Modeling Guided Inquiry and School Librarian Instructional Partnerships to Pre-Service Teachers Through Digital Video Production

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The last ten years in school library research reflect an expanded definition of information literacy along with a stronger emphasis on in-depth information literacy development, concluding that a fundamental shift in instruction provided by school librarians is needed; one that not only helps students find information, but develops students' abilities to interact with, and learn from information, engaging with it in critical ways. Collaboratively designed and implemented through an instructional partnership between the school librarian and a classroom teacher, Guided Inquiry instruction helps students gain meaningful understanding and develop a personal perspective by exploring, comparing, and contrasting multiple information sources. Despite the frequently touted benefits of instructional partnerships between school librarians and classroom teachers, these structures are rarely, if ever, modeled by school library and pre-service teacher educators. This study examined the process and challenges inherit in designing and modeling Guided Inquiry units of instruction, through a school librarian instructional partnership model, in pre-service teacher education, exploring its impact on teacher candidate willingness to identify school librarians as co-teachers. Findings from the present study indicate Guided Inquiry units co-taught by school library educators and teacher educators help teacher candidates both successfully navigate the research process and develop a mental model of the school librarian as a co-teacher.

Keywords: school library education, instructional partnerships, Guided Inquiry Design, school library research, co-teaching

Introduction

In the summer of 2019, *Forbes* published an article that spread through social media like wildfire. A quick and accessible primer on the importance of information literacy, the piece, "A Reminder That 'Fake News' Is an Information Literacy Problem – Not a Technology Problem," was shared by many librarians and educators, sparking thoughtful online discussions on ways school librarians (in particular) attempt to thread information literacy through the K-12 curriculum (Leetaru, 2019). These discussions highlighted concerns over the continued defunding of school library programs, barriers to school librarian pedagogical involvement, and frustration at the lack of awareness of the school librarian's role in developing information literacy. The article, written by a senior fellow at the George Washington University Center for Cyber and Homeland Security, also highlighted a growing awareness of a dynamic familiar to librarians: the distinct difference between technological proficiency

Journal of Education for Library and Information Science 2023
Vol. 62, No. 2 DOI: 10.3138/jelis-2022-0015

KEY POINTS:

- Guided Inquiry units co-taught by school library educators and teacher educators help teacher candidates both successfully navigate the research process and develop a mental model of the school librarian as a co-teacher.
- Without a school librarian's guidance on inquiry, student projects explore portions of an instructional unit's concepts that hold student interest resulting in an inconsistent student mastery of the unit's learning objectives.
- The more educators adhere to the scaffolding recommended in the Guided Inquiry model, the more students shift their efforts from an expedient completion of an assignment or project, to the process and journey of inquiry itself.

and information literacy, despite the tendency of stakeholders to confound the two. Leetaru (2019) exemplified this awareness when he explained "suggestions like requiring programming and data science courses in school would certainly create more technically-literate [*sic*] citizens, but this is not the same as data literacy and the kind of critical thinking it requires." Leetaru (2019) claimed, "societies must teach their children from a young age how to perform research, understand sourcing, triangulate information, triage contested narratives and recognize the importance of where information comes from, not just what it says."

A growing public awareness of the importance of information literacy aligns closely with recent updates made to the National School Library Standards (AASL, 2018). The standards emphasize information literacy throughout each of the six shared foundations (Inquire, Include, Collaborate, Curate, Explore, and Engage), and domains (Think, Create, Share, Grow). In fact, the very names of each foundation and domain are actions that depend on an information literate skill set. As an example, the standards call on school librarians to aid students in "devising and implementing a plan to fill knowledge gaps," and "cultivating networks that allow learners to build on their own prior knowledge and create new knowledge." Before proceeding, it is important to understand how the term information literacy is defined in this paper. The word 'literacy' in the English language has now come to represent a whole series of actions (e.g., text decoding, reading comprehension, knowledge creation, information exchange). When it is placed behind a discipline such as *financial literacy* or *civic literacy*, what is meant is that an individual with this skill set can procure, select, evaluate, engage with, curate, apply, and create new knowledge within that discipline, in a way that is deemed successful by the standards of that same discipline (Keefe & Copeland, 2011). If one approaches the definition of literacy in this way, one begins to understand that literacy is: (a) more than interacting with text and (b) action-based, leading to an informed decision of some type (Freeburg, 2017). Another way to look at it is to re-title terms: *information literacy in finance*, *information literacy in media*, *information literacy in civics*, *information literacy in data*, *information literacy in science*.

The last ten years in school library education research reflect this expanded definition of information literacy along with a stronger emphasis on in-depth information literacy development, concluding that a fundamental shift in instruction provided by school librarians is needed; one that not only helps students find information, but develops students' abilities to interact with and learn from information, engaging with it in critical ways (Johnston & Green, 2018; Todd, 2012). The ability to apply these information literacy skills in personal inquiry is a foundational requirement for tackling ill-structured problems, a life-long cognitive requirement for successful participation in a global economy (Eseryel, Ifenthaler, & Ge, 2013).

Guided inquiry is an inquiry model well-suited to support K-12 student growth in information literacy, ill-structured information problem-solving, self-awareness of learning patterns, innovation, and design (Akcaoglu & Green, 2019; Kuhlthau, Maniotes, & Caspari, 2015). Collaboratively designed and implemented through an instructional partnership between the school librarian and a classroom teacher, Guided Inquiry instruction helps students gain meaningful understanding and develop a personal perspective by exploring, comparing, and contrasting multiple information sources (Kuhlthau, 2010). Although students engaged in inquiry should be able to observe, experience, reflect, and struggle with ill-defined information problems, opportunities to practice problem-solving of any nature are difficult to come by in formal K-12 schooling settings (Akcaoglu & Green, 2019). In addition, despite the frequently touted benefits of instructional partnerships between school librarians and classroom teachers, these structures are rarely, if ever, modeled by school library and pre-service teacher educators (Green et al., 2013).

