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Preservice Elementary Teachers' Use of Text on Slides to Support Planned Instruction

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This study describes the ways in which 36 preservice elementary teachers (PSETs) incorporated text into slides (n = 158) they designed for use with K-5 students during whole-group mathematics instruction. A qualitative content analysis was conducted to determine the extent and purposes for which the PSETs used slide text. Overall, 80% of slides contained text, which was closely aligned with what the PSETs planned to say during instruction. Text was used for three primary purposes: to convey information, to prompt student engagement, and to prompt teacher action. Study findings indicate that instruction in visual literacy skills should be incorporated into teacher education coursework if teacher educators expect PSETs to use slides effectively in their teaching. The findings also highlight the potential utility of slide text as a tool to support novice teachers as they learn to enact cognitively demanding teaching practices, such as engaging students in discussion during lessons. Collectively, the results suggest that slides designed for teaching should be viewed as shared spaces, to be used by and useful to both students and their teachers. Recommendations for ways PSETs may be taught to use slides as a shared space are included.

The past two decades have seen a rapid infusion of digital learning technologies in classroom instruction. Digital projectors, interactive whiteboards, and large touchscreens are common forms of technology available for use in elementary classrooms today (National Science Board, 2018). One way that teachers employ these technologies is by creating slides that can be projected and used during instruction. Common classroom slideware programs include presentation software such as PowerPoint, Prezi, and Google Slides, as well as proprietary software specifically designed to be used with interactive whiteboards such as SMART Notebook (SMART, 2021) and ClassFlow (ClassFlow, 2021). Multiple studies have documented that slideware, particularly freely available presentation slideware such as Google Slides, is frequently used in elementary classrooms by both practicing teachers (e.g., Karsenti, 2016; Kenny, 2011; Ponce et al., 2018; Putra et al., 2019; Sheffield, 2015) and teacher candidates (e.g., Polly & Binns, 2018).

While this body of research offers verification that slideware technology is used to support instruction, few studies offer a detailed description of what the slides look like when used with young students (see Bourbour, 2020, and Ponce et al., 2018, for exceptions). Instead, much of the research describing specific ways slideware is used in classroom instruction has been conducted in lecture halls at the university level (Baker et al., 2018; Garner & Alley, 2013; Mayer, 2020; Smith-Peavler et al., 2019).

Based on this research, useful guidelines for slide design have been developed to assist those who develop lectures for adults. Yet these guidelines do not account for the specific ways in which elementary teachers must design slides to ensure that slide content is appropriate for young learners (Roblyer & Bennett, 2001). In addition, and central to this study, research does not offer insight into how to design slides that support the more student-centered and interactive forms of instruction expected of elementary teachers (Council of Chief State School Officers, 2013; Major & Warwick, 2019). As a result, much uncertainty exists about how slides are used to assist instruction at the elementary level, how they should be used, and what preservice teachers need to learn about slide design to use this technology effectively once in their own classrooms (Baker et al., 2018).

Using slides *effectively* in instruction requires more from teachers than simply putting content on slides and then projecting those slides using classroom hardware (Brumberger, 2011). Slide content can include text, photographs, clipart, videos, animations, and GIFs. When designing their own slides, teachers must choose appropriate content both in terms of its type and its message (Eustler, 2021; Lee & Jones, 2018; Little, 2015; Ruiz-Gallardo et al., 2019).

Teachers also must intentionally arrange content on the slides so that it supports their instructional goals as well as their students' learning (Little, 2015; Roblyer & Bennett, 2001; Sosa, 2009). In other words, teachers must attend both to the *function* and the *form* of the content included on slides and understand how both aspects can productively contribute to or undermine their instructional intentions (Little, 2015).

For preservice elementary teachers (PSETs), understanding how to navigate slide design requires visual literacy skills, or the ability to understand, communicate with, and ethically use visual materials (Kedra, 2018). Research indicates that visual literacy must be taught actively and is not acquired simply through exposure to visuals or through use of technologies that support the production of visual media, including slideware (Averginou & Pettersson, 2011; Brumberger, 2011; Sadik, 2011). A growing body of literature recognizes the need for developing teachers' visual literacy skills during their teacher education coursework (Alpan, 2015; Anderson et al., 2021; Brumberger, 2019; Eustler, 2021; Little, 2015; Roblyer & Bennett, 2001).

Research on preservice and in-service teachers' visual literacy skills has suggested that teachers find it challenging to choose or design visual models that accurately convey intended messages (Johnson, 2013; Lee & Jones, 2018; Ruiz-Gallardo et al., 2019), to incorporate a variety of types of content (Eustler, 2021), and to use design elements such as color and spacing effectively (Alpan, 2015; Yeh & Lohr, 2010). An emerging body of research demonstrates that explicit instruction in visual literacy skills improves teachers' abilities to design and use visual media in their instruction (Huilcapi-Collantes et al., 2020; Sadik, 2011; Yeh & Cheng, 2010; Yeh & Lohr, 2010).

This study aimed to contribute to this growing area of research by exploring the ways that PSETs used text on slides designed for use during whole-group mathematics instruction. Slide text is of interest, in part, because it is easy to for PSETs to incorporate into slides and commonly featured on slides used in instruction at the university level (Uzun & Kilis, 2019). However, the emerging reading abilities of elementary students makes the use of slide text of questionable value in PK-5 instruction.

Since few studies has been published on the specific ways in which PSETs are designing slides, the data are unclear as to what extent PSETs are using slide text and their reasons for doing so. It is unclear what, if anything, PSETs need to learn (or perhaps, *unlearn*) about using text to design slides that effectively support their instructional goals and their students' learning. Understanding the PSETs' existing knowledge and visual literacy practices can help teacher educators create lessons that build on preservice teachers' knowledge of slideware and address their learning needs. As such, the following research question guided this study: What was the function and form of text on slides designed by preservice elementary teachers for use in whole group mathematics instruction?

Visual Literacy Skills and Competency Standards

In the Association of College and Resource Libraries (ACRL, 2011) *Visual Literacy Competency Standards for Higher Education,* visual literacy was defined as "a set of abilities that enables an individual to effectively find, interpret, evaluate, use, and create images and visual media" (para. 2). Much of the published work related to visual literacy has been theoretical in nature, devoted to proposing frameworks and models to understand and define visual literacy (Avgerinou & Pettersson, 2011; Brumberger, 2019; Kedra, 2018). Kedra contended that visual literacy research should focus less on defining visual literacy and more on developing a practical

understanding of the visual literacy skills that are necessary in different contexts. Building on Kedra's proposal, Brumberger recommended that the *Visual Literacy Competency Standards for Higher Education* be used as a starting point for such research.

The *Visual Literacy Competency Standards for Higher Education* offer useful descriptors of many of the skills required of K-12 teachers when they create slides (Huilcapi-Collantes et al., 2020). In particular, Standards 1, 5, and 6 are directly related to the work of selecting and creating visual media and materials (see Table 1). These competency standards specify that the visually literate preservice teacher should be able to articulate the *purpose* of content included on a slide, define the *audience* for that content, use different *types* of visuals, and ensure that the types of visuals chosen are *aligned* with the different purposes and audiences.

One shortcoming of the ACRL (2011) competency standards is they indicate that aesthetic criteria must be considered when selecting and designing visual media but do not describe the specific skills required to design visual content that it is easily understood and appropriate for use in classroom settings. In 2001, Roblyer and Bennett proposed a set of required visual literacy skills for teachers (summarized in Table 2). Like the ACRL competency standards, Roblyer and Bennett noted that the *function* of content is important for teachers to consider, emphasizing that visual content must be relevant, accurate, and age appropriate. However, in comparison to the ACRL competency standards, Roblyer and Bennett offered a more detailed description of the ways teachers must attend to the *form* of visual content, including taking into consideration the amount of content, its layout, and how design elements such as color and font choice can impact students' understanding.

Several of the guidelines are specific to the use of text, including the need for teachers to limit the amount of text on slides, choose font styles and colors that are easy to read, and limit the number of different fonts used. Thus, for the purposes of this study, Roblyer and Bennett's (2001) list usefully supplements the *Visual Literacy Competency Standards for Higher Education* by detailing design considerations that are of particular importance to teachers and relevant to use of slide text in classrooms.

The framework used to guide this study synthesizes elements from both Roblyer and Bennett's (2001) list of visual literacy skills for teachers and the *Visual Literacy Competency Standards for Higher Education,* since neither was fully representative of the kinds of skills that preservice teachers need to design slides effectively for use in their instruction. The synthesized frame work names five areas of competency that the visually literate preservice teacher must draw upon to design effective slides (see Table 3). These competencies are organized based on the categories of function and form to emphasize that the visually literate preservice teacher must attend to both aspects when creating slides.

