Ingenuity in the Pandemic: A Cross-Course Science-Literacy Integration Project

Brittany E. Kiser, Lynn University, United States
Kelly A. Burlison, Lynn University, United States

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Abstract
When faced with compressed hybrid courses amidst the pandemic, two university teacher educators sought to leverage the opportunity into an innovative, collaborative project to increase authentic learning experiences for their students. Pre-service teachers in one elementary literacy and one elementary science education course collaborated on a science-literacy integration project, bringing their content expertise and shared understanding of strategies to modify and improve existing lessons to equally involve reading and science. The result of this integration project proved to benefit students in their presentation skills, experimentation skills, and teaching modalities, while gaining a new perspective of our intellectual climate. Within this article, the authors seek to establish the importance of incorporating science education into the literacy curriculum of pre-service teachers, as well as to share reflections on experiences, work, and insights of those pre-service teachers already exposed to these studies.

Keywords: Literacy and Science Integration, Pre-service Teachers, Virtual Instruction, Collaboration, Elementary

Introduction

As teacher educators, it is essential that the focus is not only to prepare pre-service teachers to be impactful in the K-12 classroom, but also to regularly reflect on the power and influence exerted on future generations of students in doing so. The teacher educator's role is to recognize and utilize this power to mold pre-service teachers to be cognizant of the injustices in this world and how education can change them. Not only will current pre-service teachers be educating K-12 students with exponentially increasing technological skills; educational research also suggests the importance of blending curricula across the content areas, as opposed to teaching within segmented silos (Romance & Vitale, 2016; van Zee, Jansen, Winograd, Crowl & Devit, 2013).

To begin with, science, when implemented in the classroom effectively, involves a great deal of critical thinking, real-world application and transdisciplinary content. Students must be adept at research, interpret, read, apply mathematical concepts and communicate both orally and in written format. In other words, immersion in science activities necessitates the 21st century skills that global market leaders insist our future workforce have. The United States Bureau of Labor Statistics projected that careers in STEM fields would grow by approximately one million more by the year 2022 than those in 2012 (Vilorio, 2014). If this proves to be accurate, today's students require, at the very least, exposure to the science fields, which may realistically be their future career. However, increasing pressures of accountability in elementary schools, with a particular focus on mathematics and English language arts, leaves little room for science education (Webb & Rule, 2014). This issue of concern is compounded when elementary students matriculate to the secondary level, now woefully unprepared for the rigors of scientific thinking and content at this standing. Given that research has shown students' general academic interests to decline from elementary to middle school, the average student is not likely to seek out the foundational science concepts necessary for success on their own (Schunk, Pintrich, & Meece, 2013). When considering the role of schools in society, it is clear that schools are, at the very least, intended to produce students that are capable, productive, happy citizens. If current career projections and research are to be taken into account, and we do wish to meet the aforementioned goal, the increased participation in science activities, clubs and courses is indisputable. The integration of science and literacy instruction in early years may be the beginning of this journey toward student success in future science education; thus our pre-service educators must be familiar with this process of integration in order to effectively teach it in their own elementary classrooms.

However, it is not enough to merely add science content within the reading block or vice-versa, lest we inadvertently negatively impact student achievement. One of these practices which has particularly been studied is reading from the textbook. In a study attempting to correlate course grade and score on the American College Testing (ACT) college readiness assessment with time spent reading the textbook in high school Biology, the amount of time spent reading the textbook in class was found to be neither a predictor for course grade or achievement on the ACT (Wyss, Dolenc, Xiaoqing and Tai, 2013). In a similar manner, it was determined by Su (2014) that the sole act of reading from the textbook in United States middle school science classrooms is associated with low performance on the Trends in International Mathematics and Science Study (TIMSS). Thus, it is essential that instruction and activities in pre-service teachers' classrooms are carefully planned to integrate science content and literacy education at a high cognitive level which may later be transferred to the K-12 classroom as discussed above.

Background

The COVID-19 pandemic presented a number of unique challenges to educators over the past year. In higher education, institutions which had primarily provided face-to-face instruction were required to shift to blended and online instruction in mere days (Paudel, 2021). At the university site where this science-literacy integration project was implemented, the administration developed an innovative scheduling format to address these challenges, ensure continued learning and overall maintain a safe environment for faculty, staff and students. In an effort to meet the aforementioned goals, the four-week term was created. To minimize contact with other individuals across the university, students took no more than two courses per four-week term and were split into groups, alternately attending class face-to-face and via a Zoom Cloud Meeting, to curtail the number of individuals in a classroom at a given time. This form of blended learning has been shown to be effective in higher education settings (Paudel, 2021). In addition, instead of meeting two or three times per week with a professor, the format involved class meetings for 150 minutes at a time, Mondays through Thursdays. Within this novel schedule, students maintained the standard instructional hours but with less exposure to others, alongside required face masks and increased sanitization and social distancing, thus a higher safety factor. As practitioners of education, the professors authoring this paper recognized the value and significance of providing students with a unique opportunity under such circumstances.

