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The Top 500 Mathematics Pins: An Analysis of Elementary Mathematics Activities on Pinterest

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A 2017 study found that 87% of elementary teachers reported consulting Pinterest when planning mathematical lessons (Hertel & Wessman-Enzinger, 2017). When searching for resources on Pinterest, preservice teachers identified looking at the number of pins to determine their quality (Sawyer & Meyers, 2018). This leaves teacher educators wondering, what is the quality of materials that preservice and inservice teachers are finding on Pinterest? We conducted a document analysis on the top 500 elementary mathematics pins found on Pinterest to determine what kinds of elementary mathematics materials are available, what mathematics topics are represented, the level of cognitive demand of the elementary mathematics activities, and how the image found on the activities relates to the level of cognitive demand. We found that less than two percent of activities are the highest level of cognitive demand and decorative images are correlated with lower level elementary mathematics activities. With this information, teacher educators could help prepare teachers to decide which resources they should use and what they should look for to increase the level of cognitive demand of elementary mathematics activities they implement in their classroom.

Keywords: *Mathematics Task, Pinterest, Level of Cognitive Demand*

Social media has changed the way teachers find and implement activities in their classrooms; teachers often search online for activities rather than finding activities in traditional textbooks (Carpenter, Cassaday & Monti, 2018; Sawyer & Meyers, 2018). Researchers found that one of the most common social media websites that teachers use to search for classroom activities is Pinterest (Hertel & Wessman-Enzinger, 2017; Hunter & Hall, 2018; Sawyer & Meyers, 2018). Yet little is known about the quality of educational activities on Pinterest or other such sites. This paper seeks to begin to address this question about quality by specifically looking at elementary mathematics activities found on Pinterest.

PINTEREST

Pinterest (<http://pinterest.com>), which launched in March 2010, is a free pinboard-style sharing website amassing more than 11 million active users (Hansen, Nowlan, & Winter, 2012). The website identifies itself as a visual discovery engine which allows for inspiration from members' social bookmarks (Pinterest, 2019). Although it is a search engine, Pinterest also serves as a social media platform (Kerali, 2018). We define social media as internet-based applications that offer individuals or groups the ability to create profiles designed to offer member supported communication (Obar & Wildma, 2015). Pinterest is a form of social media because it provides an online means of communicating through shared information created from its visual search engine. The website is different from other social media platforms such as Facebook because it focuses on identifying other websites or "pinboards" of interest to its users versus displaying information about the members.

Pinterest offers pinboards focusing on makeup, home decor, hair tutorials, DIY, recipes, workouts, lesson planning, and much more (Pinterest, 2019). Users select a topic of interest and view the "pins" (i.e. the visual representations of the linked websites relating to the selected topic that were pinned by other members on Pinterest). Pinterest is especially popular with teachers. In 2017, 87% of elementary mathematics teachers reported consulting Pinterest when planning lessons (Hertel & Wessman-Enzinger, 2017). For example, if a teacher searches for lesson ideas for teaching addition, the search engine will show hundreds of pins previously posted by other users; the teacher would see worksheets, activities or tasks, and blogs that focus on addition. When searching for resources on Pinterest, preservice teachers identified looking at the number of times a teaching resource

was pinned as a means of determining the quality of the resource (Sawyer & Meyers, 2018). This leaves teacher educators wondering, what is the quality of materials that preservice and inservice teachers are finding on Pinterest?

PURPOSE

As mathematics teacher educators and future elementary school teachers, we focus this paper specifically on elementary mathematics. We determined the quality of elementary mathematics tasks found on Pinterest using Smith and Stein's (1998) Task Analysis Guide framework which defines levels of cognitive demand for mathematics tasks. In an attempt to determine the quality of the most frequently pinned educational tasks, we sought to investigate the top 500 elementary mathematics pins on Pinterest to answer the following questions:

1. What kinds of elementary mathematics materials are found on Pinterest?
2. What elementary mathematics topics are represented in the pins?
3. If the pins include mathematics tasks, what is their associated level of cognitive demand?
4. How does the presence and type of an image(s) found on mathematics task relate to the level of cognitive demand?

CONCEPTUAL FRAMEWORK

We classify the quality of the elementary mathematics tasks found on Pinterest in terms of their cognitive demand as explicated by Smith and Stein (1998), whose well-respected tool is known as the Task Analysis Guide (TAG). TAG describes four levels of cognitive demand for mathematics tasks: memorization, procedures without connections to concepts or meaning, procedures with connections to concepts and meaning, and doing mathematics (Smith & Stein, 1998). Smith and Stein explain that memorization and procedures without connections relate to a lower-level of cognitive demand, while procedures with connections and doing mathematics relate to a higher-level of cognitive demand.

The lowest level of cognitive demand, memorization, occurs when students learn material in isolation from other mathematics concepts, typically focusing on speed or rote knowledge. Procedures without connections (the second lowest level of cognitive demand) involves performing arithmetic

processes which requires a higher level of thinking than memorization. Despite this, Smith and Stein explain that such tasks need little cognitive effort, especially when a memorized algorithm can simply be applied or no explanation is necessary. For procedures without connections, students learn concepts in isolation and often have a difficult time relating them to an underlying conceptual meaning. This, in turn, often results in a correct-answer oriented mindset (Smith & Stein, 1998).

The third highest level of cognitive demand, procedures with connections, involves working with problems in multiple ways. For example, visual diagrams or manipulatives can be used to connect underlying concepts and symbolic representations (Smith & Stein, 1998). Procedures with connections require more cognitive effort because the focus is on making mathematical connections rather than on obtaining correct answers in isolation. The final and highest level of cognitive demand is what Smith and Stein refer to as doing mathematics. Doing mathematics requires non-algorithmic thinking and therefore, tasks at this level are multifaceted, making connections between mathematics content, and placing responsibility on the student to explore and understand the mathematics. When working at this highest level, students sometimes experience anxiety due to the non-algorithmic approaches tasks that this level often require (Smith & Stein, 1998).

