

The Periodic Tile Project: Exploring the Elements With Teacher Candidates Through Science and Art

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Abstract

Studies have shown that teacher candidates enrolled in teacher preparation programs, particularly those in early childhood and elementary certification tracks, do not feel comfortable with science content or feel confident in their ability to teach science effectively as they enter student teaching. The Periodic Tile Project is an interdisciplinary project and performance assessment that takes an essential component of the chemistry curriculum that is often treated as a static tool to be memorized and brings the dynamic facets of the elements to life through the integration of science and art. Integrating science and art in performance-based assessments has been shown to increase engagement, self-motivation, and sense of ownership and enhance expression and communication skills in K–12 students. It can provide the same benefits to science teacher candidates. This article describes the use of the Periodic Tile Project with teacher candidates to explore the elements in a fun, meaningful, and memorable way.

Introduction

Studies have shown that teacher candidates (TCs) (also referred to as preservice teachers) enrolled in teacher preparation programs, particularly those focusing on elementary grade levels, do not feel comfortable with science content or feel confident in their ability to teach science effectively as they enter student teaching (Brígido et al., 2013; Gunning & Mensah, 2011; Palmer, 2006). These studies align with the results of the 2018 National Survey of Science and Mathematics Education (NSSME+; Banilower et al., 2018). Of the elementary teachers surveyed in the 2018 NSSME+, “only 31 percent feel very well prepared to teach science,” as compared to “77 percent for reading/language arts” (p. 31). Additionally, only 38% of middle school teachers, on average, felt prepared to teach science (pp. 33–34). Recognizing this frustrating trend, science methods instructors implemented an interdisciplinary project exploring elements, the periodic table, and their connection to the arts.

The notion of integrating science and the arts—and going from STEM (*Science, Technology, Engineering, and Mathematics*) to STEAM (with the added *A* for *Arts*)—is not new and is one of a host of modified versions of STEM. Modified versions of STEAM include but are not limited to STEAMIE (with the added *I* and *E* for *Innovation* and *Entrepreneurship*,

respectively) and two versions of STREAM—one in which the added *R* is for *Reading* or *wRiting* and another in which the *R* is for *Robotics* (Bequette & Bequette, 2012; Burrow & Cross, 2019; Maslyk, 2016).

Unfortunately, there is minimal literature on science–art integration that addresses the needs and foci of science teachers and science teacher educators, as opposed to elementary and secondary students and teachers. More specifically, the literature on science–art integration written with teacher candidates and teacher educators in mind often describes why such integration is important without addressing how to achieve it. Further, there is insufficient literature on the consequences of science–art integration on teacher candidates’ science content knowledge. As a result, teacher educators interested in incorporating science–art integration into science methods courses are left to fend for themselves and use strategies that may not be appropriate or effective for their teacher candidates.

This article addresses both the why and how of science–art integration via an activity conducted in science methods courses called the Periodic Tile Project (PTP). The PTP was originally developed and used in my high school physical science and chemistry classes. I have long been fascinated by the periodic table, and I frequently joked with my students that they should keep a copy of the periodic table close to their hearts because chemistry is more important than life itself. The purpose of the PTP was to reinforce specific science content knowledge while engaging students in a research project and sharing their research in a fun and creative way. The original project was inspired by the Periodic Table Project at the University of Waterloo (<https://uwaterloo.ca/chemistry/international-year-chemistry/periodic-table-project>) and shares student research aspects of the project described by Young (2007). I later adapted and integrated the PTP into both elementary and early secondary science methods courses.

As with secondary students, the original purpose of using the PTP with TCs was to reinforce content knowledge, engage in a research project, and share that research creatively. However, when used with TCs as part of a science methods course, the PTP also enables science teacher educators to model an effective strategy for TCs to use in their classrooms that could be used to initiate in-depth discussions on topics such as interdisciplinary teaching and learning, performance assessments, and rubric creation. In this article, I describe the process used to assign and evaluate the PTP in the context of an elementary science methods course. Student comments and feedback are provided to show that the PTP has had a positive impact on TCs on multiple fronts. Additionally, I discuss why it is important for science teacher educators to provide TCs with models and opportunities to make interdisciplinary connections between science and art. I share these experiences so that other science teacher educators may replicate this project with their own TCs.