Within one term, one professor taught *Literacy in the Primary Grades* during the same time block in which another professor was teaching *Science in the Elementary School*, both required education courses for pre-service teachers enrolled in this institution. The professors collaborated on the development of an assignment that consisted of an interactive peer-teaching presentation in which aspects of a science-literacy integrated curriculum were shared. Both believe that by introducing science and literacy curricula as an integrated unit rather than stand-alone subjects, students can link personal experiences to concepts, develop connections across content and draw conclusions. The goal of this collaborative, integrated project was to engage pre-service teachers in hands-on activities and discourse surrounding the efficacy of science-literacy integration programs in the teacher preparation program setting. The pre-service teachers presented various exemplars of their lessons and insights, which foster an emphasis on student voice and student choice through the use of technology.

Materials and Methods: The Approach

The literacy professor had become aware of a set of curriculum created by a community partner, built around science and STEM concepts alongside a literacy component. These activities were developed with the goal of helping children to "build on prior knowledge, promote curiosity and [help children] learn important cooperation and teamwork skills" (Literacy Coalition of Palm Beach County, 2021, para. 1). The activities were leveled, one for grades K-2 and one for grades 3-5, each focused on a different topic that can be applied to a science concept, such as bubbles and windmills. The curriculum for each included a nonfiction text, hands-on activity and brief description of the science behind the activity. The literacy professor took note of the teaching opportunity offered through these activities and taught students to align the STEM stories to a well-written lesson plan aligned to state standards, learning objectives, literacy instructional strategies and assessments. The students partnered with a community literacy program that provides reading activities to after-school children. The children participate in fun and engaging reading lessons, hands-on activities and introduce young creative minds to various ways of thinking and exploring the world

(Literacy Coalition of Palm Beach County, 2021). The community literacy program needed assistance with providing state standards to their STEM stories as well as an extended learning activity that can help promote curiosity while building teamwork and collaboration.

Planning for Collaboration

As the students had been working toward demonstrating mastery of content and instructional strategies through the development of effective lesson plans in their respective courses, the professors planned for the students to spend one, 150-minute class meeting with both classes together. With various students meeting for class in two different Zoom Cloud Meetings and two different classrooms, the professors felt it would be most productive to have all students from both courses meet online in a single Zoom Cloud Meeting. This would allow for all students to receive the same instruction, exchange contact information as needed, and provide time to begin work on this collaborative project, with the rest of the task to be completed outside of class and due nine days later. The professors further determined to utilize the Gradual Release of Responsibility instructional framework for this task, popularized by Pearson and Gallagher (1983), in which the activity would be modeled with feedback prior to setting the students to work on their own.

Students were enrolled in either *Science in the Elementary School* or *Literacy in the Primary Grades*. Between the two courses, there were a total of 24 students, which were broken into five collaborative groups-- four groups of five students and one group of four students. Having the advantage of familiarity with their students' abilities, strengths and deficiencies, the professors were able to select the group members to account for and balance the known capacities. For example, students with the most solid lesson-writing skills were assigned to different groups, as were those with strong points in the varied content areas. Each group contained at least two students from the literacy course and two students from the science course.

Modeling the Collaborative Process

Being part of a small university and an even smaller college, education majors frequently take their courses with the same individuals, getting to know their cohorts over time. To ensure the students recognized one another in this virtual environment, the professors began the first of the two-class meetings with a brief activity, requesting that each student identify one individual in the opposite class with whom they shared something in common and to share this in whole-group format. Once familiarized, the students were introduced to the collaborative project, followed by a brief explanation by the literacy professor regarding the work already completed in this course, as discussed above. The science professor then discussed the importance of incorporating an aligned science standard alongside the activity and variations on the provided activities to make these suitable for use in a virtual or hybrid classroom environment, such as those created by the pandemic. The students were then split into Zoom Cloud Meeting breakout rooms with the following instructions: In their respective small groups, the literacy students were instructed to share their starting activity along with the literacy standard and informational text selected to correspond with the lesson. The group would then work together to modify or alter the initial activity for a digital learning environment and to seek an appropriate state science standard that corresponded with both the informational text and the activity. During this time, the professors moved from breakout room to breakout room to provide clarification and guidance. When completed, all groups

returned to the main room to share what they had come up with and to receive feedback, comments and suggestions.

The Task

At the conclusion of the modeled activity and critique, each group was assigned a new topic from the community partner supplied list that was not previously covered. Each topic included two starter activities and a fictional text. Student groups were tasked with developing six lesson activities, one for each grade level K-5, with each to include:

- an aligned state literacy standard
- an aligned state science standard
- an informational text which corresponded with the science topic and state literacy standard
- a virtual adaptation of the activity for the online classroom, appropriate for the grade level, which aligned with the state science standard, and
- an assessment addressing both content standards.