In addition to explaining levels of cognitive demand, Smith and Stein (1998b) present a framework that incorporates their work with the TAG, The Mathematics Task Framework. They discuss how the identified level of a mathematics task as printed instructional material can be altered both by how the teacher sets up the task and how the task is implemented by the students. They explain that “the nature of tasks often changes as they pass from one phase to another” (p. 270, 1998b). They found that it is important for teachers to be aware of both the identified level of cognitive demand of mathematics tasks but also how to focus on classroom implementation since how teachers set-up and implement tasks has the possibility to either increase or decrease the level of cognitive demand. For this paper, we consider a modified version of the Mathematics Task Framework as conceptualized by Wilhelm in 2014 (Figure 1).

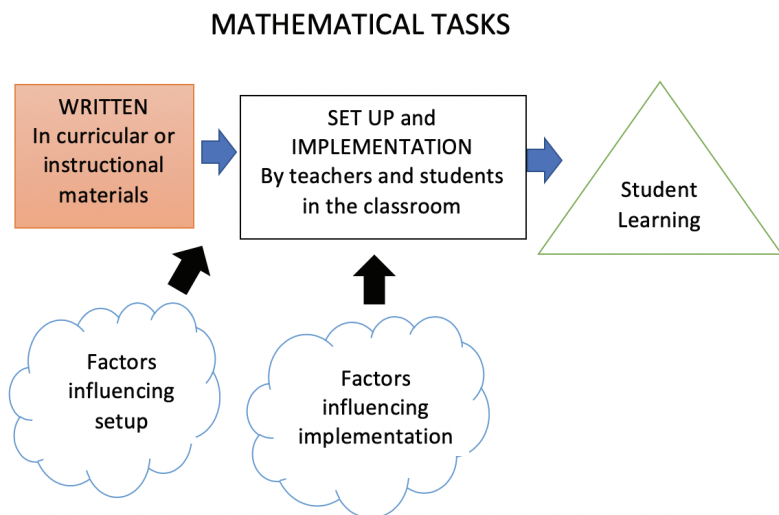


Figure 1. Wilhelm’s (2014) Modification of Smith & Stein’s (1998b) Mathematics Task Framework.

For this particular study, we focus on the first phase of the framework considering elementary mathematics tasks appearing as instructional materials online. Tasks designs are important to classroom instruction because of their influence on other classroom components. In *Principles to Actions*, the authors explain that teachers must “regularly select and implement tasks that promote reasoning and problem solving” so students “have the opportunity to engage in high-level thinking” (NCTM, 2014, p. 17). However, choosing a task that is considered to be at a high-level of demand does not guarantee it will either be setup or implemented at the same level. Researchers found that implementing tasks at a high level is difficult for teachers; teachers’ actions, such as choices regarding scaffolding a task (Henningsen & Stein, 1997) or the expectations of discourse (Hiebert & Wearne, 2003) can alter the level of demand. During implementation, it is most common for the level of demand to decrease (National Council of Teachers of Mathematics, 2007). Thus how a task is implemented has a direct impact on the final component of the framework, student learning, which has been shown can increase when students are exposed to high-demand tasks (e.g. Zohar & Dori, 2003).

Wilhelm states, “The cognitive demand of the selected task sets the stage for the cognitive demand over the course of the lesson” (2014, p. 640).

Thus, while it is imperative to keep all aspects of the framework under consideration when studying differing levels of cognitive demand of mathematics tasks, for this study, we are solely focused on the first component. We are interested in learning more about the quality of mathematics resources available online on Pinterest. The level of demand of tasks available to teachers on Pinterest will affect the task implementation and most importantly student learning.

LITERATURE REVIEW

For this literature review, we first synthesize the body of academic work done by mathematics education researchers who have considered the cognitive demand of elementary mathematics tasks in the classroom. We then discuss studies using Smith and Stein's Task Analysis Guide as a means of determining tasks' level of cognitive demand. After discussing work using TAG, we share research about teachers' use of educational materials found online.

High-Cognitive Demand Tasks

Choosing and implementing high level mathematics tasks in the classroom provides students with the opportunity to learn mathematics (e.g. Boaler, 2002; Hiebert & Wearne, 1993; Zohar & Dori, 2003). When students engage in high-quality mathematics tasks, students tend to engage in classroom discourse which "mediate(s) the relationship between teaching and learning" (Hiebert & Wearne, 1993, p. 420). The effects of working with high level mathematics tasks was found to benefit all students, not just students considered high achievers (Zohar & Dori, 2003). Due to the importance of exposing students to tasks at high levels of cognitive demand, teachers must have access to such tasks.

To classify tasks when analyzing curricula at both the secondary (e.g. Brändström, 2005; Jones & Tarr, 2007) and elementary level (e.g. NCTM, 2017; Stein, Smith, Henningsen, & Silver, 2000), Smith & Stein's (1998) TAG, has often been used. For example, Jones and Tarr (2007) considered the subject of probability in terms of the cognitive demand present in various mathematics textbooks. They concluded that a majority of tasks in the alternate Standards Era textbooks had high levels of cognitive demand, while 85% of problems in the non-Standards Era textbooks were of a low-

er level of cognitive demand. Furthermore, Brändström (2005) evaluated a seventh-grade textbook and determined that all tasks regardless of intended level of demand functioned at a low cognitive demand when implemented, even when the book stated that a task was differentiated for learners. Further, NCTM published an article looking into the levels of cognitive demand of elementary mathematics tasks and found that cognitive demand can vary within mathematics topics (NCTM, 2007).