Table 1
Selected Visual Literacy Competencies Related to Creating Visual Media

Standard	Performance indicator	Selected learning outcomes
The visually literate higher education student determines the nature and extent of the visual materials needed (Standard 1)	The visually literate higher education student defines and articulates the need for an image	The visually literate higher education student: - Defines the purpose of the image within the project (e.g., illustration, evidence, primary source, focus of analysis, critique, commentary) - Defines the scope (e.g., reach, audience) and environment (e.g., academic environment, open web) of the planned image use
The visually literate higher education student uses images and visual media effectively (Standard 5)	The visually literate higher education student uses images effectively for different purposes	The visually literate higher education student: - Plans for strategic use of images and visual media within a project - Selects appropriate images and visual media aligned with a project's purpose - Integrates images into projects purposefully, considering meaning, aesthetic criteria, visual impact, and audience - Uses images for a variety of purposes (e.g., as illustrations, evidence, visual models, primary sources, focus of analysis) - Uses images for subject-specific and interdisciplinary research, communication, and learning
The visually literate higher education student designs and creates meaningful images and visual media (Standard 6)	The visually literate higher education student produces visual materials for a range of projects and scholarly uses	The visually literate higher education student: - Produces images and visual media for a defined audience - Aligns visual content with the overall purpose of a project

Note. Adapted from the *ACRL Visual Literacy Competency Standards for Higher Education* by the American Library Association, 2011 (http://www.ala.org/acrl/standards/visualliteracy). Copyright 2011 by the American Library Association.

Table 2
Visual Literacy Skills Needed for Teachers to Create and Use Visual Media in Instruction

Teacher Skills	Subskills
The visually literate teacher selects materials that have good visual literacy attributes	The visually literate teacher: - Determines if adequate numbers of visuals are included to help students visualize concepts - Reviews visuals for age-appropriateness - Analyzes visuals to determine if they are relevant, clear, and accurate - Scrutinizes visual images to determine if they communicate unintended messages
The visually literate teacher produces materials that meet basic visual literacy standards	The visually literate teacher: - Chooses fonts that are easy to read - Limits the number of different fonts - Selects appropriate font size - Incorporates color for interest and choose contrasting background and text colors for easy legibility - Follows the left-to-right reading pattern when laying out materials - Limits the number of words and lines on slides - Uses white space for separation and emphasis of concepts - Presents one concept or idea per slide - Uses visuals tied to the topic rather than extraneous clipart

Note. Adapted from "The fifth literacy: Research to support a mandate for technology-based visual literacy in preservice teacher education" by M. D. Roblyer and E. K. Bennett, 2001, *Journal of Computing in Teacher Education*, *17*(2), pp. 8-15. Copyright 2001 by the International Society for Technology in Education.

Table 3
Preservice Teachers' Visual Literacy Competencies for Effective Slide Design

Category	Competency
Function	The visually literate preservice teacher uses slide content (e.g., text, images, video) effectively for different **purposes**.
	The visually literate preservice teacher aligns slide content with the needs of the **audience**for that content (e.g., age-appropriateness, relevance, clarity).
Form	The visually literate teacher uses a variety of **types** of visual content in their slides (e.g., text, clipart, photograph, chart, diagram, gif, animation, video).
	The visually literate preservice teacher limits the **amount** of content included on each slide.
	The visually literate preservice teacher considers **aesthetic criteria** when integrating content into slides (e.g., color choices, size of font and images, slide layout).

Literature Review

To date, no detailed investigation of preservice elementary teachers' use of slide text to support their planned instruction has been conducted. However, research on the use of slides by university instructors in combination with research on the use of interactive whiteboards by K-12 teachers together offer useful insights into ways in which slide text may both impede and support effective instruction. The following sections offer a brief overview of pertinent findings from these two bodies of literature.

Slide Text Should Complement Images

Research on the use of slide text to support lectures or presentations suggests that text is most effective when it *complements* (rather than repeats or replaces) information conveyed orally in a presentation or visually on the slide (Fenesi & Kim, 2014; Garner & Alley, 2013; Mayer, 2020; Smith-Peavler et al., 2019). Mayer explained that slide text duplicating a presenter's spoken words can negatively impact students' understanding of the content of the presentation, because written and spoken words are both processed in the language regions of the brain and, thus, can interfere with one another when presented in tandem. Rather

than using slide text to communicate information, Mayer emphasized the importance of incorporating images into slides when the goal of instruction is the communication of information. However, his research also demonstrated that slide text can be a useful partner for images when it is used in intentional ways, particularly when text is used to highlight (or signal) key information or when labels are placed next to graphics.

Slide Text May Support Instructors

While numerous studies have identified instructors reading bullet points of text to students as a problematic use of slideware from the students' point-of-view (e.g., Hill et al., 2012; Mayer, 2020; Yilmazel-Sahin, 2009), some studies suggest that that ability to use slide text to "script" instruction may be considered a benefit of slideware from the point-of-view of the instructor.

Surveys of university instructors' perceptions of the benefits of slideware found that instructors appreciate the ways that slide text can serve as a memory aid for the instructor, keep instruction focused, and help ensure that instruction proceeds as planned (Hight et al., 2013; Hill et al., 2012). A pair of studies on the ways scholars use PowerPoint suggest that the ability to use slide text as a memory aid may be particularly appreciated by novices and anxious presenters (Hertz et al. 2015, 2016).

Hertz et al. (2015) found that presenters they identified as "beginners" included nearly twice as much text in their slide decks as compared to the slide decks of more advanced presenters. In a follow-up study, the same researchers found that anxious presenters used more slide text than those who reported less speaking anxiety and tended to use their slides as "speaking notes" during their presentations (Hertz et al., 2016, p. 356). The researchers concluded that the novices and anxious presenters included additional slide text to help overcome their anxiety toward presenting. They also speculated that beginners, in particular, "may be less aware of their use of a relatively large number of words, because they probably have seen many presentations of their peers who use similar quantities of text" (Hertz et al., 2015, p. 284). Their findings validate concerns raised by earlier researchers and theorists that unskilled or novice presenters will use slide text as a tool to help themselves without a clear understanding of or regard for its impact on their audience (Adams, 2006; Farkas, 2005).

Slide Text May Support a Variety of Instructional Practices

One concern about slide text as an instructional aid is that it has the potential to support a teacher-centered, transmission model of teaching and learning, particularly when teachers read bullet points of text to students during instruction (Adams, 2006). While there is evidence that many university instructors use text in this manner (Uzun & Kilis, 2019), there is also evidence that slide text can prompt or support students' active engagement in a lesson.

For instance, slide text can be used as the focal point for a discussion (Elliott & Gordon, 2006; Major & Warwick, 2019) and to display key

vocabulary (Murcia, 2010). Text also can be used to embed questions about key lesson points into slideware presentations, thereby creating opportunities for students to engage with the presented material (Elliot & Gordon, 2006; Gier & Kreiner; 2009; Murcia & Sheffield, 2010; Valdez, 2013). Finally, when used in partnership with an interactive whiteboard, text can be used to annotate other content or capture students' ideas and contributions to a lesson in real-time (Beauchamp & Kennewell, 2013; Ponce et al., 2018).

Methods

Participants and Research Context

Participants in this study were 36 preservice elementary teachers (32 were female and four were male) enrolled in two sections of an elementary mathematics methods course. The PSETs were junior- or senior-level undergraduate Elementary Education majors at a midsized public university in the Midwest. The mathematics methods course was offered in the first semester of a three-semester sequence of methods coursework, culminating in student teaching during the third semester. The instructor for the course had been a mathematics teacher educator for 7 years at the time this course was taught and was the researcher of this study.

Data Sources

Data for this study were obtained from examining the slides and lesson plans written by the PSETs midway through their elementary mathematics methods course. The Institutional Review Board from my institution granted permission to use students' work generated in the course. All participants signed consent forms for me to use their coursework in this study. Because all classrooms where PSETs taught during the field experience portion of the methods course were equipped with an interactive whiteboard or large digital touchscreen, PSETs were encouraged to make use of this technology by preparing slides that could be used during instruction. However, they were neither required to do so nor given explicit instructions on how to create slides for use in elementary classrooms prior to writing the lesson plans used in this study.

Of the 36 PSETs, one constructed a slide deck using PowerPoint, two made slide decks using SMART Notebook software, and the remaining 33 PSETs used Google Slides. All data for this study were derived from the first drafts of lesson plans involving mathematical reasoning or problem solving and slide decks created by the PSETs.