Integrating Science and Art

Researchers note “that interdisciplinary work in the arts and sciences can lead to curricular components that combine aesthetic and analytical modes of thinking (Fitzsimmons, 2011) to the betterment of both science and art” (Bequette & Bequette, 2012, p. 43). The benefits of integrating art and science with K–12 students are well documented and include increased engagement, self-motivation, and sense of ownership as well as deeper thinking and questioning, enhanced expression and communication skills, and improved academic achievement (Frazier & Caemmerer, 2014; Hegedus et al., 2016; Maslyk, 2016; Merten, 2011; Sousa & Pilecki, 2013; Stellflue et al., 2005). Maslyk (2016) notes that the addition of the arts “to STEM learning enhances the existing opportunities for critical thinking, problem solving, and communication” (pp. 7–8).

Research has found that both TCs and inservice teachers experience many of the same benefits when planning and implementing integrated science–art lessons and assessments. Notably, Frazier and Caemmerer (2014) found that the integration of art and science compelled them “to consider new ways of looking at students and learning, actively seeking multiple modes of expression when designing learning experiences for our students” (p. 42). Additionally, Belardo et al. (2017) explain that “integrated learning experiences are an effective way to improve pre-service teachers’ self-ratings of knowledge and ability to develop and eventually engage their students with interdisciplinary connections (Medina-Jerez, Dambekalns, & Middleton, 2012)” (pp. 217–218).

However, researchers have also noted several challenges in integrating science and art. Maslyk (2016) and Sousa and Pilecki (2013) note that one of the biggest challenges is for both teachers and students to shift from convergent to divergent thinking. “Most students have experienced a school culture that is focused mainly on ‘getting the right answer and getting it quickly’” (Sousa & Pilecki, 2013, p. 46). Divergent thinking, for students, means that there is no longer one correct answer to every question. For teachers, this means that they must look beyond the answer key and encourage students to generate their own questions and devise means for answering them.

Another challenge is to ensure that the experience is purposeful and meaningful for teachers and students. “We need to ensure that we are making meaningful connections between subject areas” (Maslyk, 2016, p. 7). Like integrating technology into our classrooms, the integration of the arts into STEM should not be done for its own sake. Instead, combining science and art should be approached with a clear purpose and an intent to create an integrated experience that is fun, creative, and supports content knowledge learning.

The Rationale for the Development of the Project

The choice to focus on the elements of the periodic table was strategic. Beginning-of-course surveys ($n = 252$) revealed that when asked to rate their level of confidence with physical, life, and earth and space sciences, only 7% of the TCs reported feeling “very comfortable and/or confident” with content related to physical science as compared to life science (63%)

and earth and space science (30%). This mirrors results from the 2018 NSSME+ (Banilower, 2018). In that national survey, only 13% of elementary teachers reported feeling “very well prepared” to teach physical science, as compared with life science (24%) and earth and space science (20%; p. 32). Of the middle school teachers surveyed, 42% considered themselves “very well prepared” to teach chemistry, as compared with physics (20%), earth and space science (35%), and biology (49%; p. 34).

The survey also presented TCs with a variety of interdisciplinary combinations (e.g., science and art, science and math, and science and social studies) and asked them to rate their perception about which combinations could be easily integrated. Responses showed that only 6% of TCs perceived science and art to be “easily integrated” as compared to 42% for science and mathematics and 41% for science and English language arts. These statistics were not entirely unexpected. TCs noted in the discussion that science–mathematics links were commonly referenced throughout their schooling, especially with the rise of STEM. Additionally, the teacher preparation program at the University of Houston-Downtown does not offer a fine arts methods course, so there are limited opportunities to create interdisciplinary connections between different courses (Allaire et al., 2020).

For this reason, a variety of creative methods for engaging TCs in and reinforcing physical science content knowledge (e.g., basic chemistry, forces, motion, and heat or energy) have been integrated into science methods courses. As noted previously, the PTP, a crossdisciplinary, science–art project, was originally developed as a high school project and was adapted and integrated into my elementary science methods courses to support TCs.

The periodic table was chosen for this project because it is an essential tool in discussing elements and how they relate to other forms of matter, such as compounds and mixtures. As part of both the elementary and early secondary science standards and the science teaching competencies, TCs must have basic knowledge of the periodic table and its elements. Thus, the PTP complemented an instructor-led lesson on elements, compounds, and mixtures and demonstrated how TCs could engage and authentically assess their students in such a lesson.