Even when tasks identified as eliciting high levels of cognitive demand are available, it is difficult for teachers to choose and implement mathematics tasks at the highest levels of cognitive demand. Wilhelm (2014) found that teachers' mathematical knowledge for teaching (MKT) was related to their choice of tasks; teachers with lower levels of MKT tended to choose lower level mathematics tasks to implement in their classrooms. Thus, teachers need professional development focused on task selection.

Smith and Stein's TAG has been used with both preservice and inservice teachers as a means of professional development to classify mathematics tasks according to their level of cognitive demand. Boston (2013) worked with secondary education mathematics teachers on choosing and implementing cognitively demanding math tasks before and after a professional development workshop. Boston concluded that after taking the workshop, teachers were able to correctly classify the cognitive demand of mathematics tasks (Boston, 2013). Stein et al. (2000) found the best way to avoid the problem of textbooks not offering enough tasks with high levels of cognitive demand was to have teachers learn to sort tasks by their level of cognitive demand. When teachers learned how to identify the level of cognitive demand of tasks, they were more likely to choose higher level tasks to implement in their classrooms. All of this reviewed professional work with teachers was focused on traditional curricula; we are not aware of any studies looking specifically at open-source, online educational materials.

Popularity of Online Educational Materials

In 2017, researchers began evaluating online educational resources and found that many elementary school teachers used Pinterest and Google for mathematics lesson plan ideas (Hertel & Wessman-Enzinger, 2017). Over half a million educational posts are pinned on Pinterest everyday, and education-related pins are the second most searched for item on Pinterest (Hertel & Wessman-Enzinger, 2017). These pins often lead to a paid resource site such as Teachers Pay Teachers (TpT), where many of the lessons cost

three to eight dollars (Joyce, 2015). Researchers found that teachers tend to base the merit of a lesson plan on its user rating, even though high ratings can oftentimes be explained by teachers' self-promotions of their posts via social media sites such as Instagram (Sawyer & Meyers, 2018). A 2018 article claimed that some teachers' promotions of their products amasses over 100,000 followers and often results in over \$200,000 of profit each year (Reinstein, 2018).

Shifting towards Online Resources

Prior to our current age of personal sharing on the internet, licensing and copyright laws made it difficult to reuse or repurpose online educational resources (Wiley, 2008). Now, many resources are available through new licensing strategies such as Creative Commons which allow for wider access. (Jenkins, Ford, & Green, 2013; Kelly, 2014). Thus, many teachers now search online to find tasks for their classrooms (Hunter & Hall, 2018), and they are often self-motivated to find and use such resources (Hylén, 2006). To find tasks online, teachers often use other teachers as a starting point, trusting that the sites they recommend will be trustworthy (Clements & Pawlowski, 2012). However, despite the fact that teachers use online resources and researchers such as Jones & Tarr (2007) called for "analyzing broader range of materials" (p. 21) beyond traditional textbooks and curricula, there has not been much work looking into what resources teachers choose online. This study helps to close the gap in the research to better understand the quality of the resources teachers choose from Pinterest.

METHODOLOGY

We conducted a three-step document analysis process (Bowen, 2009) to assess Pinterest's top 500 elementary mathematics tasks. To determine significant relationships between various characteristics, correlational data were analyzed using the Pearson chi-square test for independence and Spearman's rho correlation (Pallant, 2013).

Data collection

In one of our previous investigations, we found that teachers often select Pinterest posts based on their number of pins (Sawyer & Meyers, 2018).

Since the initial investigation was completed, Pinterest removed the algorithm calculating the number of people who pinned a resource to one of their own created boards within the site. Pinterest noted that counting the number of pins would consequently result in the oldest pins having the largest value, thus they changed their algorithms to look at the top viewed pins by their members (Kynes, 2018). Because top viewed often means the posts promoted by teachers (Reinstein, 2018), we decided to see if the top 500 pins for elementary mathematics tasks included high-quality elementary mathematics materials with high levels of cognitive demand.

On June 6th, 2018, we downloaded the top 500 pins provided on Pinterest under the search term: “elementary math activities.” Once downloaded, we quickly realized that some of the results were copies of manipulatives, classroom posters, or lists of common core standards rather than mathematics activities or tasks. Consequently, we could not identify the level of cognitive demand of all 500 pins. Also, because many tasks included multiple types of questions or multiple worksheets, we chose to consider each post as potentially comprised of multiple mathematics tasks. To clarify, we adopted Doyle’s (1983) definition of academic tasks as “answers students are required to produce and the routes that can be used to obtain these answers” (Doyle, 1983, p. 161). Of the 500 files downloaded from Pinterest, our dataset consisted of 355 resources that qualified as elementary mathematics activities containing at least one mathematics task.

Data Analysis

We conducted a three-step document analysis process using QSR NVivo 10.2 to answer our research questions (Bowen, 2009). The first phase of data analysis was to code each pin for identifying attributes including the intended topic. During this phase of analysis, one researcher worked independently to code attributes; any questions were brought to the full research team for negotiation. The purpose for coding the mathematics topic was to capture the foci of the various elementary mathematics tasks, first coding topics that emerged and then collapsing them into the Common Core State Standards of Mathematics Strands (Table 1) (NGACBP, 2010). For examples of coding, see Appendix A.

Table 1
Topics as They Were Organized by Common Core Bands

Common Core Strands	Topics
Counting and Cardinality	One to one correspondence, comparing numbers, counting and ordering, subitizing
Operations and Algebraic Thinking	Addition, subtraction, multiplication, division, patterns, even or odd, prime and composite, fact families, number bonds
Numbers and Operations in Base ten	Base 10, place value, decomposing numbers, ten frame, rounding, hundreds chart, number sense
Numbers and Operations-Fractions	Fractions, decimals
Measurement and Data	Graphing, tally markers, time, money, unit conversions, area and perimeter, angles, measurement, estimation, number line
Geometry	Shapes, symmetry, coordinate plane, sorting, lines, position words
Statistics and Probability, Rational and Proportional Relationships, the Number System	Central tendency, probability, combinations, percent, integers

The second phase of data analysis included coding each pin to determine if it contained mathematics tasks and then coding for the tasks' associated levels of cognitive demand: memorization, procedures without connections, procedures with connections, and doing mathematics (Smith & Stein, 1998). Because pins could contain multiple mathematics tasks, each pin received a minimum, mode, and maximum level of cognitive demand code (see Appendix B for examples of codes). For this paper, the mode level of cognitive demand is presented and analyzed.