Although the PSETs had some limited exposure to writing lesson plans in earlier coursework, the plans in this study corresponded to their first official opportunity to plan and teach a mathematics lesson to elementary students. Following the submission of these plans and slides, PSETs received feedback from both the instructor and their cooperating teachers, and in many cases, the actual plans and slides they used while teaching differed substantially from their initial drafts based on this feedback. Since the final drafts of the slides and the corresponding lesson plans were often heavily influenced by both the course instructor and the PSETs'

cooperating teachers, this study examined the initial, rather than final, drafts of the slides and lesson plans, as these initial drafts are more representative of the PSETs' own visual literacy skills and ways of using slide text.

To gather information about how the PSETs planned to use the slides during instruction, I designed a lesson plan template for slide-assisted lessons. This template was piloted and refined during the two semesters prior to the semester in which the data were collected to ensure that the information collected on the plans was sufficiently accurate and detailed. This template split the lesson plans into separate plan sections based on the slides. Each plan section consisted of a small screenshot of a slide next to a detailed description of the PSET's plan for instruction corresponding with that slide. Figure 1 shows a typical example of a plan section from a PSET's lesson plan.

For their initial drafts of their slide-assisted lesson plans, the 36 PSETs generated a total of 158 slides and corresponding plan sections. Two additional plan sections (created by different PSETs) were excluded from the analysis, as they did not have a corresponding slide (both plans instead indicated that the PSET intended to switch to using the document camera for that portion of the instruction). The number of slides within an individual PSET's slide deck ranged from 1 to 7, with a mean of 4.4 slides per slide deck.

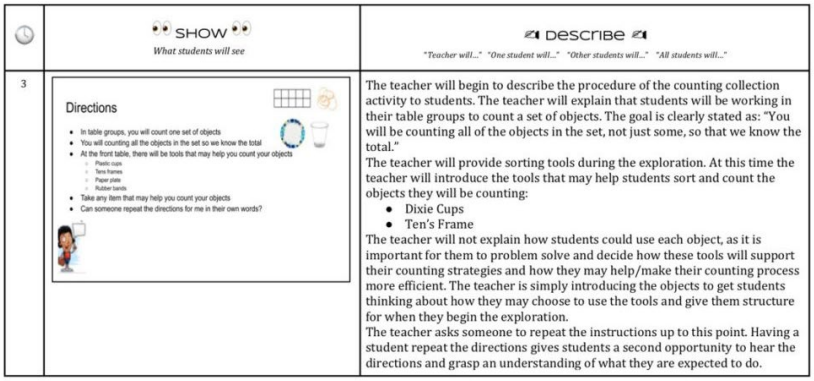
Data Analysis

Prior studies have used the analysis of lesson plans to investigate the ways that preservice teachers plan to integrate technology into their instruction (Cuenca, 2021; Lyublinskaya & Tournaki, 2014; Paratore et al., 2016; Polly & Binns, 2018; Sias et al., 2017). The principles of qualitative content analysis (QCA; Schreier, 2012) guided the investigation in this study of the different functions and forms of text on the PSETs' slides. QCA is a systematic method for analyzing data that is well-suited to descriptive research questions like those guiding this study.

I coded and analyzed the data, taking several steps to increase the trustworthiness of the findings (as recommended by Elo et al., 2014). First, throughout the coding process, the slide text was considered the primary unit of analysis, while the corresponding lesson plans were used to support inferences made about the slide text. As shown in Figure 1, these corresponding plans were typically detailed and were, therefore, a source of the rich data necessary for QCA (Schreier, 2012).

Second, a detailed coding guide was created for each category and referenced throughout both the coding process and while writing up the results to ensure that the interpretations could be applied consistently across slides. Codes that involved making inferences about the slide text (i.e., the purpose of text and the audience use of the text) were cross-referenced with the corresponding plan sections and coded as "unclear" if the corresponding plan section did not support the given inference.

Figure 1
A Single Plan Section Showing a PSET's Plan for Instruction Corresponding to a Particular Slide



Note. The PSET created a total of five slides and corresponding plan sections for their planned launch of this Counting Collections activity. The example shown is the fourth slide and plan section.

Third, once the coding frame was constructed, all units of text on the slides were coded at least twice, with 2 or more weeks between coding passes, to ensure intrarater reliability (Schreier, 2012). The process of repeatedly coding data with at least 2 weeks between each coding pass was repeated until no codes were changed. A detailed description of the coding process for each aspect of the slide text analyzed is included in the following sections followed by the findings of this study.

Analysis Related to the Purpose of the Text

To investigate the purposes for which slide text was used, the slide text was divided into units of analysis. The unit of analysis was typically a distinct line or bullet point of text, but when blocks of text were used, the unit of analysis was a sentence. To establish categories describing the purposes for which text was used on slides to support instruction, the units of text on the slides were analyzed using multiple coding methods, including open, descriptive, and focused coding (as in Saldana, 2013). The constant comparative method (Glaser & Strauss, 1967) was used throughout the analysis to compare new data to existing data and create or condense codes as needed. This process resulted in 15 descriptive codes.

To build the coding frame, I grouped these descriptive codes into categories that described the purposes for which text was used. Two categories for the coding frame were established based on the review of the literature: information related to the task and prompts for student engagement. An additional two data-driven categories were also created: prompts for teacher action and unclear. Based on this coding frame, binary qualitative codes were used to obtain quantitative data about the frequencies with which different purposes of text appeared on the slides. As units of text on a slide were often interrelated, slides were coded based on the existence of a given category of text on the slide, rather than on the

frequency with which that category appeared. However, slides could contain more than one category of text.

Analysis Related to the Audiences' Use of Text

This study considered both the teacher and the students as potential audiences for the slide text. Therefore, each slide received two audience codes: one for the teacher and one for the students. The unit of analysis in each case was all the text on a given slide, with the corresponding plan section used to triangulate inferences about the ways the different audiences might use the slide text during instruction. The lesson plan sections corresponding to individual slides were examined for evidence of ways that the PSETs and their students might use the slide text during instruction. The following sections describe in more detail the coding process for each of these two audiences.

The Teacher as the Audience for Slide Text. Prior research has found that reading text from slides is common in university courses (Uzun & Kilis, 2019) and that presenters may intentionally use slide text as a script for themselves to use during presentations (Hertz et al., 2015, 2016). Thus, for the dimension of the Teacher as the Audience for the slide text, I examined slides and plans for evidence that the PSETs could use slide text to script their instruction. Since the study data included only the slides and lesson plans, I could not directly assess whether the PSETs read the slide text aloud during instruction. Instead, magnitude coding (Saldana, 2013) was used to capture the degree to which the planned teacher talk was reflected in the slide text.

Three subcategories of codes were used: Close Match, Partial Match, and Unclear. Slides were coded as having text that was a Close Match for planned teacher talk when the text captured all key aspects of what the plan indicated the teacher would say or do during that portion of instruction. For instance, when a plan stated that "the teacher will explain the directions for the game" and the corresponding slide had text that listed those directions, the code of Close Match was applied (e.g., see the slide and plan in Figure 1). The code of Partial Match was applied when the slide text mirrored only part of what the plan indicated the teacher would say during that portion of instruction. In these cases, the plans also included additional information, prompts, or questions to be verbalized by the teacher that were not captured by the slide text.

Finally, the code of Unclear was applied when the planned teacher talk did not correspond to the slide text or when the details in the plan were insufficient to support such an inference. Slides that were coded as having a Close Match or Partial Match were then interpreted as having the potential use of acting as a script or partial script for the teacher, respectively. The goal of this analysis was twofold: (a) to capture the extent to which PSETs' slides had text that reflected things that the PSET planned to say during instruction, and (b) to capture the degree to which the PSETs planned to say *more* than what the slide text indicated.

The Students as the Audience for Slide Text. In general, elementary students cannot be expected to read as proficiently as their older

counterparts, so being aware of the extent to which students will need to read and use slide text is an important visual literacy skill for preservice elementary teachers. Thus, the goal of the analysis for the category of Students as the Audience for slide text was to capture the extent to which the PSETs' slides had text that students might need to read during the lesson.