Context and Participants

The University of Houston-Downtown is a 4-year university in Texas that is a federally recognized Hispanic-Serving Institution. Science methods courses are a required part of the teacher preparation program for all TCs and are based on the science teaching competencies outlined by the Texas Education Agency (TEA). These competencies also form the basis of the TCs’ content-based certification exam, and TCs must be able to demonstrate these competencies during field-experience lessons, student teaching, and beyond. The PTP was facilitated between the fall 2019 and fall 2021 semesters—with minor modifications made to accommodate the shift from in-person to online learning environments

during the COVID-19 pandemic. All the participating TCs were part of the early childhood through sixth grade (EC–6) or fourth through eighth grade (4–8) cohorts and were seeking either an English as a Second Language (ESL) or a bilingual education certification.

The PTP requires each TC to research an element from the periodic table, obtain specific information about that element, and use that information to create a two-dimensional artistic representation of their element. It is a creative, interdisciplinary, instructive, and authentic method for TCs to explore the elements as part of their science methods coursework, which can be facilitated in face-to-face classes and in synchronous or asynchronous online learning environments. The PTP is based on the science teaching competencies described by the TEA (2022) for EC–6 and 4–8 certification areas focusing on atoms, elements, and organization or properties of the periodic table. The PTP also addresses TEA Art Standard II —“understand[ing] the skills and techniques needed for personal and creative expression through the creation of original works of art”—as well as several Visual Arts teaching competencies such as selecting appropriate techniques to create art in various media, demonstrating knowledge of the element of art (e.g., color, shape, form, and space), and integrating instruction in the visual arts with instruction with other subject areas. Both science and fine arts competencies are areas that TCs must know for their content-based certification exams and must demonstrate during class- and field-based lessons, student teaching, and beyond.

The purpose of PTP, as explored in the present article, was: (1) to build and support TC science content knowledge; (2) to demonstrate to TCs that researching the periodic table could be relatively simple and fun; (3) to model the use of an authentic assessment, as opposed to a paper-and-pencil quiz, to gauge student knowledge and encourage creativity; and (4) to demonstrate the incorporation of multiple disciplines (science–art) into a single project. As a performance-based assessment, the PTP allows TCs to apply their knowledge and engage in a task—creating element-inspired artwork—using critical thinking and creativity (Flynn, 2008; Stoll & Schultz, 2019).

Several factors contribute to these survey results related to TCs’ lack of confidence in their physical science content knowledge. First, neither the university nor the teacher preparation program requires TCs to enroll in specific science courses such as chemistry or physics. Combined with a large nontraditional student population at the university with an average undergraduate age of 26.5 years (University of Houston-Downtown, Office of Institutional Research, 2020, p. 14), there are TCs for whom their last chemistry course may have been years ago in high school. Similarly, some TCs may have never taken a standalone high school or college physics course. This issue is compounded by an overwhelming focus on literacy in the university’s teacher preparation program that leaves limited time for other disciplines, namely science, mathematics, and social studies.

Stage 1: Elemental Research

In Stage 1 of the PTP, elements were randomly assigned to TCs to ensure that as many elements were researched as possible and that everyone had a different element. Depending on the total number of students, instructors may want to be strategic in which elements are in the element pool. In the final stage of this project, TCs' artwork is combined into a one-of-a-kind periodic table. For a smaller class, including all elements will result in sizeable gaps in the periodic table; therefore, instructors may want to focus on specific groups or families or on periods for a better visual impact.

Assigning elements can be handled in several ways. One option is to cut up a periodic table before class and have TCs pick elements out of a bowl. Another option is to use a deck of element cards and have TCs select randomly. Instructors can carry over the remaining elements to another class to cover more of the periodic table or offer students the opportunity to do additional elements as an extra-credit assignment.

A PTP template and rubric was provided electronically to the TCs to record their research findings and develop their artwork. The PTP template (see Figure 1) is a graphic organizer that guides students to research and write down necessary information about their element. (If you are providing a hard copy, I would recommend that the PTP template be printed on cardstock—unless you plan to mount the paper tiles onto ceramic tiles.)

The PTP template is a very flexible format and, when used in an elementary or secondary classroom, can be customized to make it age and grade-level appropriate. For example, the template for a high school or postsecondary chemistry course could be more technical and require students to research groups or families of elements, electron configurations, and various periodic trends. On the other hand, a PTP template for elementary students could be simple and limited to name, symbol, and state of matter.