The third phase of data analysis included coding the types of pictures provided with or on the elementary mathematics tasks due to emergent researcher noticing of different image types and subsequent research indicating that some teachers select classroom tasks due to visual appeal (Carpenter, Cassaday, & Monti, 2018). We wanted to determine if the level of cognitive demand required for elementary mathematics tasks with decorative pictures differed from those with functional pictures. As seen in Appendix C, we used Brändström's (2005) categorization scheme of *functional*, when

the picture aided in solving the problem, *decorative*, when there was a picture but it was not needed to solve the problem, and *no picture* if there was no image present (Brändström, 2005). A task could receive both a functional and a decorative code if both types of images were included.

For both phases two and three, three researchers worked together to reach inter-rater reliability. We conducted one cycle of coding together using a random number generator to select 10 tasks from Pinterest. We then conducted four more rounds separately before reaching reliability. Fleiss Kappa (Fleiss, Cohen, & Everitt, 1969) was used to measure reliability; on the fourth and final round, an acceptable kappa for each level of demand was reached (ranging from .781 to .895). Throughout the coding process, we created a codebook to assist with reliability (DeCuir-Gunby, Marshall & McCulloch, 2011). After the three researchers met reliability, we asked the fourth group researcher who was unfamiliar with the coding process to apply the codebook to 10 randomly selected pins in order to evaluate the accuracy of the codebook. After one round, we reached reliability, again using Fleiss Kappa, which indicated the codebook was reliable. After reaching reliability, two coders independently coded the remaining pins.

Once coding was completed, we conducted the Pearson chi-square statistical tests to determine the relationship between the level of cognitive demand, the topic, and the picture type of the elementary mathematics tasks (Bollen, 1989). Since we had a large sample size, we selected alpha as 0.05, thus setting the criteria that the p -value must be less than 0.05 for us to reject the null hypothesis that there is no relationship between the two variables. We used Spearman's rho rank order correlation to determine the association between the level of cognitive demand and picture type. Since we preselected our alpha as 0.05, when the p -value was less than alpha there was evidence of a correlation. Specifically, the ranking was scored one for only decorative images, two for decorative and functional images, and three for only functional images. A significant positive correlation would indicate that pins with higher levels of cognitive demand had functional images.

FINDINGS

Of the 500 pins we analyzed, we found that 145 (29%) pins did not contain elementary mathematics tasks while 355 (71%) were elementary mathematics tasks. Thus, we categorized the 500 pins into 20 different categories (Table 2). The top non-tasks were grouped into: Blogs (23%), Worksheets (15%), Crafts (9%), and Decorations (8%). The top elementary math-

ematical tasks were: Worksheets (33%), Activity Cards (29%), and Games (16%).

Table 2
Pin Type

Type of pin	Non-Task	Task	Total
Activity Cards, Task Cards	0 (0%)	102 (28.7%)	102 (20.4%)
Anchor Charts, Notebooks, Interactive Anchor Chart	11 (7.5%)	1 (0.3%)	12 (2.4%)
App, List of Apps	3 (2.1%)	4 (1.1%)	7 (1.4%)
Blog, Blog Post	33 (22.6%)	27 (7.6%)	60 (12%)
Book, Booklet, Bookmark	6 (4.1%)	1 (0.3%)	7 (1.4%)
Bundles, Handouts, Worksheets, Virtual Worksheets, Online Worksheets, Interactive Worksheets, Worksheet Game	22 (15.1%)	116 (32.7%)	138 (27.6%)
Crafts, Coloring	13 (8.9%)	0 (0%)	13 (2.6%)
Games	8 (5.5%)	58 (16.3%)	66 (13.2%)
Centers, Guided Math Groups, Stations Math Workshop	7 (4.8%)	13 (3.7%)	20 (4%)
Mixed	7 (4.8%)	12 (3.4%)	19 (3.8%)
Riddles, Puzzles, Matching	1 (0.7%)	2 (0.6%)	3 (0.6%)
Videos	5 (3.4%)	0 (0%)	5 (1%)
Tool, Mats, Strategy, Manipulatives	10 (6.8%)	4 (1.1%)	14 (2.8%)
Running Records/ Assessment	1 (0.7%)	0 (0%)	1 (0.2%)
Decorations, Poster	11 (7.5%)	1 (0.3%)	12 (2.4%)

Type of pin	Non-Task	Task	Total
Project	3 (2.1%)	7 (2%)	10 (2%)
Curriculum, Unit	1 (7%)	3 (0.8%)	4 (0.8%)
Song	2 (1.4%)	0 (0%)	2 (0.4%)
Number Talks	0 (0%)	3 (0.8%)	3 (0.6%)
N/A	1 (0.7%)	1 (0.3%)	2 (0.4%)
Total	145 (100%)	355 (100%)	500 (100%)

Table 3 contains the results of the coding of the 500 pins for their associated Common Core State Standards for Mathematics' content strands (NGACBP, 2010). We found that most of the pins (39%) concerned Number and Operations in Base Ten with both tasks (42%) and non-tasks (34%) having the largest concentration of pins. The second most common strand for both tasks (25%) and non-tasks (19%) was Operations and Algebraic Thinking (23%). This similarity between tasks and non-tasks ended for the third most popular strands. The third highest concentration of non-tasks was No Mathematics (16%) which included mathematics posters or print out manipulatives that could not be connected to a specific content strand. On the other hand, the third concentration of pins with tasks was the Measurement and Data (13%) strand; these included tasks for measuring objects using non-standard manipulatives.