Therefore, the purpose of this study was to examine the process and challenges inherit in designing and modeling Guided Inquiry units of instruction, through a school librarian instructional partnership model, in pre-service elementary science teacher education. Science was selected as the content area of focus for this study because the school librarian's presence as an instructional partner, one with a strong background in student inquiry, serves to support the elementary classroom teacher through planning and implementation of scientific investigations (Johnston, 2018). The National Science Teachers Association (NSTA) recommends elementary science teachers complete undergraduate coursework in life, earth, and physical sciences. Unfortunately, only 36% of teachers report taking these classes (Banilower et al., 2013). This results in a teaching profession that has had "limited opportunities to engage in scientific investigations and may be unprepared to engage their students in scientific practices in ways that build conceptual understanding" (NASEM, 2015, p. 72).

Background

If anything separates the role of the school librarian from that of a classroom teacher, it is the difference in educator training and preparation on the subject of inquiry. While school librarians are trained to guide students through engaging with information in critical ways, classroom teachers commonly do not complete in-depth pre-service coursework on information literacy and inquiry models. When left to their own devices, classroom teachers tend to focus exclusively on location skills, despite information literacy standards clearly outlining information seeking, access, evaluation, use, and communication (Newell, 2008). Even this exclusive focus is problematic since teachers not only typically lack the ability to conduct effective information search, retrieval, and evaluation themselves, but also are not equipped with the knowledge to develop these abilities in their students (Claro et al., 2018;

van Deursen & van Diepen, 2013; Hinostroza et al., 2016; Tallvid, 2016). Consequently, students who complete research or inquiry assignments with a classroom teacher only, tend to score lower on measurements of learning gains. In the absence of an explicit model for information problem-solving, students spend precious time and cognitive effort developing processes to address information challenges; time that is then taken away from developing an actual research project (Johnston & Green, 2018; Krueger & Donham, 2013; Varlejs & Stec, 2014). In contrast, students who participate in these types of activities, under the supervision of a school librarian, are described by teachers as inquisitive, imaginative, and motivated to solve real problems that can help real people (Small, 2014).

Guided Inquiry

Guided Inquiry Design (GID) is an inquiry model that scaffolds student-driven inquiry through activity sequencing, information resource use, and problem-solving, using elements such as educator facilitation, technology-enabled learning, and curation of information resources (Kuhlthau, Maniotes & Caspari, 2015). It is grounded on a large body of research that resulted in the creation of the Information Search Process Model (Kuhlthau, 2004). Kuhlthau identified seven stages that students progressed through when completing larger research projects: 1) initiating a research project, 2) selecting a topic, 3) exploring for focus, 4) formulating a focus, 5) collecting information on focus, 6) preparing to present, and 7) assessing the process (Kuhlthau, 1985). Kuhlthau determined "students experience a dip in confidence and an increase in uncertainty when they least expect it … they often expect to be able to simply collect information and complete an assignment … when their expectations do not match what they are experiencing, they become confused, anxious, and frustrated" (Kuhlthau, 2019).

As a model, Guided Inquiry (see Figure 1) recognizes and addresses the learner's emotional journey with particular attention paid to the phases where students most often struggle: exploration and formulation (Kuhlthau, 2004). As students complete Guided Inquiry projects and activities, they are guided and scaffolded by an instructional team made up of the school librarian, the classroom teacher, and other experts, helping them gain meaningful understanding while developing a unique perspective of the content covered. Ultimately, the goal of GID is to help students learn "in the information environment of the 'real world' where everyday tasks require learning from information. Through its structure, students personalize the inquiry process recognizing that 'this is my process, this is the way I learn'" (Kuhlthau, 2010, p. 6).

Guided Inquiry instructional activities contain six characteristics: (1) students actively engage with and reflect on their learning experience; (2) students build on prior knowledge; (3) students are scaffolded throughout so that higher order thinking is encouraged; (4) students develop in-depth knowledge of the content through a learning sequence; (5) students are given opportunities to interact with the content in different ways; and (6) students collaborate with others to extend their own learning (Kuhlthau, Maniotes & Caspari, 2015). These characteristics make it possible for educators to focus on student-centered learning that targets individual student learning needs in more self-paced activities versus other

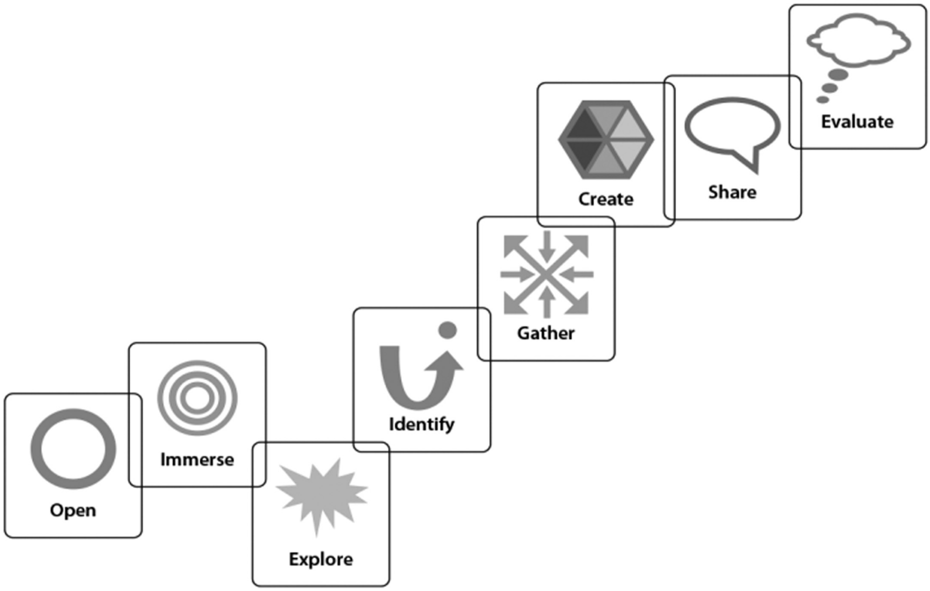

Figure 1: Guided Inquiry Design

direct approaches that assume all learners are at the same academic starting point (Chu et al., 2017).