Magnitude coding (Saldana, 2013) was used to capture how directly the plan stated that slide text would be read by students. Three codes were established for this category: Read, Possibly Read, and Unclear. The code of Read was applied when the plan explicitly stated that one or more students would be asked to read at least some of the text on the slide, either silently or aloud. The code of Possibly Read was applied when the plan did not directly state that students would be expected to read slide text but included an activity or question that could most readily be completed if students did so. For instance, the slide shown in Figure 1 was coded as having text that students would Possibly Read because a student would be asked to repeat the directions captured by the slide text, but the plan did not indicate if PSET expected the student to reread the directions for the class or to simply restate the directions from memory. If the plan offered no indication as to how the students were expected to use the slide text and the plan did not involve any prompts or activities in which students might reasonably need to read the text to participate, the code of Unclear was applied.

Analysis Related to the Amount of Text

To determine the extent to which PSETs used text on their slides, the text on each slide was copied to a table within the online shareable document app, Google Docs, and the word count tool was used to count the number of words on each slide. Only the words that were entered as text on the slides were counted. Words embedded within an image, such as the text on a scanned copy of a handout, were not included in this count. Thus, the counts should be taken as the minimum amount of text that was present on the slides. None of the PSETs' plans referenced using text embedded within images as part of instruction, such as reading the text on a handout to the students.

Analysis Related to the Layout of Text

Finally, to obtain a rough sketch of where the text was located on the slides, each slide was split horizontally into equal thirds and coded for the presence or absence of text in that third of the slide. The top, middle, and bottom thirds of each slide were coded with a 1 if one or more words were present in that portion of the slide and a 0 if not. In cases where words were split horizontally, the text was coded as being in the section in which more than half of the text was present. There was only one instance in which the words appeared to be split exactly in half horizontally. In this case, the text was coded as being in the upper of the two sections. These data were then used to obtain occurrence frequencies for the different layouts of text on the slides based on the location of text within the different horizontal sections of the slide.

Findings

This study was guided by the question, What was the function and form of text on slides designed by preservice elementary teachers for use in whole group mathematics instruction? As slides are a form of visual media, designing slides draws on preservice teachers' visual literacy skills. A qualitative content analysis of the PSETs' slides and their corresponding lesson plans was conducted to describe the function and form of slide text based on four aspects of visual literacy related to slide design, namely purpose, audience use, amount, and layout. The following sections describe the results of that analysis for each of these four aspects.

The Purposes of Slide Text

The text on the slides was examined to better understand the purposes for which PSETs were using slide text to support the launch of their mathematics lessons. The corresponding lesson plans were used to support interpretations as necessary. Three primary categories of purposes were derived from that analysis: Conveying Information About the Task, Prompting Student Engagement During the Lesson, and Prompting Teacher Action During the Lesson. A fourth category of Unclear was used when the purpose of the text could not be inferred from the corresponding lesson plan. Figures 2 through 6 show examples of how each of the three main purposes of text appeared on slides. The titles for each figure describe the purposes of text appearing on the slide as well as the grade level for which the slide was designed.

As shown on the slide in Figure 2, slides could contain text related to more than one purpose. However, such overlaps were rare, with only 16% of slides with text (n = 20 slides) containing text from more than one category. The following sections offer a more detailed description of ways PSETs used slide text in relation to the three primary categories as well as information about how often the different types of text appeared on slides and within the PSETs' slide decks.

Figure 2
Slide for First Grade Students With Informational Text Summarizing Directions for a "Counting Collections" Task and a Question Prompting Student Engagement

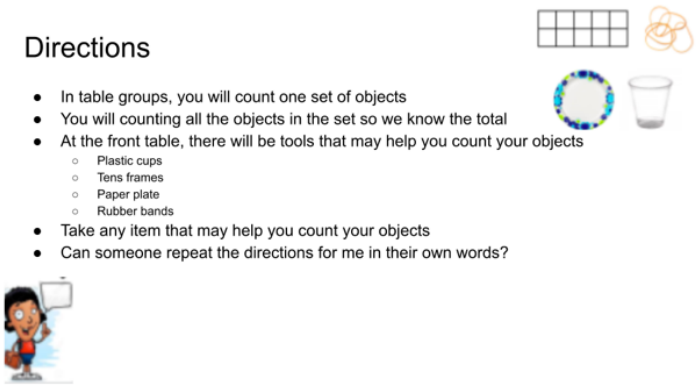


Figure 3
Slide for First Grade Students With Informational Text in the Form of a Title for a Mathematics Game

Figure 4
Slide for Kindergarten Students With Text Prompting Students to Think of Strategies Before Beginning a Counting Collections Activity

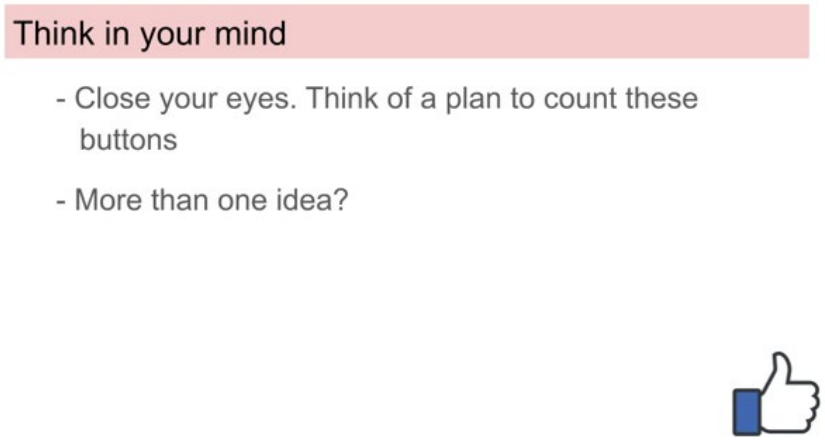


Figure 5
Slide for Kindergarten Students With Text Prompting Discussion About the Missing Elements of a Pattern

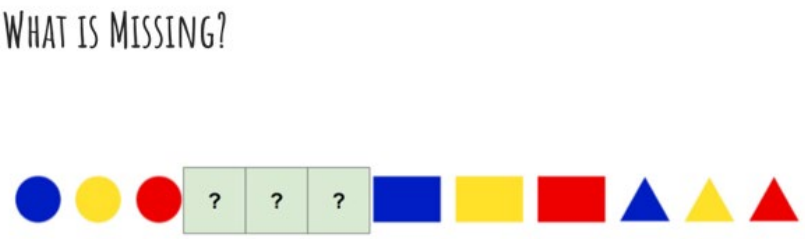


Figure 6
Slide for Fifth Grade Students With Text Prompting the Teacher to Play a Model Round of a Game

Purpose 1: Convey Information About the Task

The most common purpose of slide text was to convey information about the task. Of the slides with text, 65% (n = 82 slides) contained informational text. The use of informational text was so common that 52% of *all* slides created by the PSETs (including the slides without text) contained informational text of some kind. Slides with informational text appeared in 89% of PSETs' slide sets (n = 32 PSETs), as every PSET who included text on their slides also included informational text on at least one slide.

Figures 2 and 3 show two examples of slides with informational text. As exemplified by these slides, the amount of informational text on a slide varied from only a few words to slides nearly filled with text. The informational text itself took several forms: directions for the task (Figure 2), lists of materials needed for the day's task, an informational title for the task (Figure 3), vocabulary words and their definitions, and labels for visual elements shown on the slide. The most common type of informational text was directions for the task, which appeared on 23% of slides with text (n = 29) and in 44% of the slide decks (n = 16 PSETs).

Purpose 2: Prompt Student Engagement in the Lesson

The second most common use of text on slides was to prompt student engagement in the lesson. Overall, 37% of slides with text (n = 46) contained text that prompted student engagement and 61% of the PSETs (n = 22) included at least one textual prompt for student engagement somewhere within their slide decks.

Figures 2, 4, and 5 show examples of slides with text that prompted student engagement in the lesson. The most common example of text from this category was a question or prompt for students to think about or discuss during the lesson, such as "What is missing?" (Figure 5) or "Can someone repeat the directions for me in their own words?" (Figure 2).

Questions or prompts for discussion appeared on 32% of the slides with text (n = 40 slides) and were included in 56% of the PSETs' slide decks (n = 20 PSETs). Other examples of text to prompt student engagement included instructions for student interaction, such as "Turn and talk to your neighbor," and instructions for immediate student action, such as "Close your eyes" (Figure 4). The use of text to prompt immediate student action or interaction was relatively rare, appearing on only 8% of slides with text (n = 10 slides) and in 22% of the PSETs' slide decks (n = 8).

Purpose 3: Prompt Teacher Action

The final purpose of text derived from the analysis of the slides and lesson plans was the use of text to prompt teacher action at a given point in their instruction. This use of text was not common, appearing on only 10% of slides with text (n = 12 slides). However, 28% of the PSETs (n = 10) included at least one slide with text of this type into their slide decks, so it was more common across the set of PSETs than it was within the set of slides.