Table 3
Common Core Strands Associated with Tasks and Non-Tasks

Common Core Strands	Non-Task	Task	Total
No Mathematics – 0	24 (16.4%)	0 (0%)	24 (4.85%)
Counting and Cardinality – 1	2 (1.4%)	13 (3.7%)	15 (3%)
Operations and Algebraic Thinking – 2	27 (18.5%)	89 (25.1%)	116 (23.2%)

Common Core Strands	Non-Task	Task	Total
Numbers and Operations in Base Ten – 3	49 (33.6%)	148 (41.7%)	197 (39.4%)
Numbers and Operations-Fractions – 4	14 (9.6%)	29 (8.2%)	43 (8.6%)
Measurement and Data – 5	13 (8.6%)	45 (12.7%)	58 (11.6%)
Geometry - 6	13 (9.6%)	30 (8.5%)	43 (8.6%)
Statistics and Probability, Rational and Proportional Relationships, the number system – 7	0 (0%)	1 (0.3%)	1 (0.2%)
Mixed – 8	3 (2.1%)	0 (2.8%)	3 (0.6%)
Total	145 (100%)	355 (100%)	500 (100%)

Level of Cognitive Demand

After analyzing the 355 pins that included elementary mathematics tasks for their mode level of cognitive demand, we found that 53% of them consisted of lower-level mathematical tasks, those coded as memorization or procedures without connections (Figure 2).

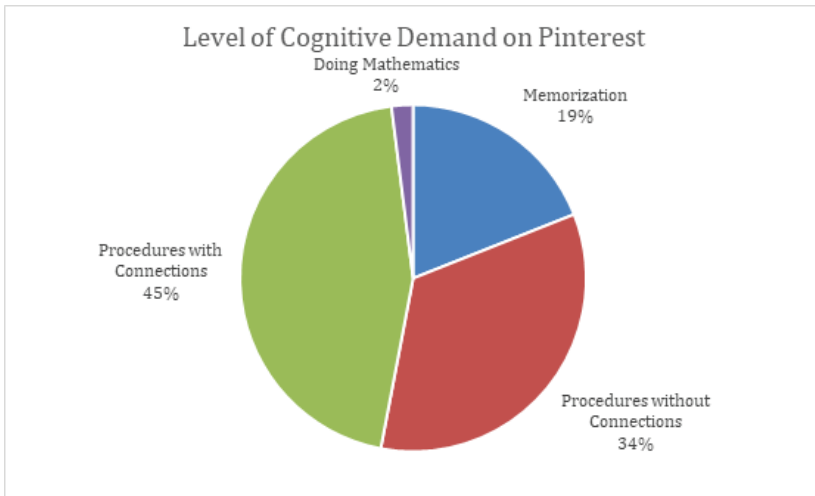


Figure 2. Level of Cognitive Demand on Pinterest.

The smallest category we identified, Doing Mathematics, consisted of 2% of all the pins in our sample. We found that the largest percentage of the top-rated elementary mathematics tasks on Pinterest were procedures with connections, followed by procedures without connections (Table 4).

Table 4
Level of Cognitive Demand on Pinterest

		Frequency	Percentage
Lower-level Demands	Memorization	69	19.4%
	Procedures without connections	120	33.8%
Higher-level Demands	Procedures with connections	160	45.1%
	Doing Mathematics	6	1.7%
	Total	355	100%

Level of Cognitive Demand and Mathematical Topic

We also investigated the statistical difference between the level of cognitive demand and the mathematics topic. As seen in Table 5, there is a

vast difference between the strands and the cognitive demand. Notice that while 27% of the geometry tasks consisted of memorization, only 3% of the fraction tasks were considered as memorization tasks. Each category number one through seven in Table 5 corresponds to the Common Core Strands mentioned in Table 3.

Table 5
Level of Cognitive Demand and Mathematical Topic

			Mode				
			Memorization	Procedures without connections	Procedures with connections	Doing Mathematics	Total
Category	1	Count	1	4	8	0	13
		% within category	7.7%	30.8%	61.5%	0.0%	100.0%
	2	Count	16	31	41	1	89
		% within category	18%	34.8%	46.1%	1.1%	100.0%
	3	Count	37	43	66	2	148
		% within category	25%	29.1%	44.6%	1.4%	100.0%
	4	Count	1	5	21	2	29
		% within category	3.4%	17.2%	72.4%	6.9%	100.0%
	5	Count	6	27	11	1	45
		% within category	13.3%	60%	24.4%	2.2%	100.0%
	6	Count	8	10	12	0	30
		% within category	26.7%	33.3%	40%	0.0%	100.0%
	7	Count	0	0	1	0	1
		% within category	0.0%	0.0%	100.0%	0.0%	100.0%
Total		Count	69	120	160	6	355
		% within category	19.4%	33.8%	45.1%	1.7%	100.0%

To conduct the statistical analysis of the results, we combined the tasks coded as memorization and procedures without connections into a larger

category of tasks with lower levels of cognitive demand. Similarly, we combined the procedures with connections and doing mathematics into a larger category of tasks with higher levels of demand. We did not consider the statistics and probability strand because we did not have enough tasks for it to be considered significant. With our preselected alpha value of .05, we determined that $p = 0.001$ when we conducted our Pearson chi-squared test, which is less than our alpha. Therefore, there is a statistically significant difference between the mathematics topic and the level of cognitive demand. Most of the items in the geometry strand had a lower level of cognitive demand (73%). Alternatively, most of the items in the Numbered Operations with Fractions strand contained elementary mathematics tasks with higher levels of cognitive demand (79%). Thus, when teachers are selecting tasks in these domains, there is a statistically significant difference in the level of cognitive demand found in top elementary mathematics tasks pins posted on Pinterest.