Guided Inquiry and Science in Elementary Education

Guided Inquiry is particularly well-suited to student exploration of science concepts. The Next Generation Science Standards (NGSS) are informed by three dimensions that describe scientific knowledge as both "a body of knowledge" and the process of theory building that "continually extends, refines, and revises" that knowledge (NRC, 2014).

Students engaged in scientific inquiry and practice should be able to observe, experience, reflect, reason, and communicate scientific findings with others. These characteristics are present throughout the process of initiation, selection, exploration, formulation, collection, presentation, and assessment; so that the Guided Inquiry process easily lends itself to the exploration of scientific concepts. The Guided Inquiry framework also encourages collaboration with outside experts. Within the context of elementary science, this aspect of Guided Inquiry addresses another severe gap in teacher preparation for science teaching identified by the National Academies of Sciences, Engineering, and Medicine (NASEM): the ability to design and implement authentic investigations that mirror real-world practices, "closely integrated with core science ideas and crosscutting concepts" (2015, p. 73).

Digital Video Technologies and Science

When discussing innovative inquiry practices, it is easy to overlook the potential of tools that have been available for some time—potential unlocked when these tools are integrated in meaningful ways. One such standard technology, digital video, deserves a second look, a revisiting as a tool for Guided Inquiry units in the elementary science classroom. The characteristics, capabilities, and accessibility of digital video have dramatically expanded in the last five years. Today, access to a smartphone, an iPad, other tablet devices, and a myriad of web-based, mobile, and free and open-source applications, are all that is needed to collect (and often edit) high quality digital video recordings. Student-created video project ideas include storytelling, book trailers, animations, data collection, science fair projects, short presentations, interviews, sketches, mini documentaries, news broadcasts, or dramatizations (Green, Inan, & Maushak, 2014). There is an extensive body of research, spanning a decade, that extols the benefits of student-created video projects for social learning opportunities, authentic and real-world endeavors and generators of high student-engagement, particularly in student populations with additional learning needs (Goulah, 2007; Green, Inan, & Maushak, 2014; Hafner & Miller, 2011).

Within the science classroom, digital video projects incorporate multi-sensory input features which enable students to interact with content in auditory, visual, and tactile forms, a key feature in student learning of STEM concepts (Carr, 2012; Guzey & Maurina, 2017; Hill 2011). In addition, there is considerable historical precedence for the use of handheld computers and devices in K-12 classrooms to support scientific inquiry (Chen, Kao, & Sheu, 2003; Roschelle et al., 2005; Stroup, 2002; Yarnall et al., 2003). Research details the use of mobile devices in science to improve science learning through collaborative projects, participatory simulations, observation, and concept mapping (Bano et al., 2018; Green et al., 2014; Jones & Stapleton, 2017). Chan et al. (2012) found students who had access to tools such as participatory simulations during Guided Inquiry projects tested considerably higher on learning gains and demonstrated a more in-depth understanding of challenging scientific concepts than students who did not utilize those technologies. Ultimately, student-created video projects developed within the framework of Guided Inquiry, help learners shift from a microscopic focus on abstract ideas to broader and practical applications so that learners work to employ new ideas, grappling to construct mental models and concrete representations for authentic audiences.

Purpose of Study

Guided Inquiry was developed as "an innovative team approach to teaching and learning where teachers and school librarians, with other experts and specialists, join together to design and implement inquiry learning" (Kuhlthau, 2019). However, school librarians have historically found these types of collaborative teaching relationships difficult to establish and maintain (Montiel-Overall & Jones, 2011). While instructional partnerships between school librarians and STEM teachers appear to be "an effective means to promote the development of 21st century skills within the context of STEM courses," there is little evidence to indicate this is a frequent occurrence (Latham et al., 2016, p. 193). Despite the American Association of School Librarians' continuous advocacy of school librarians as instructional partners,

Table 1: Participants per Semester

	Semester 1	Semester 2	Semester 3
n	52	53	59
Males	7	2	2
Females	45	51	57

classroom teachers still fail to place the school librarian in this role (Green et al., 2013; Latham et al., 2016).

In a previous study, Green et al. (2013) found pre-service teachers who were exposed to lessons co-taught by school library educators and science education faculty, as well as workshops led by practicing school librarians, were more likely to identify school librarians as master teachers, "clearly articulating their roles as instructional partners" (p. 404). Therefore, the purpose of this study was to examine the potential, the process, and the challenges inherit in designing and modeling Guided Inquiry units of instruction, through an instructional partnership between school library and teacher education faculty, in pre-service teacher education. To that end, we sought to answer the following research question: "What aspects of the Guided Inquiry co-teaching experience were considered important as faculty made decisions about designing and revising the instructional unit?"

Methodology

This qualitative exploratory case study investigated the integration of a technology-rich Guided Inquiry unit, co-taught by a school library educator and a teacher educator, into a pre-service teacher education science course. An exploratory perspective was chosen for two reasons. First, it allowed researchers to examine the implementation of the GID without predetermined expectations of any effect (Yin, 1994). Second, this qualitative approach supported the collection of rich and detailed descriptive data, yet bound collection by the length of each semester the instructional unit was taught (Denzin & Lincoln, 2008).