Students were encouraged to consider how the content and skills of each lesson would build upon one another across grade levels. The Zoom Cloud Meeting breakout rooms were then re-opened to allow the small groups to begin their work. Once again, the professors shifted from room to room to ensure students did not have any questions on the assignment and to provide guidance and suggestions as needed.

All students returned to the whole group one final time to revisit the assignment instructions, ask for clarifying information and complete a brief closing activity. For the summary question, students responded to the prompt "Name one skill you practiced today." via an online application that processed the answers into a word cloud, making trending responses larger in font than those less prominent. Key themes identified from this short evaluation included the following terms: teamwork, creativity, literacy.

Results: Lessons Learned

Nine days later, the two classes met once again in a single Zoom Cloud Meeting for an intended 150-minute timeframe, in which each group would present for all students their six lesson activities as described in the previous section. After each presentation, the class and professors would pose probing questions and provide feedback regarding what was shared. Ultimately, this process took over 180 minutes, thirty minutes beyond the allotted class time.

The professors felt it was vital that the pre-service teachers recognize the value in cross-curricular instruction in the elementary classroom, particularly with regard to the integration of science and literacy instruction, thus while other groups presented, each individual student completed a professor-developed graphic organizer of "glows and grows" for each group, referring to the strengths and weaknesses of the shared lessons as shown in Figure 1 on the subsequent page. The objective of this particular task was to actively engage the pre-service teachers in examining the components of the science-literacy integration lessons developed by their peers in comparison to those of their own group. Students then submitted these graphic organizers for a grade at the close of the presentations.

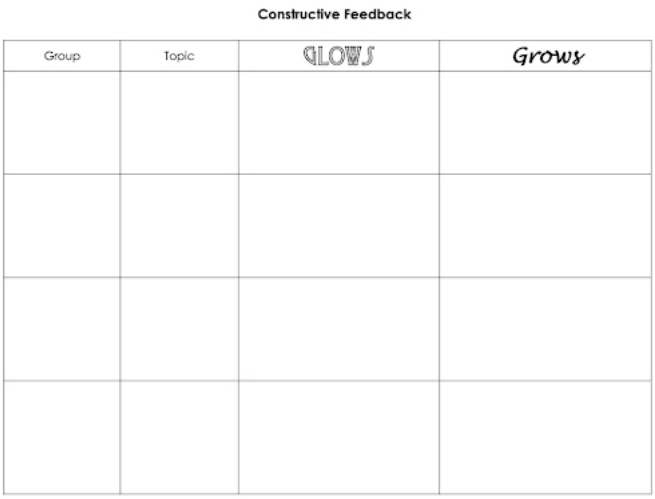

Figure 1: "Glows and Grows" Graphic Organizer

At the close of the presentation and feedback portions of the class meeting, all students were instructed to complete a brief reflection, in which they identified which set of lessons best exemplified science-literacy integration. Students were then to send a private message using the Zoom Cloud Meeting chat feature to their professor of recording indicating their response. Interestingly, the general consensus of answers aligned with the viewpoint of the professors, indicating that students were able to identify those groups of lessons that were best integrated, despite not being as successful at creating these themselves. The professors met together afterward to debrief and reflect upon the science-literacy integration project, discussing the merits of and lessons learned from this experience. The professors worked through each set of submitted group lessons and peer feedback graphic organizers, together examining, grading and providing written evaluations.

The professors learned valuable information regarding the performance of their respective students through these activities, which would not have been apparent without this collaborative project. The nature of this assignment involved higher-order thinking skills, wherein it was noted that some students struggled. A typical misconception that both professors noticed were the use of the state standards, how they aligned to the lesson, and the appropriateness of grade level activities. The professors were aware that students had some difficulty unpacking the standards; however, it was evident that students did not understand how to combine standards that were cross-curricular and provide grade-level activities and assessments upon questioning and requested explanations. This collaborative project allowed the professors to delve deeper into the lesson plan and provide specific feedback on scientific knowledge, literacy instruction, assessment and strategies for incorporating all within a single lesson. By integrating both science and literacy, the professors found that students were more likely to master both disciplines and would apply this type of interdisciplinary instructional methods to their future classrooms.

Discussion: Analysis and Insights

Several implications emerged following the analysis related to this science-literacy integration project that can help explain students' growth. In examining the students' peer feedback, such as those shown in Figures 2 and 3[1] below, common themes included

[1] Written permission to use the student work has been secured from each student.

appropriateness of activity to grade level, alignment of assessment to standards, alignment of standards to grade level, connection between informational text and science standard. Interestingly, as the majority of student participants most often noted these aspects, the authors wonder if this is due to simplicity, a certain apparentness, or merely that these are components most often focused on throughout the college of education courses.