Level of Cognitive Demand and Pictures

Concerning the visual aspects of the top elementary mathematics tasks posted on Pinterest, 42% of the pins included no pictures, instead they only contained words and numbers (Table 6). Twenty eight percent of pins included functional pictures that served as aids in solving the mathematics tasks, while 14% only included decorative images which were not necessary for solving the mathematics tasks. We considered these values to determine if there was a relationship between a task's image type and its level of cognitive demand.

Table 6

<i>Images</i>		
Name	Frequency	Percent
None	150	42.3%
Decorative	49	13.8%
Decorative/Functional	58	16.3%
Functional	98	27.6%
Total	355	100%

When looking at the observed level of cognitive demand in an elementary mathematics task versus the image types, we noticed that they have different frequencies (Table 7). Tasks with decorative pictures had a 67% chance of being at a lower level of cognitive demand, while tasks with functional pictures had a 47% chance. To determine if there was a correlation between decorative images and lower levels of cognitive demand, we chose to remove the pins with no image and focus only on decorative, both decorative and functional, and functional tasks.

Table 7
Level of Cognitive Demand and Pinterest Image

		Mode					
			Memorization	Without	With	Doing Math	Total
Image	No image	Count	28	48	72	2	150
		% within Image	18.7%	32%	48.0%	1.3%	100.0%
	Decorative	Count	14	19	15	1	49
		% within Image	28.6%	38.8%	30.6%	2%	100.0%
	Decorative/ Functional	Count	6	28	24	0	58
		% within Image	10.3%	48.3%	41.4%	0.0%	100.0%
	Functional	Count	21	25	49	3	98
		% within Image	21.4%	25.5%	50.0%	3.1%	100.0%
Total		Count	69	120	160	6	355
		% within Image	19.4%	38.8%	45.1%	1.7%	100.0%

We conducted the Spearman's rho test to determine if there was a correlation and statistical difference between the level of cognitive demand and its image type. There was a significant positive correlation with $\rho = 0.161$ and $p = 0.015$ between level of cognitive demand and the picture type, meaning higher levels of cognitive demand correlated with functional images. If the picture provided on an elementary mathematics task was purely decorative, the task was more likely to have a lower level of cognitive demand.

DISCUSSION

We structure the discussion around answering each of our research questions. When teachers search for “elementary math activities” on Pinterest, our results indicate that teachers will find 71% of the top pins to be mathematical tasks that could be implemented in their classroom. With only 29% of the pins not containing mathematics tasks, we believe teachers would be able to find elementary math activities relatively easily using this visual search engine especially if the teachers are looking for handouts and worksheets since they could easily scroll past the non-tasks. While teachers should be able to find various worksheets, Pinterest does not offer a large variety of mathematical content areas. Less than 1% of the mathematics tasks represented in the pins were on data, statistics and probability content and many other content areas were covered by 12% or less of the mathematics tasks. Yet, Pinterest seems to be a good tool for finding elementary mathematics tasks focused on numbers and operations in base ten, and algebraic thinking.

Concerning level of cognitive demand, for the pins that contained elementary mathematics tasks, it was most common for the tasks to be at the procedures with connections (the second-highest) level. This is good news for teachers who use Pinterest to search for resources on Pinterest because the chance of finding a pin with higher levels of cognitive demand was only slightly under 50%. However, the data also indicated that when teachers choose a mathematics task, it will most likely not be at the highest level of cognitive demand of doing mathematics. We found that the top Pinterest posts do not often include elementary mathematics tasks with the highest level of cognitive demand, with just 2% coded as doing mathematics.

In a different paper (Wismer, Dick, Shapiro, & Sawyer, under review) we report on findings from a similar study completed with elementary mathematics resources posted on Teachers Pay Teachers; the findings were surprisingly similar, with only 1% of the resources studied including tasks considered doing mathematics. This dearth of resources at the highest level of cognitive demand is particularly concerning given Smith and Stein’s (1998) assertion that we should have mathematics tasks at various levels of cognitive demand within the classroom. Pinterest does not provide all four levels equally. As part of the Task Selection Framework (Smith & Stein, 1998b), the first step is identifying a task’s level of cognitive demand; thus mathematics teacher educators need to ensure that teachers know how to identify levels of cognitive demand. And beyond identification, teachers also need to be taught how to adapt the resources they find to be at a higher level of cog-

nitive demand (Davis, Beyer, Forbes, & Stevens, 2011). Adapting resources can be intimidating for teachers due to a perceived lack of knowledge, thus some teachers avoid adapting resources altogether (Ding & Carlson, 2013) which again points to a need for teacher professional development. In addition, we believe teacher educators can help teachers develop the skills necessary to become effective, well informed producers of curricular materials (Lapp, Fisher, Frey, & Gonzalez, 2014).

Another important finding was the statistically significant difference between mathematics topics and levels of cognitive demand on Pinterest. NCTM (2007) found similar differences between mathematical topics and their cognitive demand for traditional printed curriculum. We find this not to be surprising given that one focus in elementary school is to learn mathematics vocabulary (NGACBP, 2010). For example, a result of this focus could be that teachers tend to use memorization tasks to teach topics such as new geometry terms (Lindquist & Clements, 2001). Even though these tasks could be taught through higher levels of cognitive demand, many teachers rely on lower level techniques (Brändström, 2005; Lindquist & Clements, 2001). From this perspective, whether teachers choose tasks at high or low levels of cognitive demand when teaching a topic may depend on their interpretations of the standards. Regardless, teachers need to be aware of the differences in levels of cognitive demand based on the different mathematics topic strands.