Participants

All iterations of the GID unit examined in this study occurred over three consecutive semesters. Study participants (see Table 1) were enrolled in a physical science course offered for early childhood and middle grades education majors at a large university located in the Southeastern United States. This integrated science course was designed to build content knowledge in the areas of physics and chemistry.

At the time of the study, all participants were pursuing a bachelor's degree in either Early Childhood or Middle Grades Education. These degrees eventually lead to teacher certification in grades K-4 and 4–8.

Data Collection and Analysis

Qualitative data collection was conducted during three iterations of design, implementation, and redesign over three, consecutive semesters. The Guided Inquiry Unit designed and delivered during this study occurred in a constructionist learning environment where learners created tangible representations of learning to share with others, presented these representations to an authentic audience, and then incorporated the audience's feedback (Harel & Papert, 1991). Data collected comprised not only the final student project, but all student work product generated along the way including a design log, lesson plans, instructional partnership notes, course materials, inquiry journals, storyboards, and student-generated videos. These artifacts were used to inform cycles of design and redesign, and ultimately address research questions.

Data analysis was conducted through Interpretive Phenomenological Analysis (IPA), an approach where the researcher gathers a variety of data from the perspective of an interpretive bricoleur who "understands that research is an interactive process, shaped by his or her own personal history, biography, gender, social class, race, ethnicity, and by those of the people in the setting" (Denzin & Lincoln 1999, p. 6). While not widely applied in Library and Information Science research, IPA has recently been used in teacher education studies when the researcher's goal is to understand teacher candidate experiences from a data-driven, rather than a theory-driven standpoint (van Wyk, 2017). In this study, IPA enabled researchers to examine the instructional partnership experience from the perspective of the teacher candidates, and from their own perspectives as teacher and school library educators "recognizing contextual factors that may influence how individuals attached meaning to their own experiences" (van Wyk, 2017, p. 10212).

Instructional Design Framework

Due to its focus on the design, implementation, and redesign of an instructional unit, emphasizing the use of technology, media, and materials, the ASSURE model guided and informed the creation, development, and evaluation of the Guided Inquiry Unit examined in this study. ASSURE (see Figure 2) is an instructional systems design process specifically tailored for K-12 settings, that is particularly effective for the integration of media in instruction (Smaldino et al., 2019).

ASSURE guides the instructor through a process that begins with analyzing learners in detail, establishing their knowledge and abilities so that differentiation can occur. It continues with a clarification of "the intended outcomes or expectations" as "no instruction should begin without everyone having a clear understanding of what is supposed to happen" (Grant, 2010). Next, the instructor selects appropriate strategies and resources, prioritizing those that are most likely to keep students engaged with the content. These should also be selected in support of activities that require learner participation and create space and opportunity for constructive feedback. During the last step, the ASSURE model guides the instructor to examine the design's impact on student mastery of learning outcomes and to revise the instructional plan before it is taught again (Smaldino et al., 2019).

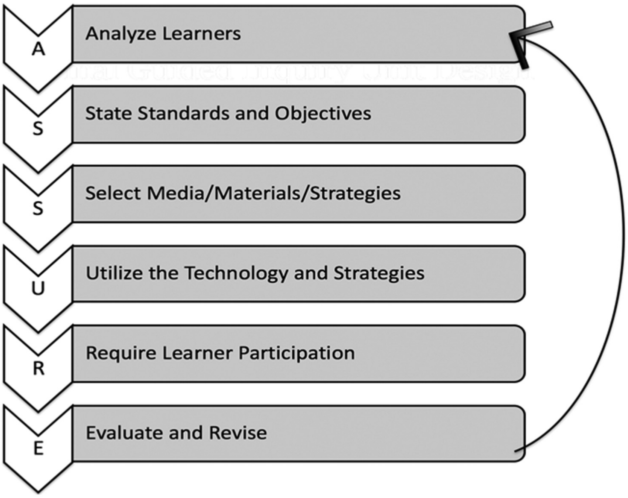

Figure 2: ASSURE model

Description of the Guided Inquiry Unit

Successful inter-professional collaborations occur when both individuals have "mutual respect and shared vision, based on clear understanding of the roles, ethics, and language of all collaborators" (Latham et al., 2016, p. 194). In addition, successful implementation of Guided Inquiry by instructional partnerships between school library professionals and science educators is likely achieved when the skill set and support for such collaborations are available (Schmidt, Kowalski, & Nevins, 2010; Schultz-Jones, 2010). The authors of this paper, one a school library educator and one a science teacher educator, developed a mutually respectful relationship through previous collaborative efforts (research and writing, academic presentations, and pursuit of grant funding). We both shared a vision for technology-integration in student-centered learning, and we both enjoyed the support of a college that promoted interdisciplinary research. Over time, we carved out a plan for co-teaching that clearly delineated responsibilities while remaining flexible and responsive to the demands of higher education faculty schedules.

As we worked through the initial phases of the ASSURE model (A = analyze learners, S = state standards and objectives), we determined that pre-service teachers struggled with the physical science concepts of force and motion, and that these concepts could potentially be better addressed through Guided Inquiry. Due to requirements set by the state teacher certification exam, pre-service teachers also needed to be able to demonstrate the ability to produce and edit digital video, and so we designed a digital video project as the final assessment for the unit. Green, Inan, and Maushak (2014) found "preteaching of technology skills before full-scale implementations of instructional units helped students maintain focus on academic goals and avoid becoming cognitively overwhelmed" (p. 302). Therefore, we decided to use a smaller course assignment (physical elements), scheduled