Topic	GLOWS	Grows
Wind	Their activities were relevant to the topic	Standards that aling and add more visuals
weather	Very orgnized, books were relevant to the topics	Activities that are more easy or hard according to grade level
Owls	their activities were appropiate to the grade levels.	Standards were not aligned.
Gravity.	The assessments were appropiate and matched the standard.	reading portion and activities were ok.

Figure 2: Sample student A completed feedback graphic organizer

Topic	GLOWS	Grows
Weather vanes	*Activities with KAHOOT use great questions They used a lot of class discussions to help keep students informed.*	*More specific on class discussions and linking to the literacy standards*
Kinetic and Potential Energy	*Activities were great to use for each grade and allowed for different activities to work well with the content*	*More clearly explain their activities and the connection to the standards and how it is used virtually as well.*
Owl Pellets	*I really enjoyed the field trip idea for Kindergarten and using flipgrid as a good virtual assessment for students*	*Have more clear connections with the reading standards and how it will play a part in the lesson*
Gravity & Motion	*Using a graphic organizer is a fantastic idea They really help with students to learn more vocabulary, build on their knowledge and be used as a guide for help*	*Assigning the standards to the assessments and activities is again important. After all groups have gone I've noticed this to be a overall challenge for everyone*

Figure 3: Sample student B completed feedback graphic organizer

In contrast, the professor's evaluation of the groups' work focused on differing core similarities. Noted strengths of the various group projects included: strong selection of informational texts to align with the science content, incorporation of nature of science standards alongside the content standards (physical science, earth/space science, life science), and interactive read-alouds which made good use of the strategies taught. Flaws and opportunities for growth were also explained to each group and as teachable moments to all students on the whole, which most notably encompassed the following skills: reading and understanding what the standard is asking the student to do in order to align properly to

activities and assessments; ensuring activities can be realistically applied to the online or hybrid learning environment; developing clear connections of all components within the lessons to the standards; taking age-appropriate vocabulary and instructions into account; including a separate, science-focused activity; and creating assessments which are separate from the learning activities. Ediger (2010) stated that it is essential that school students are able to utilize the knowledge gained from ongoing reading experiences and apply this knowledge to other educational situations. Because students in today's society spend such little time on reading during their daily lives, a struggling reader is often not engaged in prior literacy experiences (Biancarosa & Snow, 2006).

Conclusion

If it is the goal of education to prepare students for future careers, it is clear that both literacy and science must be a strong component of the curriculum. Odom and Bell (2015) stress the need to better understand the associations among teacher demonstration lectures, student attitudes and the subsequent student performance in science courses. In a similar strain, Su (2014) recommends a study of classroom science instructional approaches through observation, an in-depth analysis of educator perceptions related to science teaching and a review of student perspectives with regards to science education and cultural background. Moreover, it is suggested that there is a need for science education worldwide to increase the level of cognitive demand upon our students (Calado, Neves & Morais, 2013). Similarly, in the United States, only 31% of 8th-grade and 12th-grade students met the NAEP reading proficiency standard for their respective grade levels (Fritz et al., 2009). Therefore reading instruction throughout the country has failed to meet the proficiency mark as well. It is necessary for all students to receive interventions that will help them attain the foundational academic skills that are essential for college and career readiness (Just Read! Florida, 2011). One method to do so is to promote further study into the maintenance of high caliber metacognitive demand between curriculum standards and curriculum delivery (Calado, Neves & Morais, 2013).

While current research continues to point to the importance of cross-curricular integration in the K-12 classroom setting, teacher education programs must proceed to do the same. Research has articulated a demand for higher quality teacher preparation and professional development programs, which may be exacerbated by the traditional teaching methods to which educators were themselves introduced (Kiser, 2018; Odom & Bell, 2015). Pre-service teachers cannot be expected to successfully design and implement units of instruction that address more than one content area unless they are taught the whys and hows and allotted the opportunity to practice these vital skills within their preparation coursework. The pre-service teacher must be furnished with appropriate intellectual challenges which empower them to engage with material and construct their individual understanding while employing and applying transdisciplinary connections (Bruner, 1960). This includes providing the time to collaborate with peers, experiment with technological resources and develop presentation aptitudes, all with the support of continuous, specific feedback. This paper has described one such project of literacy and science integration, which has demonstrated the value of educating pre-service teachers in the art of integration, an impossible feat sans the successful collaboration of professors as well as students. When pre-service teachers are encouraged to work together in applying technology, science content and literacy strategies in an equally balanced lesson to state standards, students expand their understanding of all that is involved.

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Contact email: bkiser@lynn.edu