Finally, this data analysis indicates a correlation between lower level mathematical tasks and decorative images for the top elementary mathematics activities pins on Pinterest. A potential benefit of this finding is that it provides an easy way for teachers to identify whether a task is likely to represent a high or low level of cognitive demand. If the pin's image appears to be both visually appealing and unrelated to the mathematics task, there is a good chance that it does not support higher level thinking. Unfortunately, many teachers select tasks based on their visual appeal (Sawyer & Meyers, 2018) which our data suggests is often correlated with lower levels of cognitive demand. Teachers should be made aware of this potential pitfall in their searches for elementary mathematics activities on Pinterest.

IMPLICATIONS

The data implies specific implications to the teacher education field on how to support teachers' searching for elementary mathematics tasks online as well as a need for more information about the other websites that display

higher level of cognitive demand tasks. Finally, we posit new questions investigating who is creating these resources thus influencing the mathematics education field online.

Support Responsible Use of Sites Such as Pinterest

Teachers often use websites like Pinterest because they either have a limited supply of resources, or because websites are easily accessible (Sawyer & Meyers, 2018). Alternatively, many mathematics teacher educators assume that tasks from websites like Pinterest are “bad” and not mathematically rigorous (Sawyer, 2016). This assumption is not completely true; we found some elementary mathematics tasks on Pinterest that can be considered mathematically rigorous. In light of this, we encourage a mindset that critically evaluates rather than criticizes mathematics tasks found on Pinterest. Therefore, when inservice or preservice teachers cite going to Pinterest to find elementary mathematics tasks, encourage them to explain their reasons behind their selection and discuss with them ways to adapt the resources they choose to best benefit their students. As Dan Sawyer, a Virginia fifth grade teacher, explained:

It’s like sex education: We need to teach how to use it responsibly. Some people say abstinence only, which I think is what most preservice teachers are taught. They think we should only teach educators how to create their own curricular resources and that using other people’s resources is something to be avoided. They’ll even give you a fresh copy of Bloom’s taxonomy and talk about proper verb choice for 20 minutes. At the end of the day, though, you’re not any closer to a usable resource and you’re left feeling frustrated and out of options. On the other hand, I think most experienced teachers take a more practical approach and realize teaching preservice teachers how to be responsible curators is way more effective. We know you’re going to use other people’s resources at some point as a practicing teacher, so we should educate you as to how to choose good resources and curricular items. I can’t think of a single teacher I’ve worked with who doesn’t use online resources from places like Pinterest or Teachers Pay Teachers, but I’ve never had one single professional development that talked about smart and sound ways to select resources.

Helping our teachers to be critical consumers of today’s resources includes teaching them to become their own peer reviewer of materials found online.

We call for teacher educators to teach teachers to determine the level of cognitive demand, as well as to identify functional pictures.

Teachers are going to use online materials from social media websites like Pinterest that they find most valuable (Huyen, 2006), so the best strategy we can suggest is for teacher educators to support them through their selection, adaptation and classroom implementation. We posit that one way to do this is to formally work with teachers using the Task Selection Framework as a means of professional development similar to Boston (2013). First, teach teachers to use the TAG to identify tasks' levels of cognitive demand, then work with teachers to adapt tasks for their classrooms, support teachers as they implement the tasks in their classroom and again work with teachers to study their students' learning as a result of the classroom implementation. In general we believe that to help our teachers succeed in today's classrooms, we need to provide teachers with a critical lens. Curricula is changing in the world of teaching, and teacher educators need to be aware that the change is not necessarily bad but something we must address to help teachers become critical curators of educational resources in the future.

Support Awareness of Other Websites

In addition, we need teachers to understand that if they do not plan to adapt the resource then Pinterest might not be the best website for searching for elementary mathematics resources. The majority of the items are low-level cognitive demand, and the pins only support a limited number of mathematical content areas. Therefore, teachers need to know of other websites that offer resources that are higher-level cognitive demand and provide these underrepresented subjects like geometry and statistics. Higher-level demand mathematical tasks are more likely to be found online from websites that include a vetting process, such as NCTM.org or Illuminations (Dick, Shapiro, & Sawyer, under review). Yet since these higher-level tasks exist on the webisphere, there is a need for these materials to be pinned on Pinterest and other social media platforms that do not include a vetting component. Teacher educators and national organizations can support teachers who use these resources by participating in this media. We can provide easily accessible higher-level mathematics tasks for teachers in an area they already search. Many organizations and schools already participate on Twitter and Facebook, and this research suggests that as teacher educators, perhaps we need to participate on Pinterest as well.

Creators Need to be Known

The data indicates that we do not have a full grasp of what teachers are viewing online. Even when we are searching for “elementary mathematics activities” a variety of materials are found through this visual search engine. This leads to the question of who is creating the materials on these online websites and how do the tags get assigned. We know teachers are using Pinterest (Hunter & Hall, 2018), but we do not have knowledge about the creators of these materials. Textbook companies are no longer gatekeepers of resources which opens up teachers to vast and numerous materials found online. However opening this gate also increases the possibility of invalid and inaccurate materials to be circulated (Sawyer, 2016). Since the education field does not know who is creating the materials, we do not know who is influencing the field in either positive or negative manners. Future research would be needed to understand this new growing body of curriculum creators and sharers.

FUTURE RESEARCH AND LIMITATIONS

This work was completed for the top 500 elementary mathematics tasks found on Pinterest. We are aware that Pinterest provides significantly more mathematical resources on its website, so our study is limited to the number of pins we analyzed. We also know teachers utilize social media sites such as Pinterest when lesson planning for other subjects (Hunter & Hall, 2018), thus we believe similar studies could be conducted in other content areas. Future research could also be conducted on a larger sample from the website or other teacher education websites to determine if they have similar levels of cognitive demand for their mathematical tasks. Sawyer and Meyers (2018) found elementary teachers especially interested in using Pinterest, but we are curious if middle or secondary mathematical content would be as prevalent with low level of demand.

