Missing flag of prior-year score	316.0***	316.0***	297.0***	297.1***	297.1***
	(3.216)	(3.215)	(3.390)	(3.389)	(3.390)
Nonpin teacher		3.158	2.318	.140	9.431^{+}
		(2.033)	(1.848)	(2.433)	(4.926)
Curated resources:					
Proportion of remembering-level pins				–14.22**	
				(5.418)	
School-level average proportion of remembering-level pins				11.15	
				(9.903)	
Proportion of understanding-level pins					13.74*
					(6.884)
Proportion of applying-level pins					21.34*
					(9.071)
Proportion of high-level pins					–6.106
					(8.511)
Proportion of pins of other resources					–6.069
					(6.782)
School-level average proportion of understanding-level pins					17.17
					(11.65)
School-level average proportion of applying-level pins					7.008
					(10.94)
School-level average proportion of high-level pins					5.159
					(13.61)
School-level average proportion of pins of other resources					3.084
					(8.496)

Note.—Standard errors are in parentheses.

$^{+}$ $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

differ, with both positive and negative relationships, depending on the level of the revised Bloom's taxonomy.

Across the cognitive levels of remembering and understanding, the effect of elementary teachers' curation of mathematics pins moves from negative to positive. The coefficient for the fixed effect on the proportion of remembering-level pins was –14.22 (p-value $< .01$), as shown in Model 4, whereas the fixed effect for the proportion of understanding-level pins was 13.74 (p-value $< .05$). In other words, if teachers only curated mathematics pins at the remembering level, the base level of Bloom's taxonomy, their students' average achievement went down by around 14 points. In contrast, if teachers curated understanding-level pins, the second level of Bloom's taxonomy, students' average achievement increased by around 14 points.

The returns to pinning mathematics resources above the remembering level continue as teachers' curate pins further up within the revised Bloom's taxonomy. Teachers curating pins at the applying level (i.e., the third level of Bloom's taxonomy) had a positive effect on students' achievement, with an estimated coefficient of 21.34 (p-value $= .02$). We tested for significant effects of curating high cognitive demand–level pins and pins that were other resources and found no significant differences. Finally, we found no statistically significant differential effects on pins' cognitive demand levels aggregated at schools. In other words, the pins' cognitive demand level–effect on students' average achievement plays a role at the class level but not the school level.

Teachers who did not curate pins have no significant effect on students' achievement, as shown in Model 3. The standard error estimates are increased in the last two models, which could be due to a collinearity issue. We conducted a multicollinearity test and found no significant inflation variances happen to the predictor of interests.

Across all models, student-level covariates, including age, English-language learner, primary exception due to special education, and a teacher-student ethnicity group match, show consistent significant effects. Specifically, students who are older, are English-language learners, are Black, make requests for special education, and are eligible for free and reduced-priced lunch tend to achieve less on average than their peers who are not.

At the class level, teachers with graduate and advanced degrees promote students' average achievement around five points, whereas teachers' experience, being female, or being Black do not have significant effects. Classroom composition variables, including proportions of students who are English-language learners, need primary exception, and Black, significantly and negatively affect student achievement gains. No significant effects were detected for school-level student composition and background variables. However, with more teachers early in their career, more female teachers, and teachers with a graduate degree, in a given school students' achievement was negatively affected. Finally, significant grade- and year-specific fixed effects were detected. Compared with grade 6, students' achievements are significantly lower in grades 4 and 5, which reflects the ISTEP+ design that the passing threshold increases by grade levels. Regardless of grade level, students tended to achieve higher in previous years, on average, compared with the last year's testing (i.e., spring 2017), except for the year of 2015. Regarding districts, no districts effects were found. Preliminary ANOVA tests of achievement across years and districts have shown similar results for students' average achievement across years and districts.

Discussion

Examining elementary teachers' use of social media as a conduit for curation of instructional materials provides an opportunity to observe and consider teachers' planning in real time, over time. This work stands as the first to connect teachers' virtual curation of instructional resources to their students' achievement. Estimating students' growth across years, we find teachers' curation of instructional tasks, requiring students to use skills including understanding and applying knowledge, relates to increases in learning. This stands in contrast to teachers curating resources requiring students to remember or memorize facts, in which learning decreased over time. In other words, resources focused on the base functions of recall, memorization, retelling, and understanding are less related to growth in student learning as reflected by state assessments. However, what this does not say is what state assessments are meant to capture, do capture, and how this may vary according to students and teachers' local context.

Elementary school mathematics teaching often includes an emphasis on fact memorization and drills to learn procedures for addition and subtraction, multiplication and division. Our results suggest that perhaps increases in these activities may negatively relate to students' learning. This may be because their curriculum sufficiently covers rote memorization, or it may be because students find greater learning when they engage actively around a mathematics task.