Table 2: Semester Instructional Schedule

Design Cycle 1: Spring	Design Cycle 2: Summer	Design Cycle 3: Fall
Jan: Element Video Content Guide	May-June (4 weeks):	Aug: Element Storyboard
	Wk1: Element Video	Element Video Content Guide
Feb: Element Video, **Began Guided Inquiry**	Wk2: Began **Guided Inquiry Project**	Sep: **Began Guided Inquiry**
Mar: Continued Guided Inquiry/Expert Visit	Wk3: Continued Guided Inquiry/Expert Visit	Oct: Continued Guided Inquiry/Expert Visit
Apr: Concluded Guided Inquiry	Wk4: Concluded Guided Inquiry	Nov: Concluded Guided Inquiry

before the inquiry unit to teach students storyboarding and digital video production (S = select media/materials/strategies). To help learners explore force and motion in an authentic manner, we brought in an outside expert: a roller coaster engineer who agreed to meet with our students, answer questions, and offer feedback on their inquiry process. Table 2 shows how the element video assignment and Guided Inquiry unit were scheduled during each semester of the study.

The unit began with one 90-minute class where the first 10 to 15 minutes were dedicated to exploration, as students brainstormed their experiences with roller coasters. Then, students built up background knowledge by watching videos, and exploring simulations (U = utilize technology and strategies). During this phase, students responded to initial inquiry journal prompts on interesting ideas to explore. Based on the journal prompt responses, students were placed in inquiry circles centered around common themes. Students chose areas within those themes that they would like to dig into further. In the next class, students met with our "field expert," the roller coaster engineer, who through video conference, offered them feedback on their ideas for inquiry and answered questions they might have about how force and motion influence the design of roller coasters. Students returned to their inquiry circles and discussed possible questions or ideas for further exploration. Each inquiry circle posted these ideas and questions on large notepaper around the room (R = require learner participation). Students were then allowed to choose the question or idea that they found the most interesting. Finally, with a bit of faculty guidance, inquiry groups of three or four were formed.

For the unit's performance assessment, groups were given the option of developing a question that could be tested through experimentation, then recreated in a video experiment; or producing an informative video that introduced and explained a minimum of three, interesting concepts about their question (E = evaluate and revise). Giving students a choice in performance assessments allowed us to model differentiation of instruction in a science classroom by providing "specific alternatives for individuals to learn as deeply as possible and as quickly as possible, without assuming one student's road map for learning is identical to anyone else's" (Tomlinson, 2014, p. 4). For the remainder of the inquiry process, students maintained a robust inquiry journal. Each group also developed detailed storyboards and scripts to present the information they learned (a skill they developed during the element video project). Groups who planned to test their question through experimentation wrote out a controlled experiment to accompany their storyboard.

Findings and Discussion

In this study, data analysis continued throughout the design, implementation, and redesign process, enabling "context-dependent inquiry and inductive data analysis which informed and established procedures for each subsequent design cycle" (Green et al., 2014, p. 67). Therefore, to preserve contextual accuracy and transparency of the design process, analysis of data collected during each cycle will be discussed following its description. This approach to findings and discussion was also applied to present interpretation of findings with minimal bias by the researchers, who both served an instructional role in the study's setting.

Design Cycle: Semester 1

In the first iteration of the study, we modified a pre-existing assignment, "Physical Elements," to introduce students to the digital video production prior to completing a larger Guided Inquiry Unit. Based on previous research conducted by one of the authors of this paper, we posited that if students initially went through the video planning and production process while covering a more basic scientific concept (each group assigned one physical element to define and introduce) within a simpler assignment, then they would be able to more effectively dedicate the time and energy needed to develop a detailed storyboard, and troubleshoot creating a video during the more extensive Guided Inquiry process (Green, Inan, & Maushak, 2014). Teacher candidates were paired off and each team assigned an element from the periodic table. Teacher candidates were then asked to develop a storyboard and eventual video that introduced the assigned element to the rest of the class through a commercial that advertised the element as a product.

The Teacher Educator also took this opportunity to introduce the School Library Educator to the class as a visiting instructor who would be helping with special projects throughout the semester. During the "Physical Elements" assignment, students were presented with the storyboard and video requirements that would also be in place for Guided Inquiry work later in the semester. Students were given the option of either using their own personal device to video-record or checking out a camera from the College of Education's instructional resource center. Students then completed the Guided Inquiry unit on force and motion as described in the "Description of the Guided Inquiry Unit" section of this article.

Instructional roles. During semester 1, the School Library Educator spent a considerable amount of time on tech support and feedback targeting video production and editing throughout completion of the Element Video assignment. All teacher candidate questions directed at the School Library Educator were limited to this area despite the Teacher Educator also having demonstrated strong technological knowledge throughout the earlier part of the semester. This perception of expertise carried over into the Guided Inquiry project. In multiple instances, teacher candidates had inquiry-based questions and purposely directed these to the Teacher Educator, refusing any offers of inquiry help from the School Library Educator. This division became so prominent it influenced the Teacher Educator to modify the School Library Educator's role in grading both the Element Video and the GID projects, removing the School Library Educator's feedback from inquiry and content rubric categories and requesting that the School Library Educator limit feedback to the storyboards, scripts, and video products.

Evaluation of Guided Inquiry Design and co-teaching experience. At the end of the GID unit, the Teacher Educator and the School Library Educator reviewed inquiry journals, rubrics, any student questions emailed to both instructors or posted on the course's virtual discussion board, and final video productions. From this examination, we concluded that students spent too much time on technical issues, taking away from time they needed to master the academic content. We also identified an imbalance between the time spent on the Element Video and any impact the assignment had on teacher candidate ability to complete the GID unit more easily. A review of student questions helped us realize that requesting an Element Video did not help students master technology skills needed to complete the GID video because we allowed multiple devices and approaches to be used. This resulted in an increased level of technological and compatibility issues, as well as a higher number of technology-related questions, and time-consuming issues. In addition, producing the Element Video did not motivate students to create the detailed storyboards required for the GID project. Instead, it took away from the semester time allotted for the GID and encouraged students to shortchange the second video and any related student production materials. Finally, the inquiry journals completed during the GID unit did not demonstrate a consistent student understanding of the concepts of force and motion. The Teacher Educator concluded that removing the School Library Educator's guidance on inquiry resulted in student projects that explored portions of the unit's scientific concepts, reflecting student interested instead of a consistent student achievement of the unit's learning objectives.