CONCLUSION

In conclusion, we want teacher educators to support responsible use of social media sites such as Pinterest in their classroom. We believe this can begin with the Task Selection Framework (Smith & Stein, 1998b; Wilhem, 2014) and working with teachers to identify the level of cognitive demand

of mathematics tasks. Inservice and preservice teachers need to be aware of what is and is not available on various websites. Since there are clear shortcomings of Pinterest as a repository of elementary mathematics activities, this paper is also a call to other educators to pin higher level cognitive demand tasks to place on this platform to support teachers as well as to pin or create mathematical tasks in underrepresented content areas like geometry, statistics, and cardinality. If you have good resources, Pinterest is a place that is in desperate need of your knowledge.

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APPENDIX A

<i>Topic Coding</i>		
Math Topic	Coding Descriptions and Reasoning	Example
Counting and Cardinality	If a pin included activities including one to one correspondence, comparing numbers, counting and ordering, subitizing, numbers,	Card Counting Math Activity for Kids. Retrieved from: https://www.Pinterest.com/pin/312437292894985347/
Operations and Algebraic Thinking	If a pin included activities including addition, subtraction, multiplication, division, patterns, even or odd, prime and composite, fact families, number, bonds	Adding and Subtracting 10 and 100. Retrieved from: https://www.Pinterest.com/pin/312437292895020850/
Numbers and Operations in Base Ten	If a pin included activities including on base 10, place value, decomposing numbers, ten frame, rounding, hundreds chart, number sense	Place Value: 1st Grade Centers - The Brown Bag Teacher. Retrieved from: https://www.Pinterest.com/pin/312437292894985851/
Numbers and Operations-fractions	If a pin included activities including fractions, decimals	Fraction Match Up. Retrieved from: https://www.Pinterest.com/pin/231583605809087036/
Measurement and Data	If a pin included activities including graphing, tally markers, time, money, unit conversions, area and perimeter, angles, measurement, estimation, number line	Graphing and Data Analysis in First grade. Retrieved from: https://www.Pinterest.com/pin/AcHc3QQz3RCOGVc6M4EX4u-vzzZWKfkiZogE_j7NOuwOgP-shboSiAlf8/
Geometry	If a pin included activities including shapes, symmetry, coordinate plane, sorting, lines, position words	Geoboard Activity Cards {FREE Geometry Challenge}. Retrieved from: https://www.Pinterest.com/pin/AUMrOmDpeMM9rlc-mmIzolqCC9VtXZGWKEBlq-g6lYhfAMWhScbLmUx4/
Statistics and Probability, Rational and Proportional relationships, the number system	If a pin included activities including central tendency, probability, combinations, percent, integers	Mean Median Mode Range FREE Quiz and Answer Key. Retrieved from: https://www.Pinterest.com/pin/298504281530350329/

APPENDIX B

Examples of Pinterest Level of Cognitive Demand Codes

Level of Cognitive Demand	Example from Pinterest
Memorization	<p>“Each player gets one flash card and then walks around the room quizzing their classmates. If the players both answer correctly, they swap cards and repeat the process. If either player gets the answer wrong, have the student holding that flashcard give the correct answer before trading.” 5 fun ways to practice math facts. Retrieved from: https://www.Pinterest.com/pin/312437292894985926/</p>
Procedures without connections	<p>“Students roll the dice and subtract the numbers. If his/her difference is on the board, he/she covers it with a counter. The first player to cover four numbers in a row is the winner.” Two Digit Subtraction Games. Retrieved from: https://www.Pinterest.com/pin/ATDeyk0XUXjJQEqUv5M6auQj45eYKOyU-C16LcqwbJPqIYIQha2DxBYo/</p>
Procedures with connections	<p>“The biggest addend comes first and forms the base of the tower. A smaller number is added on top. Children slide the first number and then count on. We used lots of explaining to our learning partner and discussing the process and why it works to ensure that everyone understands.</p> <ul style="list-style-type: none"> – Slide and count strategy – Do children understand what they are doing?.” Active Adding. Retrieved from: https://www.Pinterest.com/pin/AdmElcJvO-ijUthMDpuxXBSS0q3vs4GPWO1nJ6f9-6B7g-YArXMm7AaE/
Doing mathematics	<p>“When asking students to solve problems like this, encourage them to show their thinking by adding other “benchmark” numbers rather than simply guessing. Better yet, have them share their thinking so others can learn from different strategies.”</p> <p>5 ways to explore place value. Retrieved from: https://www.Pinterest.com/pin/312437292894985027/</p>

APPENDIX C

Example of Pinterest Picture Codes

Picture Codes	Examples from Pinterest
Decorative	<div data-bbox="379 435 718 961"> </div> <div data-bbox="735 435 984 598"> <p>\$3.50 St. Patrick's Day Math Activities teacherspayteachers.com</p> <p>Looking for some St. Patrick's Day Math fun activities that are academic and NO PREP? This easy-to-use packet is full of high-interest, engaging St. Patrick's Day Math printables. Just print and go... More</p> </div> <div data-bbox="735 626 984 703"> <p>Comments</p> <p>Emily Shapiro saved to Math Research Project 43</p> </div> <p data-bbox="368 968 984 1029">St. Patrick's Day Math Activities. Retrieved from: https://www.Pinterest.com/pin/312437292894985086/</p>
Functional	<div data-bbox="379 1052 718 1414"> </div> <div data-bbox="735 1052 984 1258"> <p>5 Fun Ways to Use Math Name Tags</p> <p>Mr Elementary Math 10.6k followers Follow</p> <p>mrelementarymath.com</p> <p>Teach and review important math skills like number sense, place value and addition with these fun, interactive activities. Published February 20, 2017</p> </div> <div data-bbox="735 1277 984 1354"> <p>Comments</p> <p>Emily Shapiro saved to Math Research Project 179</p> </div> <p data-bbox="368 1421 984 1482">5 Fun Ways to Use Math Name Tags. Retrieved from: https://www.Pinterest.com/pin/312437292894985560/</p>