Figure 6 shows an example of a slide with text that prompted teacher action. The most common example of text from this category was text that prompted the teacher to model how to play a game (Figure 6), with 75% of the slides in this category (n = 9 slides) containing text to this effect. The other examples included prompts for the teacher to hand out whiteboards, to clarify instructions, and to transition to the next phase of instruction.

The Audiences' Use of Slide Text

This study assumed two possible audiences for slide text: the teacher and the students. The lesson plans were examined to gather data on the extent to which the two audiences might read and use slide text during the lesson. Table 4 shows the potential uses for the two audiences as well as the number and percentage of slides with text falling within each category. The following sections offer more detailed description of how the lesson plans suggested the teacher and the students would use slide text during instruction.

Table 4
Audiences' Potential Use of Text

Audience	Potential Use	*n*	%
Teacher	Script	39	31
	Partially script	56	44
	Unclear	31	25
Student	Read	5	4
	Possibly read	14	11
	Unclear	107	85
Note. *N* = 126 slides.			

The Teacher's Use of Slide Text

For the category of the Teacher as the Audience for the slide text, magnitude codes were used to capture the degree to which the text matched what the teacher planned to say during instruction based on analysis of the corresponding lesson plans. Slides were coded as having text that Matched or Partially Matched what the plan indicated the teacher would verbalize during instruction. These codes were then interpreted indicating that the text could be used to Script or Partially Script the words the teacher would say in instruction.

The slides shown in Figure 2 and Figure 4 are typical examples of slides with text that could be used to Script or Partially Script the teacher's speech during the lesson. As exemplified by these two slides, the slide text itself often added credence to the interpretation it was meant to function as a script for the teacher's speech. The text was not only written in complete or nearly complete sentences, but also written with pronouns like "me" and "you" in reference to the teacher and students, respectively (e.g., in Figure 2, "Can someone repeat the directions for me in their own words?" and in Figure 4, "Close your eyes").

Approximately three fourths of the slides with text included text that mirrored some or all of what the teacher planned to say or do during instruction (see Table 4). Most of these slides were coded as having text that could be used to Partially Script the planned teacher's talk during that portion of instruction. In all cases, although the slide text matched what the plan indicated the teacher would say during the lesson, the plan also included additional information, prompts, or questions that did not appear in any of the slide text.

In some cases, these additional prompts or information were captured by images, rather than text, on the slide (e.g., the thumbs up image on the slide shown in Figure 4). In other cases, the plan included additional questions or prompts that were not captured by any of the text or images on the corresponding slide. These were typically follow-up questions that the PSET planned to ask after conveying the information or posing the question represented in the slide text. For example, the slide shown in Figure 5 has only a single question, "What is missing?" However, the corresponding plan included multiple follow-up questions that the PSET planned to ask as the covered parts of the pattern shown on the slide were progressively revealed.

The Students' Use of Slide Text

For the category of the Students as the Audience for the slide text, magnitude codes were used to capture how directly the plan stated that students would be required to read some or all the slide text. Three codes were established for this category: Read, Possibly Read, and Unclear. Most plan sections focused more on what the teacher versus the students would say and do during instruction. In fact, many plan sections did not reference the students at all, particularly when the plan called for the teacher to explain information to the class. As a result, for most slides, it was unclear what, if anything, the PSETs' expected of students in terms of reading or using the slide text during instruction.

Only five plan sections directly stated that one or more students would be expected to read the text on the slide during instruction. One of these was in a fifth-grade lesson, two in fourth grade (both by the same PSET), one in second grade, and one in kindergarten. The plans for the second through fifth graders all involved students reading multiple lines of informational text during instruction (like the text shown on the slide in Figure 2), while the kindergarten plan involved students chorally reading a series of letters that were used to label a pattern (e.g., "ABBABB").

An additional 14 slides were coded as having text that students would Possibly Read during the lesson. In these cases, the plan included a question or activity that involved students doing something directly related to the slide text, but the plan did not explicitly state that the students would read the text to answer the question or complete the activity. For instance, a slide designed for use in a kindergarten lesson had pictures of four shapes above the sentence frame, "___ has more sides than ___." The plan indicated that students would talk with one another about which shapes shown on the slide could be put into the sentence frame to make a true statement. Although the plan did not directly state that the kindergartners would be expected to read the words in the sentence frame during these partner discussions, the task would have been difficult for students to complete without doing so. (Note that these slides were part of the PSET's initial lesson plan only and were not used in the actual lesson. In this case, the cooperating teacher helped the PSET redesign the slides to eliminate the need for students to read this text, as it was beyond the reading level of most students in the class.)

In all cases, the plans called for the teacher to verbally convey the information captured by the slide text. Possibly, the PSET expected the

students to recall what the teacher had stated verbally rather than expecting the students to read the slide text themselves.

The Amount of Text on the Slides

Text was widely used on the slides created by the PSETs, with 80% of all slides (n = 126 slides) having one or more words on the slide and 89% of PSETs (n = 32) incorporating text somewhere within their slide set. Half of the PSETs created at least one slide with only text (no images), and 56% (n = 20) had text on every slide. The 126 slides with text contained a mean of 19.8 words per slide. At the same time, there was a wide variation in the amount of text on individual slides. While half of the 126 slides with text had between one and 10 words, the other half ranged from 11 to 94 words per slide.

The amount of text on slides varied considerably based on the purpose of the text, with informational text, in general, accounting for more words on slides than either prompts for student engagement or prompts for teacher action (see Table 5). The mean number of words related to informational text on a given slide was more than twice the mean number of words related to prompts for student engagement and over five times the mean number of words related to prompts for teacher action (see Table 5).

Table 5
Amount of Slide Text by Text Purpose

Purpose	Slides With Text		Number of Words Per Slide [a]	
	n	**%**	**Mean**	**Range**
Convey information	82	65	23.4	1-94
Prompt student engagement	46	37	11.3	2-25
Prompt teacher action	12	10	4.6	1-13
Unclear & other	7	6	3.0	1-5

Note. N = 126. The number of slides across the four categories totals to more than 126 because slides could contain text from more than one category.

[a] The mean and range for each category was calculated based on the text on each slide pertaining solely to the given category divided by the number of slides with text from that category.

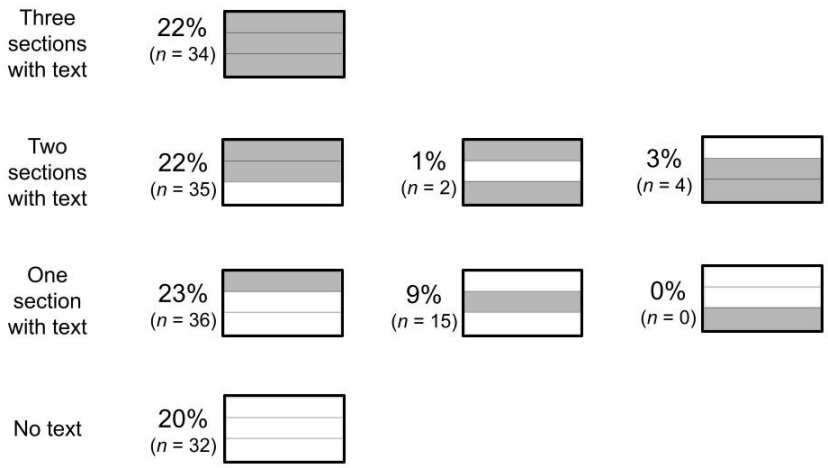
Directions slides were particularly wordy, with 27 of the 33 slides having 30 or more words (82%) used to summarize directions (e.g., Figure 2). In contrast, prompts for student engagement and prompts for teacher action were typically more succinct, often appearing as a single question in the upper portion of the slide (e.g., Figures 5 and 6). However, some slides had

multiple lines or bullet points of text that prompted student action or engagement in the lesson (e.g., Figure 4). This was typically the case when the slide included both a question and a prompt for student action, such as prompting students to turn and talk to a partner to discuss their response to the question.

The Layout of the Text on the Slides

To capture the layout of the text on the slides, each slide was split horizontally into equal thirds (top, middle, and bottom) and coded for the presence of text in that section of the slide. Figure 7 shows the different layouts of text along with the percentage and number of slides with each layout. Collectively, over two thirds of all slides (including those with no text) had text in the top portion of the slide, and over half had text in the middle portion. In contrast, there were no slides in which text appeared only in the bottom portion of the slide. Instead, when text appeared in the bottom portion, it was nearly always because the text stretched across all three sections of the slide.