Teaching and education literature show that planning and enactment are interrelated to student learning (Hennessey, 2018). In this work, we find that, in turn, teachers' curation is related to students' growth across years. What is unknown is how resources curated interact with district curriculum or may create an added depth of complexity to instruction, collegial collaboration, or planning. In fact, when we examined the impact of contextual variation on students' learning, we did not find significant effects at the school or district level. Even at the classroom level, there were few compositional effects on students' achievement. Unsurprisingly, within-student variation did relate to later academic achievement, with students who had better prior-year academic achievement earning greater scores the following year.

Perhaps importantly, a key finding is that the resources elementary teachers curate matter. Despite whether they are used within the classroom, they speak to a broader vantage of how teachers' conceptualize knowledge and their teaching practice. Examining how teachers' curation relates to student growth and varies across districts provides a first look into the connections between individuals' virtual and face-to-face interactions and the mutual dependency they hold. Combining state administrative data and social media data over time, we can gain a better understanding of elementary teachers' professional experiences as they exist within twenty-first-century schools.

This work could be extended and applied to support preservice and in-service teachers. Courses within teacher training institutions could include explicit direction as to how to find high-quality instructional resources within virtual space. Within districts, professional development could support in-service teachers as they supplement curriculum with online curation. Communities of teachers across face-to-face and social media could collectively determine curated portfolios of instructional resources. Future work could examine differences in students' learning as teachers collectively engage in curation with one another.

In twenty-first-century schools, and in an ongoing pandemic, increasing numbers of teachers move into online space to curate instructional resources (Frank & Torphy, 2019; Torphy et al., 2020). Understanding how instructional resources relate to school and student change may be of import for policy makers, district leaders, and educators at large. Particularly as the coronavirus changes the educational landscape in 2020 and beyond, purposely considering additional support for teachers' curation efforts in virtual space may be of great value. In elementary schools, teachers have risen to address the challenge of potentially teaching online across subjects. Through communication with educational leaders and elementary administrators, we may impress an understanding of how to evaluate tasks' inherent cognitive demand and effects on young learners.

Future work will expand teacher samples to include other states and greater diversity in context both via urbanicity and students' composition, racial, socioeconomic, and academic. Given the significant resources required to examine and code each pinned instructional task, we seek additional approaches to scale analyses

(Torphy et al., in press). Finally, we use the Common Core State Standards to conduct a more in-depth analysis into what particular content standards and domains teachers curate to gain better understanding into where they seek supplemental resources.

In total, by leveraging teachers' engagement in social media, we may better be able to observe how they anticipate, respond to, and react to their students' needs within elementary classrooms. As schools face demands imposed by the coronavirus pandemic, supporting teachers online is likely to grow in importance. This work may begin to address elementary leaders' considerations for online resource curation.

Appendix A

Table A1. Fixed Effects of Curated Resources and Covariates

	Model 1	Model 2	Model 3	Model 4	Model 5
Intercept	165.0*** (3.053)	162.7*** (3.395)	217.0*** (30.27)	211.1*** (29.95)	202.1*** (31.12)
Prior-year score	.711*** (.006)	.711*** (.006)	.666*** (.006)	.667*** (.006)	.667*** (.006)
Missing flag of prior-year score	316.0*** (3.216)	316.0*** (3.215)	297.0*** (3.390)	297.1*** (3.389)	297.1*** (3.390)
Nonpin teacher		3.158 (2.033)	2.318 (1.848)	.140 (2.433)	9.431^{+} (4.926)
Curated resources:					
Proportion of remembering-level pins				−14.22** (5.418)	
School-level average proportion of remembering-level pins				11.15 (9.903)	
Proportion of understanding-level pins					13.74* (6.884)
Proportion of applying-level pins					21.34* (9.071)
Proportion of high-level pins					−6.106 (8.511)
Proportion of pins of other resources					−6.069 (6.782)
School-level average proportion of understanding-level pins					17.17 (11.65)
School-level average proportion of applying-level pins					7.008 (10.94)
School-level average proportion of high-level pins					5.159 (13.61)
School-level average proportion of pins of other resources					3.084 (8.496)
Student backgrounds:					
Age			−7.236*** (.772)	−7.254*** (.772)	−7.235*** (.772)
Free and reduced lunch (FRL)			−5.115*** (.822)	−5.115*** (.822)	−5.116*** (.822)
English-language learner (ELL)			−7.586*** (1.309)	−7.574*** (1.309)	−7.575*** (1.309)
Primary exception			−6.579*** (1.098)	−6.571*** (1.098)	−6.575*** (1.098)
Female			−.933 (.661)	−.935 (.661)	−.933 (.661)