Design cycle 1 clarified the body of research encouraging introduction to technology tools prior to lengthier classroom projects to minimize student cognitive overload (Green, Inan, & Maushak, 2014). The benefits of introducing the video production process through the Element Video assignment were obliterated when we allowed too many tool options, generating a lengthy and time-consuming list of troubleshooting help requests. Findings from this cycle also confirmed previous research on lesser student learning gains when inquiry is conducted under the sole purview of a classroom teacher (Claro et al., 2018; Johnston & Green, 2018). By removing the School Library Educator's ability to directly support, address, and assess student inquiry processes, the Teacher Educator became solely responsible for establishing inquiry guidelines. Mirroring the instructional behaviors identified by Newell, 2008, the Teacher Educator focused her inquiry directions on information location and retrieval, versus evaluation and curation. As a result, students demonstrated an inconsistent and patchy understanding of the scientific concepts of force and motion when assessed on this content.

Design Cycle: Semester 2

In the second iteration of the study, we removed the video requirement from the Physical Elements assignment, since introducing video production at this stage lengthened the

Table 3: Design Cycle 2 Modifications

Design Cycle 1: Spring	Design Cycle 2: Summer
Element Video introducing assigned Element.	Element video replaced with skit.
Basic storyboard required.	Storyboard for Element skit strictly graded, and more feedback provided. Storyboard template shared.
Two weeks between conclusion of Element Video and beginning of GID Inquiry Phase.	Minimal break between projects.
No limit on GID question choice.	Limited question focuses to physics vs. physiology.
Technology tool chosen by students.	Shot and edited GID video with assigned iPads (option to film outside of class remained).
Video length 5–7 minutes.	Video length 3–5 minutes.
No limit on imported video.	Limit on imported video.

assignment and caused it to take up more time in the course schedule than was warranted by the academic content. Based on student performance in design cycle 1, we concluded that the Physical Elements assignment would serve better as an opportunity for feedback on storyboarding and presentation—skills that took longer for teacher candidates to master during the Guided Inquiry process. We replaced video with instructions for teacher candidates to develop a live skit, maintaining the requirement for a detailed storyboard. Teacher candidates were also given the storyboard template and instructions created by the American Film Institute (2008). This resource emulated actual storyboard steps undertaken by professional filmmakers, connecting learning activities to real world application (Hafner & Miller, 2011). Table 3 details all modifications applied in design cycle 2 as determined by design cycle 1 data collection and analysis.

Instructional roles. The inconsistent and patchy understanding of force and motion demonstrated by teacher candidates in design cycle 1 motivated the Teacher Educator and the School Library Educator to reduce the technical requirements of the Physical Elements assignment during design cycle 2, so that the School Library Educator could spend more time on supporting the content curation and development of the storyboards and skits. We concluded that teacher candidates needed more instruction on how to translate scientific concepts into a presentation (whether a skit or a video), a process that often involves identifying the main idea, selecting important terms, and developing helpful examples (Green, et al., 2014). We hoped that these skills would translate into a richer inquiry experience during the GID unit, as encouraged by authentic learning that is both situated in actual practice and contextualized in real-world settings within learning spaces (Kearney et al., 2012). The shift away from the School Library Educator's previous tech support role helped teacher candidates perceive the School Library Educator as a full co-instructor. Consequently, during the GID unit, teacher candidate questions directed at the School Library Educator were both tech related and inquiry-based, and while the School Library Educator's formal feedback was still limited to storyboards, scripts, and GID video products, the Teacher Educator solicited informal feedback on inquiry journals and ended design cycle 2 with a significantly more open attitude toward co-teaching the process of scientific inquiry with the School Library Educator.

Evaluation of Guided Inquiry Design and co-teaching experience. Based on findings from design cycle 1, we implemented several modifications to the GID unit design and the overall semester schedule with the purpose of both enriching the inquiry experience and achieving more consistent learning gains among the teacher candidates. First, to increase the likelihood teacher candidates would apply skills acquired during the Physical Elements assignment to the GID unit, we decreased the time between these two items from two weeks to a few days. Second, the GID model includes the "Identify" step where learners "decide the direction of their research," (Maniotes, 2021, p. 49). To scaffold this process, we further clarified the connection between roller coasters and force and motion concepts by requiring inquiry questions focus on physics instead of physiology. In providing this guideline, we hoped teacher candidates would experience "clarity on the focus of their research … [a step] essential to deep learning and searching and eventually deeper understanding" (Maniotes, 2020, p. 17). Third, we modified three technology requirements for the final GID unit video: (1) assigned iPads for video recording, (2) reduced video length to a maximum of five minutes, and (3) limited the amount of imported YouTube video allowed to 10 seconds. These modifications were put in place to help teacher candidates redirect their efforts toward the inquiry process and the presentation of content in their videos (versus the video production itself). Repeating the process conducted in design cycle 1, at the end of the GID unit completed during design cycle 2, the Teacher Educator and the School Library Educator reviewed inquiry journals, rubrics, any student questions emailed to both instructors or posted on the course's virtual discussion board, and final video productions.