Figure 7
Percentage of Slides With Text in One or More Shaded Sections



Note. *N* = 158 slides, as all slides (including those with no text) were considered for this analysis.

Notably, 22% of slides (n = 34) had text in all three regions of the slide. In all cases, informational text made up most or all the text on the slide (e.g., Figure 2). The majority of PSETs (58%, n = 21) included at least one such slide in their slide decks. However, there were no slide decks that consisted *only* of slides with text in all three sections of the slide. In fact, only 8% of the PSETs (n = 3) created more than two slides with text in all three sections of the slide. In other words, while it was common for PSETs to create at least one slide essentially filled with text, such slides were not the norm within the slide decks. Instead, like the number of words on slides, the layout of text on slides varied from slide to slide both within the PSETs' slide decks and across the set of slides.

Discussion

This study described the function and the form of text on slides designed by 36 preservice elementary teachers for use in a whole group mathematics lesson. A list of visual literacy competencies synthesized from the *Visual Literacy Competency Standards for Higher Education* (ACRL, 2011) and Roblyer and Bennett's (2001) list of visual literacy skills for teachers was used to guide the study.

The function of the slide text was described in terms of the purpose of the text in the planned instruction and the extent to which the plans implied the teacher and the students would read slide text during the lesson. The form of the slide text was described in terms of the amount of text on slides and the regions of the slide in which text appeared. This study extends the literature regarding the visual literacy skills of teachers (Alpan, 2015; Anderson et al., 2021; Eustler, 2021; Little, 2015; Roblyer & Bennett, 2001; Yeh & Lohr, 2010) and addresses calls to ensure that teachers are prepared to effectively use the technologies available in their classrooms in their instruction (Office of Educational Technology, 2017).

The findings of this study support claims that instruction in visual literacy skills should be incorporated into teacher education coursework if preservice teachers are expected to be able to design slides that support student engagement and learning (Eustler, 2021; Farrell, 2015; Roblyer & Bennett, 2001). Three findings from this study support this conclusion: (a) most slides contained text, (b) text was prominently placed on most slides, and (c) text was most often used to convey information about the task. Together, these findings mean that many of the PSETs' slides were dominated by informational text. Moreover, the amount and placement of text on these slides meant that little room remained for images or videos that could help young students make sense of the information being conveyed. Research on the use of slideware to support instruction at the university level indicates that images are more beneficial than text in terms of supporting students' understanding (Garner & Alley, 2013; Mayer, 2020), and it is reasonable to assume that these findings would extend to elementary age students, particularly given that many are emerging readers.

The reason PSETs so often used text, rather than images, to capture important information about the day's task is unclear. One possible explanation is that the PSETs found using text for this purpose easy and familiar (Adams, 2006). Slides filled with bullet points of text are commonly used in university courses (Uzun & Kilis, 2019), and the PSETs' lack of teaching experience may have meant that they simply did not consider how designing slides for elementary students might differ from designing slides for university students.

Another explanation is that the PSETs may have preferred to use images rather than text but did not know how to find or create the necessary images. Other studies have found that teachers find it challenging to choose or design visual models that accurately convey intended messages (Johnson, 2013; Lee & Jones, 2018; Ruiz-Gallardo et al., 2019).

Regardless of the underlying reason(s), these findings indicate that preservice teachers need help learning how and when to use (or, perhaps more importantly, *not use*) slide text, and how to incorporate other types of visuals into their slides. These findings are in keeping with previous research indicating that the ability to create slides is not synonymous with the ability design slides that effectively communicate intended messages (Brumberger, 2011; Garner & Alley, 2013).

Two additional important findings of this study were that most slides in PSETs' slide decks contained text and that this text was often closely aligned with what the plans indicated the preservice teacher would say during the corresponding portion of the lesson. Thus, although the slide text may not have been beneficial for the students, it was designed to benefit the preservice teachers by offering them a script to follow or a reminder of what to say. In other words, the *text was for the teacher*. This finding is consistent with prior studies that have found that novice and anxious presenters tend to use slide text to script their presentations to help themselves feel less nervous (Hertz et al., 2015, 2016).

Finally, one promising finding was that most of the PSETs included at least one slide with text that prompted student engagement in the planned lesson. Many PSETs used slide text to embed questions for student discussion into their slides, and some also included directions that prompted student interaction, such as directing students to "turn and talk" with a partner. Other studies have found that embedding questions in slides promotes student interaction and engagement during a lesson (Elliott & Gordon, 2006; Gier & Kreiner, 2009; Murcia & Sheffield, 2010; Valdez, 2013).

Notably, posing purposeful questions and facilitating student discourse were two of the effective mathematics teaching practices (National Council of Teachers of Mathematics, 2014) emphasized in the methods course for which these plans were written. Although the specific questions and prompts the PSETs included were not always strong examples of these practices, they indicate that the PSETs were purposefully using slide text to help them put the ideas being learned in their methods courses into practice.

Thus, the findings of this study raise the possibility that PSETs' inclination to use text to script their planned instruction could turn out to be a feature rather than a bug when using slideware to support novices as they learn to enact effective teaching practices within the complex environment of a classroom. In other words, rather than unilaterally discouraging the use of text on slides designed for elementary students, it may be more productive for teacher educators to encourage PSETs to include slide text that promotes the use of student-centered teaching practices during their lessons.

This conclusion stands in contrast to recommendations that slides should be designed to benefit students, rather than instructors or presenters (Hertz et al., 2015; Mayer, 2020). It also draws attention to the fact that guidelines that describe effective slide design for teaching should take into consideration the overall impact of slides on instruction, rather than narrowly focusing on students' understanding of slide content.

Implications for Teacher Education

The results of this study have implications for teacher educators seeking to ensure that their preservice teachers are prepared to effectively use the presentation technologies available in many classrooms today (Office of Educational Technology, 2017). On the one hand, simply advising preservice teachers to avoid or limit the use of text on slides could limit the potentially useful ways in which text might be leveraged to help novice teachers enact desired instructional routines and practices. On the other hand, filling slides with text, no matter how useful that text is for the novice teacher, means that little room is left on the slide for images or other multimedia content more likely to support students. Rather than viewing slides as a space that should be used entirely for the benefit of the learner (as is appropriate in the case of a presentation), it may be more productive to teach preservice teachers to think of slides as a shared space, useful to and meant to be used by both the students and the teacher during instruction.

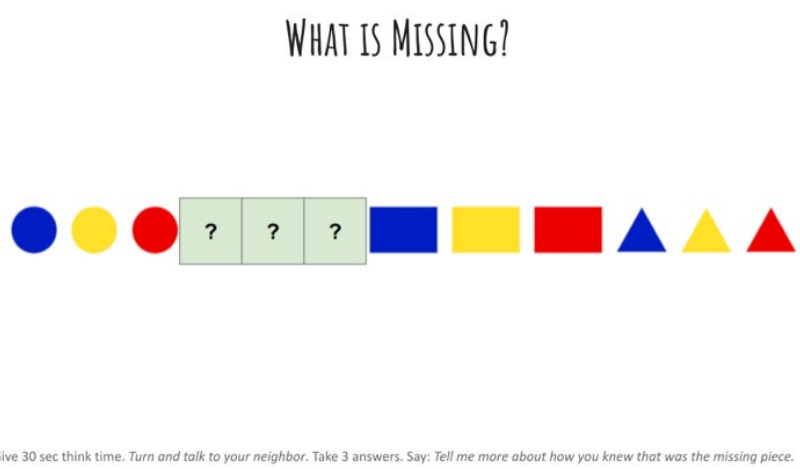
One goal of this study was to provide an evidence-based starting point for the design of instructional experiences in methods coursework that address preservice teachers' learning needs in terms of using slides as an effective technology tool within their instruction. Toward that end, I propose three preliminary guidelines that could be used to help preservice teachers learn how to productively use slides as a shared space, supportive for both themselves as novice teachers and their students (See Table 6).

Table 6
Guidelines for Preservice Teachers' Use of Text on Slides Designed to Support Student-Centered Instruction

Guideline	Brief Justification
1. Use the center portion of the slide for information that supports the students and the edges for information that supports the teacher	Pulling the *text for the teacher* away from the center and towards the edges of the screen could be a way to encourage novice teachers to make distinctions between the ways that slide content may benefit teacher versus the students during instruction, and to explicitly consider both audiences while creating slides.
2. Format text for the teacher differently than text for the students	Text that is on the slide *for the teacher's benefit only* might purposefully use a small font and be shaded to not stand out from the background of the slide (e.g., light gray text on a white slide). This would allow *text for the teacher* to be less prominent on the slide.
3. Include prompts for interaction and discussion at both the top and bottom of each slide	Most questions included on the slides in this study fell in the top half of the slides with the corresponding plans describing the preservice teacher posing the question to initiate that portion of the planned instruction. Given the fact that people generally read slides from top-to-bottom (Golombisky & Hagan, 2016), these findings suggest that it may be useful to encourage PSETs to include questions or prompts in the *bottom* section of their slides that "follow up" on the initial prompts or information that may appear in the top portion of their slides.