Table A1. (*Continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5
Black			−6.735***	−6.730***	−6.728***
			(.866)	(.866)	(.866)
Grade 4			−29.23***	−29.61***	−29.36***
			(4.080)	(4.078)	(4.076)
Grade 5			−8.747***	−9.753***	−9.669***
			(2.590)	(2.598)	(2.598)
Teacher attributes:					
Black			1.453	.914	1.087
			(3.697)	(3.657)	(3.615)
Early career teacher (ECT)			3.816+	2.657	2.687
			(2.084)	(2.098)	(2.151)
Female			2.820	2.692	2.986
			(3.248)	(3.213)	(3.198)
Graduate or advanced degree			4.572*	4.903*	4.346*
			(2.124)	(2.098)	(2.121)
Class student composition:					
Average age			−1.198	−1.653	−1.416
			(2.648)	(2.634)	(2.639)
Proportion of FRL			−.981	−.331	−.953
			(10.18)	(10.06)	(10.06)
Proportion of ELL			−34.07*	−34.63*	−36.39**
			(14.37)	(14.19)	(14.04)
Proportion of primary exception			−16.65*	−17.04*	−18.96*
			(8.284)	(8.183)	(8.214)
Proportion of female			−.710	−3.252	−.603
			(12.06)	(11.94)	(11.77)
Proportion of Black			−32.16**	−32.39**	−33.75**
			(10.54)	(10.40)	(10.30)
School-level covariates:					
Failed school			2.089	3.010	2.971
			(5.069)	(5.022)	(5.106)
Proportion of Black teacher			−8.586	−7.224	−7.714
			(5.384)	(5.364)	(5.338)
Proportion of ECT			−9.921**	−9.695**	−9.308*
			(3.637)	(3.606)	(3.884)
Proportion of female teacher			−15.62**	−17.81**	−16.91**
			(5.613)	(5.671)	(5.803)
Proportion of teachers have graduate degree			−7.854+	−9.184*	−8.953*
			(4.036)	(4.011)	(4.297)
Average student age			−1.026	−.465	−.570
			(2.414)	(2.389)	(2.446)
Proportion of FRL student			−9.628	−12.14	−9.718
			(15.67)	(15.54)	(15.75)
Proportion of ELL student			6.351	6.356	11.14
			(19.19)	(19.01)	(19.03)
Proportion of primary exception student			−9.345	−7.988	−6.504
			(11.69)	(11.56)	(11.70)
Proportion of female student			8.409	13.44	11.36
			(17.80)	(17.67)	(17.86)
Proportion of Black student			3.805	4.046	4.022
			(14.24)	(14.07)	(14.29)
Year 1			8.713*	10.25*	9.790*
			(4.440)	(4.417)	(4.593)
Year 2			16.35***	18.29***	17.64***
			(4.119)	(4.119)	(4.267)
Year 3			17.19***	16.56***	17.30***
			(3.751)	(3.738)	(3.834)

Table A1. (*Continued*)

	Model 1	Model 2	Model 3	Model 4	Model 5
Year 4			16.10***	15.38***	16.75***
			(3.515)	(3.539)	(3.560)
Year 5			−12.45***	−13.46***	−12.53***
			(3.278)	(3.289)	(3.339)
Year 6			0	0	0
			(.)	(.)	(.)
Batali School District			1.895	1.564	3.136
			(4.508)	(4.468)	(4.630)
Henderson School District			−5.212	−5.797	−5.223
			(6.042)	(5.974)	(6.138)
Lagasse School District			−1.846	−1.272	−.713
			(3.736)	(3.697)	(3.809)
			−2.494	−1.576	−2.282
			(7.147)	(7.064)	(7.105)
			1.113	.0300	1.783
Waters School District			(3.486)	(3.514)	(3.548)

Note.—Standard errors are in parentheses. Year 6 fixed effect is omitted due to collinearity issue. The collinearity issue does not affect the effects found for the curated resources.

$^{+}$ $p < .10$.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Appendix B

Table B1. Variance Estimates of Random Effects

	Model 1	Model 2	Model 3	Model 4	Model 5
Student level	1,111.275	1,111.248	1,078.66	1,078.57	1,078.65
	(15.520)	(15.520)	(15.56)	(15.25)	(15.30)
Class level	167.811	165.182	121.42	116.86	110.81
	(21.129)	(20.878)	(16.30)	(15.99)	(15.67)
ICC	.260	.260	.13	.13	.13
	(.019)	(.019)	(.012)	(.012)	(.012)
School level	221.339	223.560	46.48	52.24	52.24
	(37.910)	(38.066)	(16.05)	(16.79)	(16.79)
ICC	.148	.149	.037	.037	.042
	(.022)	(.022)	(.013)	(.013)	(.013)

Note.—ICC = intraclass correlation coefficient.

Notes

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1. Ms. Gonzalez is a pseudonym to protect confidentiality.

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