The modifications implemented in design cycle 2 translated into a much more positive and consistent learning experience for all teacher candidates. The use of the American Film Institute (2008) materials not only reduced teacher candidate confusion regarding the role and usefulness of a storyboard (see Figure 3), but their use also translated into significantly higher scores on the GID assignment's rubric scores tied to video production quality, and presentation of Guided Inquiry findings. The impact of AFI materials on these two aspects of teacher candidate work echoes research on pre-service teacher training that determined authentic and contextualized situated learning approaches result in candidates prepared for real-world classroom problem-solving (Luo, Murray, & Crompton, 2017; Snape & Fox-Turnbull, 2013).

Using AFI resources for storyboard and video production development also affected teacher candidate perception of the role of the School Library Educator. Because these materials scaffolded teacher candidate selection of camera angles and information presentation, they gave the School Library Educator a frequent opening for addressing content curation, and presentation of scientific topics in accurate and accessible ways. Analysis of storyboard production notes, and observation of teacher candidate discussion during class

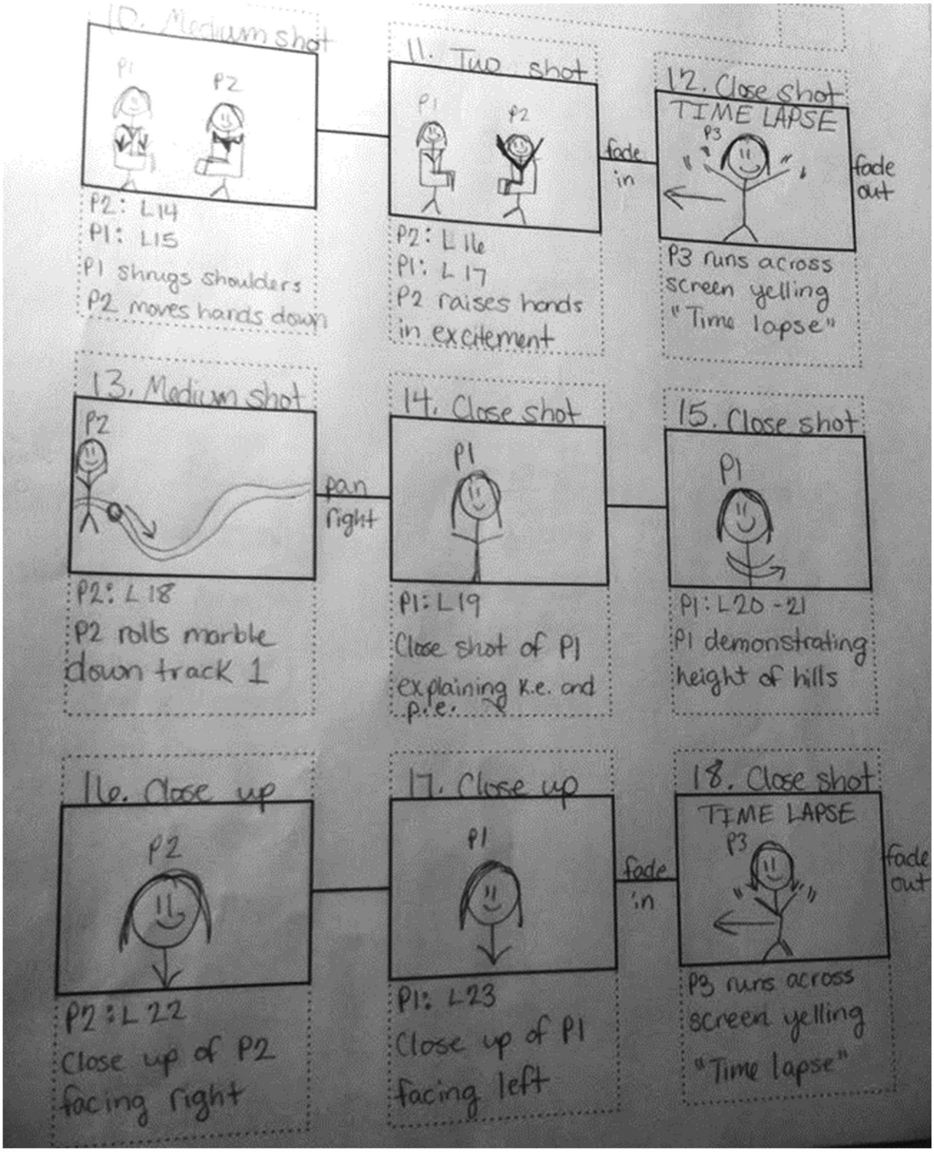

Figure 3: GID unit video storyboard with AFI terminology

demonstrated how the School Library Educator's interactions in this part of the instructional unit further cemented teacher candidate perception of the School Library Educator as a co-teacher on equal footing with the Teacher Educator (Green et al., 2013).

Table 4: Design Cycle 3 Modifications

Design Cycle 1: Spring	Design Cycle 2: Summer	Design Cycle 2: Fall
Element Video introducing assigned Element.	Element video replaced with skit.	No change
Basic storyboard required.	Storyboard for Element skit strictly graded, and more feedback provided. Storyboard template shared.	No change
Two weeks between conclusion of Element Video and beginning of GID Inquiry Phase.	Minimal break between projects.	No change
No limit on GID question choice.	Limited question focuses to physics vs. physiology.	Must include (define & explain) five key concepts related to force & motion (given list to choose from) in final video presentation.
Technology tool chosen by students.	Shot and edited GID video with assigned iPads (option to film outside of class remained).	No change
Video length 5–7 minutes.	Video length 3–5 minutes.	No change
No limit on imported video.	Limit on imported video.	No change

Design Cycle: Semester 3

In the third and final iteration of this study, we made only one significant change to the GID unit assignment (see Table 4). Based on teacher candidate questions posted online, and verbalized in class during design cycle 2, we concluded that requiring teacher candidates to include, define, and explain five key concepts related to force and motion in their final video presentation would scaffold their attempts to develop the video as an instructional product. Luo, Murray, and Crompton (2017) found that due to teacher candidate inexperience in curriculum material development, pre-service teachers preferred specific instructions and strict criteria when asked to complete these types of assignments since "nominal requirements felt overwhelming to manage and too time consuming" (para. 42); sentiments like those observed in our design cycle 2 teacher candidates.