These guidelines seek to honor novice teachers' desire to use slide text to support their own instructional needs as they undertake the complex and challenging work of teaching while still encouraging them to view the bulk of the space available on the slide as space to be designed for students' use. One potential benefit of this recommended format is that the text at the edges can simply be removed once novices find it is no longer needed, leaving slides that are specifically designed to benefit students. Figure 8 shows an example of how the slide shown in Figure 5 could be redesigned to reflect these guidelines.

Figure 8
A PSET's Slide Redesigned to Demonstrate Ways to Use the Slide as a Shared Space



Note. The prompt, "What is missing?" has been left in a large, bold font, as the question might be beneficial for both students and the teacher to see during instruction. However, the question was moved to the top edge, as per Guideline 1.

Limitations and Future Direction

This study has several limitations. First, this was a study of 36 preservice elementary teachers from a single semester of a methods course taught by the researcher of this study. Thus, the results have limited generalizability. Additional research is needed that documents how other preservice teachers use slideware technology, in general, and slide text, specifically, as collectively that information can support more robust understandings of what visual literacy skills should be addressed in teacher education coursework. In addition, the fact that I was both researcher and instructor means that the slides in this study likely reflected some of my own ways of designing and using slides. Assuming this is the case highlights the importance of methods instructors having a clear understanding of effective slide design and modeling that for prospective teachers.

Finally, this study examined slide text based only on the lesson plans and did not document the ways in which the text was used during instruction. The slide text possibly would be used differently in instruction than indicated in the PSETs' plans. Together, these limitations highlight the need for research that documents the specific ways in which slide content is used by preservice teachers during instruction, as well as how other preservice teachers incorporate text into visual media they plan to use in their instruction.

Based on the results of this study, a set of three preliminary guidelines were proposed for helping preservice teachers learn how to productively use slides as a shared space, supportive for both themselves as novice teachers and their students. A useful follow-up to this study would be to offer these guidelines to preservice teachers and then examine both the slides they design and the ways they use those slides in their instruction. Of particular interest would be studies that examine if incorporating text that prompts student discussion or engagement into slides is an effective tool for supporting novices in enacting these instructional practices during field experience lessons.

Another useful follow-up to this study would be to use the synthesized framework of visual literacy skills that was used to guide this study to assess preservice teachers' slides. This framework could be further refined and developed to include a more specific list of competencies needed by preservice teachers to use slideware effectively. Finally, the focus of this study was on the use of slide text by PSETs. However, images and videos are important components of slides and future studies should examine the ways that preservice teachers make use of these other types of slide content.

Conclusion

Given the widespread availability of both slideware and digital projectors in elementary classrooms, the need is clear for methods instructors to prepare future elementary teachers to make effective use of slideware in instruction. Two key conclusions were drawn from the study findings. First, preservice teachers' need to develop visual literacy competencies in slide design during their teacher education coursework. Second, study findings highlighted the potential utility of slide text as a tool to support novice teachers as they learn to enact unfamiliar and cognitively demanding teaching practices such as engaging students in discussion during lessons. One recommendation based on these findings is to teach preservice teachers to consider slides to be a shared space, meant to be used by and useful to both students and the teacher. Although more research is needed, the findings and recommendations from this study provide an evidence-based starting point for teacher educators interested in providing preservice teachers with guidelines for use of text on slideware during whole group instruction.

References

Adams, C. (2006). PowerPoint, habits of mind, and classroom culture. *Journal of Curriculum Studies*, *38*(4), 389-411. https://doi.org/10.1080/00220270600579141

Alpan, G. B. (2015). The reflections of visual literacy training in pre-service teachers' perceptions and instructional materials design. *Journal of Education and Human Development*, *4*(2), 143-157. https://doi.org/10.1007/s11528-021-00629-1

Anderson, E., Avgerinou, M. D., Dimas, S., & Robinson, R. (2021). Visual literacy in the K12 classroom of the 21st century: From college preparation to finding one's own voice. In M. D. Avgerinou (Ed.), *Handbook of research on K-12 blended and virtual learning through the i²Flex classroom model* (pp. 84-108). IGI Global. DOI: 10.4018/978-1-7998-7760-8

Association of College and Research Libraries. (2011, October). *Visual literacy competency standards for higher education*. American Library Association. http://www.ala.org/acrl/standards/visualliteracy

Averginou, M. D., & Pettersson, R. (2011). Toward a cohesive theory of visual literacy. *Journal of Visual Literacy*, *30*(2), 1-19. https://doi.org/10.1080/23796529.2011.11674687

Baker, J. P., Goodboy, A. K., Bowman, N. D., & Wright, A. A. (2018). Does teaching with PowerPoint increase students' learning? A meta-analysis. *Computers & Education*, *126,* 376-387. https://doi.org/10.1016/j.compedu.2018.08.003

Beauchamp, G., & Kennewell, S. (2013). Transition in pedagogical orchestration using the interactive whiteboard. *Education and Information Technologies*, *18*(2), 179-191. https://doi.org/10.1007/s10639-012-9230-z

Bourbour, M. (2020). Using digital technology in early education teaching: Learning from teachers' practice with interactive whiteboard. *International Journal of Early Years Education*, Ahead-of-print. https://doi.org/10.1080/09669760.2020.1848523

Brumberger, E. (2011). Visual literacy and the digital native: An examination of the millennial learner. *Journal of Visual Literacy*, *30*(1), 19-46. https://doi.org/10.1080/23796529.2011.11674683

Brumberger, E. (2019). Past, present, future: Mapping the research in visual literacy. *Journal of Visual Literacy*, *38*(3), 165-180. https://doi.org/10.1080/1051144X.2019.1575043

ClassFlow. (2021). *Creating and delivering lessons, polls, activities, and assessments is a snap*. https://classflow.com/features/

Council of Chief State School Officers. (2013, April). *Interstate Teacher Assessment and Support Consortium InTASC model core teaching standards and learning progressions for teachers 1.0: A resource for ongoing teacher development*. Author.

Cuenca, A. (2021). Proposing core practices for social studies teacher education: A qualitative content analysis of inquiry-based lessons. *Journal of Teacher Education*, *72*(3), 298-313. https://doi.org/10.1177/0022487120948046

Elliott, S., & Gordon, M. (2006). Using PowerPoint to promote constructivist learning. *Educational Technology*, *46*(4), 34-38. http://www.jstor.org/stable/44429313

Elo, S., Kaariainen, M., Kanste, O., Polkki, T., Utriainen, K., & Kyngas, H. (2014). Qualitative content analysis: A focus on trustworthiness. *SAGE Open*, *4*(1), 1-10. https://doi.org/10.1177/2158244014522633

Eustler, L. (2021). Making space for visual literacy in literacy teacher preparation: Preservice teachers coding to design digital books. *TechTrends*, *65*, 833-846. https://doi.org/10.1007/s11528-021-00629-1

Farkas, D. K. (2006). Toward a better understanding of PowerPoint deck design. *Information Design Journal*, *14*(2), 162-171. https://doi.org/10.1075/idj.14.2.08far

Farrell, T. A. (2015). Visual literacy (VL) in teacher preparation: Measurement to direction. *Journal of Visual Literacy*, *34*(1), 89-104. http://dx.doi.org/10.1080/23796529.2015.11674724

Fenesi, B., & Kim, J. A. (2014). Learners misperceive the benefits of redundant text in multimedia learning. *Frontiers in Psychology*, *5*(710), 1-7. https://doi.org/10.3389/fpsyg.2014.00710

Garner, J. K., & Alley, M. P. (2013). How the design of presentation slides affects audience comprehension: A case for the Assertion-Evidence approach. *International Journal of Engineering Education*, *29*(6), 1564-1579.

Gier, V. S., & Kreiner, D. S. (2009). Incorporating active learning with PowerPoint-based lectures using content-based questions. *Teaching of Psychology*, *36*, 134-139. https://doi.org/10.1080/00986280902739792

Glaser, B., & Strauss, A. (1967). *The discovery of grounded theory*. Aldine Publishing Company.

Golombisky, R., & Hagan, K. (2016) *White space is not your enemy: A beginner's guide to communicating visually through graphic, web & multimedia design* (3rd ed.). Taylor and Francis.

Hertz, B., Kerkof, P., & van Woerkum, C. (2016). PowerPoint slides as speaking notes: The influence of speaking anxiety on the use of text on

slides. *Business and Professional Communication Quarterly*, *79*(3), 348-359. https://doi.org/10.1177/2329490615620416

Hertz, B., van Woerkum, C., & Kerkhof, P. (2015). Why do scholars use PowerPoint the way they do? *Business and Professional Communication Quarterly*, *78*(3), 273-291. https://doi.org/10.1177/2329490615589171

Hight, C., Khoo, E., Cowie, B., & Torrens, R. (2013). "The slides are part of the cake": PowerPoint, software literacy, and tertiary education. In H. Carter, M. Gosper, & J. Hedberg (Eds.), *ASCILITE-Australian Society for Computers in Learning in Tertiary Education Annual Conference*, 379-384. https://www.learntechlib.org/p/171152/

Hill, A., Arford, T., Lubitow, A., & Smollin, L. M. (2012). "I'm ambivalent about it": The dilemmas of PowerPoint. *Teaching Sociology*, *40*(3), 242-256. https://doi.org/10.1177/0092055X12444071

Huilcapi-Collantes, C., Hernández, A., & Hernández-Ramos, J. P. (2020). The effect of a blended learning course of visual literacy for in-service teachers. *Journal of Information Technology Education*, *19*, 131-166. https://doi.org/10.28945/4533

Johnson, C. M. (2013). *Making a case for using visual inquiry discussion in preparing elementary social studies teachers* [Unpublished doctoral dissertation]. University of Michigan.

Karsenti, T. (2016). The interactive whiteboard: Uses, benefits, and challenges. A survey of 11,683 students and 1,131 teachers. *Canadian Journal of Learning and Technology*, *42*(5), 1-22. https://www.learntechlib.org/p/178020/

Kędra, J. (2018). What does it mean to be visually literate? Examination of visual literacy definitions in a context of higher education. *Journal of Visual Literacy*, *37*(2), 67-84. https://doi.org/10.1080/1051144X.2018.1492234

Kenny, l. (2011). Elementary education, there's an APP for that: Communication technology in the elementary school classroom. *The Elon Journal of Undergraduate Research in Communications*, *2*(1), 67-75.

Lee, T. D., & Jones, M. G. (2018). Elementary teachers' selection and use of visual models. *Journal of Science Education and Technology*, *27*(1), 1-29. https://doi.org/10.1007/s10956-017-9705-1

Little, D. (2015). Teaching visual literacy across the curriculum: suggestions and strategies. *New Directions for Teaching and Learning*, *2015*(141), 87-90. https://doi.org/10.1002/tl.20125

Lyublinskaya, I., & Tournaki, N. (2014). A study of special education teachers' TPACK development in mathematics and science through assessment of lesson plans. *Journal of Technology and Teacher Education*, *22*(4), 449-470.

Major, L., & Warwick, P. (2019). Affordances for dialogue: The role of digital technology in supporting productive classroom talk. In *The Routledge international handbook of research on dialogic education* (pp. 394-410). Routledge.

Mayer, R. E. (2020). *Multimedia learning* (3rd ed.). Cambridge University Press.

Murcia, K. (2010). Multi-modal representations in primary science: What's offered by interactive whiteboard technology. *Teaching Science*, *56*(1), 23-29. https://search.informit.org/doi/10.3316/aeipt.182334

Murcia, K., & Sheffield, R. (2010). Talking about science in interactive whiteboard classrooms. *Australasian Journal of Educational Technology*, *26*(4), 417-431. https://doi.org/10.14742/ajet.1062

National Council of Teachers of Mathematics. (2014). *Principles to actions: Supporting mathematical success for all.* Author.

National Science Board (2018). *Science and Engineering Indicators 2018*. National Science Foundation. https://www.nsf.gov/statistics/2018/nsb20181/

Office of Educational Technology. (2017). *Reimagining the role of technology in education: 2017 National Education Technology Plan update*. U. S. Department of Education. https://tech.ed.gov/netp/

Paratore, J. R., O'Brien, L. M., Jimenez, L., Salinas, A., & Ly, C. (2016). Engaging preservice teachers in integrated study and use of educational media and technology in teaching reading. *Teaching and Teacher Education*, *59*, 247-260. https://doi.org/10.1016/j.tate.2016.06.003

Polly, D., & Binns, I. (2018). Elementary education candidates' integration of technology in science units. *Contemporary Issues in Technology and Teacher Education*, *18*(4), 631-647. https://citejournal.org/volume-18/issue-4-18/science/elementary-education-candidates-integration-of-technology-in-science-units

Ponce, H. R., Mayer, R. E., Lopez, M. J., & Loyola, M. S. (2018). Adding interactive graphic organizers to a whole-class slideshow lesson. *Instructional Science, 46*, 973-988. https://doi.org/10.1007/s11251-018-9465-1

Putra, Z. H., Witri, G., & Yulita, T. (2019). Development of PowerPoint-based learning media in integrated thematic instruction of elementary school. *International Journal of Scientific and Technology Research*, *8*(10), 697-702.

Roblyer, M. D., & Bennett, E. K. (2001). The fifth literacy: Research to support a mandate for technology-based visual literacy in preservice

teacher education. *Journal of Computing in Teacher Education*, *17*(2), 8-15. https://doi.org/10.1080/10402454.2001.10784409

Ruiz-Gallardo, J. R., Fernández, B. G., & Jiménez, A. M. (2019). Visual literacy in preservice teachers: A case study in biology. *Research in Science Education*, *49*(2), 413-435. https://doi.org/10.1007/s11165-017-9634-2

Sadik, A. (2011). Improving pre-service teachers' visual literacy through online photo-sharing applications. *International Journal of Emerging Technologies in Learning*, *6*(1), 31-36. http://dx.doi.org/10.3991/ijet.v6i1.1360

Saldana, J. (2013). *The coding manual for qualitative researchers* (2nd ed.). SAGE.

Schreier, M. (2012). *Qualitative content analysis in practice*. SAGE.

Sheffield, C. C. (2015). Struggling to move beyond projection: A case study of instructional use of an interactive white board in elementary social studies. *Contemporary Issues in Technology and Teacher Education*, *15*(4), 541-567. https://citejournal.org/volume-15/issue-4-15/social-studies/struggling-to-move-beyond-projection-a-case-study-of-instructional-use-of-an-interactive-white-board-in-elementary-social-studies

Sias, C. M., Nadelson, L. S. , Juth, S. M., & Seifert, A. L. (2017). The best laid plans: Educational innovation in elementary teacher generated integrated STEM lesson plans. *The Journal of Educational Research*, *110*(3), 227-238. https://doi.org/10.1080/00220671.2016.1253539

SMART. (2021). *SMART Notebook 21*. https://support.smarttech.com/docs/software/notebook/notebook-21/en/home.cshtml

Smith-Peavler, E., Gardner, G. E., & Otter, R. (2019). PowerPoint use in the undergraduate biology classroom. *Journal of College Science Teaching*, *48*(3), 74-83. https://www.jstor.org/stable/26901285

Sosa, T. (2009). Visual literacy: The missing piece of your technology integration course. *TechTrends*, *53*(2), 55. https://doi.org/10.1007/s11528-009-0270-1

Uzun, A. M., & Kilis, S. (2019). Impressions of preservice teachers about use of PowerPoint slides by their instructors and its effects on their learning. International Journal of *Contemporary Educational Research*, *6*(1), 40-52. https://doi.org/10.33200/ijcer.547253

Valdez, A. (2013). Multimedia learning from PowerPoint: Use of adjunct questions. *Psychology Journal*, *10*(1), 35-44.

Yeh, H. T., & Cheng, Y. C. (2010). The influence of the instruction of visual design principles on improving pre-service teachers' visual

literacy. *Computers & Education*, *54*(1), 244-252. https://doi.org/10.1016/j.compedu.2009.08.008

Yeh, H. T., & Lohr, L. (2010). Towards evidence of visual literacy: Assessing pre-service teachers' perceptions of instructional visuals. *Journal of Visual Literacy*, *29*(2), 183-197. https://doi.org/10.1080/23796529.2010.11674680

Yilmazel-Sahin, Y. (2009). A comparison of graduation and undergraduate teacher education students' perceptions of their instructors' use of Microsoft PowerPoint. *Technology, Pedagogy, and Education*, *18*(3), 361-380. https://doi.org/10.1080/14759390903335866