Instructional roles. With the addition of the five key concepts in design cycle 3, the School Library Educator's shift from tech support to full co-instructor was cemented early in the minds of teacher candidates. While the Teacher Educator was responsible for introducing the scientific content, starting with the Physical Elements pre-assignment, the School Library Educator was introduced as a co-instructor responsible for helping teacher candidates create instructional skits (Physical Elements), and an instructional video (GID unit final product). Consistently throughout design cycle 3, candidate questions directed at the School Library Educator were both tech related and inquiry based. In addition, the Teacher Educator often asked the School Library Educator to address the class and describe best practices for selecting and introducing key concepts through video. Finally, in an expansion of the School Library Educator's role in assessment, the Teacher Educator included the School Library Educator's feedback on inquiry journals in her tabulation of final GID unit grades.

Evaluation of Guided Inquiry Design and co-teaching experience. After design cycle 3, the Teacher Educator and the School Library Educator reviewed inquiry journals, rubrics, any student questions emailed to both instructors or posted on the course's virtual discussion board, and final video productions, along with a significant review of the co-teaching experience itself. The completion and evaluation of three design cycles brought out the importance of the structure provided by GID to both student learning and as a foundation for role establishment in a co-teaching relationship. Regarding student learning, we found the more we adhered to the scaffolding recommended in the Guided Inquiry model, the more teacher candidates shifted their efforts from an expedient completion of the GID video to the process and journey of inquiry itself.

We especially noted this effect when stricter guidelines and authentic materials were put into place during design cycle 2, and observed it grow with the addition of the five key terms requirement in design cycle 3. Adding these components fostered the School Library Educator's role as co-instructor, expanding it from the minimal technology-support role present in design cycle 1. As the Teacher Educator and School Library Educator increased the inquiry process time in the course calendar, the co-teaching structure was also supported with increased time dedicated to daily teaching reflection, professional exchanges, and formative assessment discussion—all contributing to the success of changes implemented in both the unit's design and in co-teaching responsibilities for design cycles 2 and 3. Along with previous research examining instructional intervention to improve student inquiry, we found both the inquiry model and the co-teaching structure introduced in GID essential in helping us "recognize critical moments when instructional interventions are essential in students' information-to-knowledge experiences" (Kuhlthau, Heinström, & Todd, 2008, para. 9).

Conclusion

The purpose of this study was to examine the process and challenges inherit in designing and modeling Guided Inquiry units of instruction, through a school librarian instructional partnership model, in pre-service teacher education. To that end we asked, "What aspects of the Guided Inquiry co-teaching experience were considered important as faculty made decisions about designing and revising the instructional unit?" Three cycles of design affirmed the importance of a framework to the inquiry process. The structure provided by GID proved not only necessary for teacher candidates to develop professional and accurate videos introducing force and motion, but also to engage in fruitful information-seeking and information-curating.

Another aspect of importance identified in this study was the expansion of the School Library Educator's role as a co-instructor, and recognition of that expansion by the Teacher

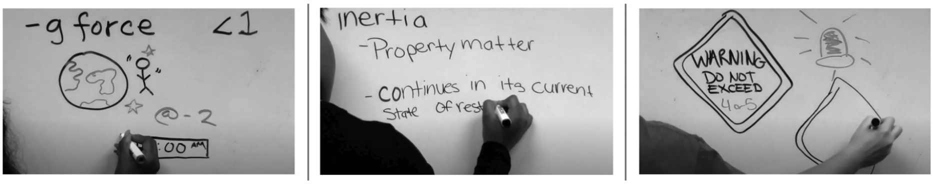

Figure 4: Teacher candidate video applying whiteboard animation techniques

Educator. This resulted in a stronger alignment between technology expectations and academic content needs as device options and video requirements were streamlined in design cycles 2 and 3. Finally, the use of real-world templates and materials and inclusion of real-world experts (e.g., American Film Institute, interview with rollercoaster engineer) motivated teacher candidates to engage in meaningful and authentic learning, as evidenced by increased effort and detail recorded in storyboards, inquiry journals, and videos (see Figure 4).

Once designated storytellers and information resource providers, today's school library education programs graduate professionals who are experts in information literacy and curriculum alignment, prepared to co-plan, co-teach, and co-assess (Montiel-Overall & Jones, 2011). Even so, establishing instructional partnerships with classroom teachers is challenging due to common constraints including lack of personnel, budgetary shortages, scheduling, and a misunderstanding of the role of the school librarian. As evidenced by the field of research and conference foci over the past two decades, technology integration specialists, administrators and library professionals continue to struggle with the concept and implementation of instructional partnerships (Lamb & Johnson, 2008; Moreillon, 2013; Baker, 2016), despite the same body of work touting these relationships as being crucial to student understanding of the research process (Kuhlthau, 2010) and student academic achievement (Rawson, Anderson, & Hughes-Hassell, 2015).

Findings from the present study indicate Guided Inquiry units co-taught by school library educators and teacher educators help teacher candidates both successfully navigate the research process and develop a mental model of the school librarian as a co-teacher. Further research examining the impact of modeled instructional partnerships on teacher candidate willingness to collaborate with a school librarian post-graduation, as well as addressing different university program structures from College of Education housed school library programs, is needed. In addition, research exploring how instructional partnerships between school library educators and teacher educators better equip school library educators to address challenges inherent to the instructional partnership structure in school library preparation curriculum would help fill a significant gap in the current literature.

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