A common concern by the TCs was that they would be graded on their artistic ability. Recognizing the varying levels of creativity, the PTP rubric (see Table 1) focuses on the purpose, image type, and supporting material used in developing the elemental artwork rather than artistic ability. This became an important discussion point, not only in relation to this specific project but also as part of a broader discussion on rubric design. The PTP rubric was adapted from visual communications rubrics used by the University of Houston-Downtown and University of Texas-Rio Grande Valley that draw from the American Association of Colleges and Universities' (AACU) *Oral Communication VALUE Rubric* (2018).

Figure 1

The Periodic Tile Project Template

Periodic Tile Project

The Periodic Table is a wonderful collection of diverse elements organized in a very logical manner. In this project, you will be assigned an element. Research your element to determine the basic information about your element listed below.

Name of your Element:	
Elemental Symbol:	Atomic Number:
Atomic Mass:	State of Matter at Room Temperature:
Discoverer:	Place of Discovery:
Year of Discovery:	How did the element get its name/symbol?
Common Uses for the Element: •	Interesting Facts About the Element: •

Artistic Interpretation

Use what you learned through your research to develop an artistic representation of your element using crayons, markers, paint, regular/colored pencils, etc. Your artwork must fit within the 4' x 4' square below, be two-dimensional, and include the element's name, atomic number, symbol, and your first name and last name initial. Your artwork will be graded using the rubric on the following page.

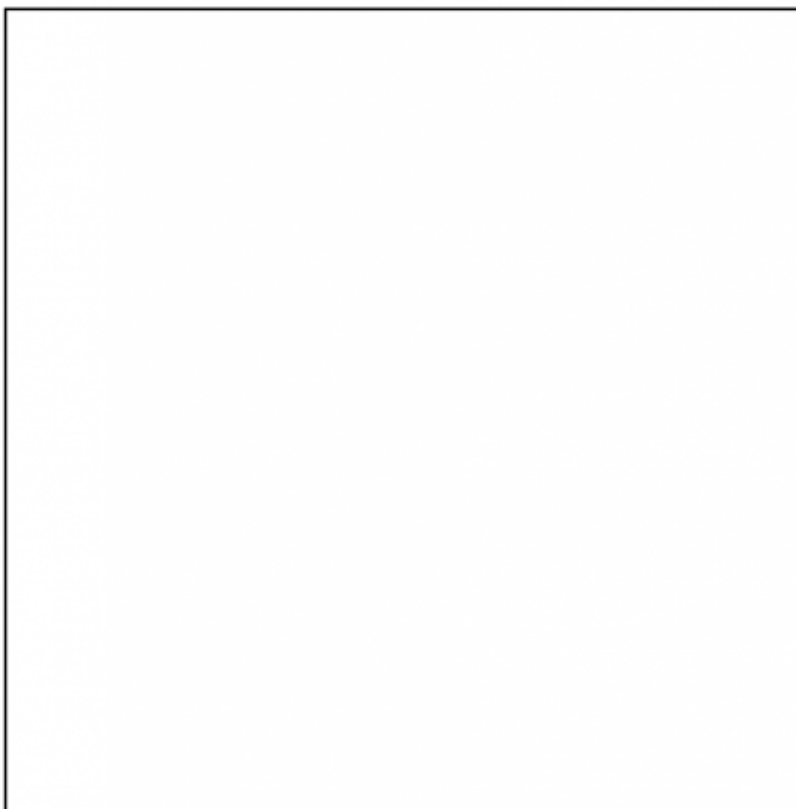


Table 1***The Periodic Tile Project Elemental Art Rubric***

	Mastery (4 pts.)	Proficient (3 pts.)	Developing (2 pts.)	Basic (1 pt.)
Required components	All required components of the elemental artwork in addition to the artwork itself (e.g., element name, symbol, and atomic number) are present and correct.	One of the required component is missing or written incorrectly.	Multiple required components are missing and/or written incorrectly.	All required components of the elemental artwork, aside from the artwork itself, are missing.
Purpose	The visual elements being used are especially effective, providing significant added value to the communication.	The visual elements are serving a clear purpose in the overall communication (e.g., they provide additional information or highlight key point).	It is not always clear what purpose the visual elements serve in the overall communication (i.e., some of the visuals may have a clear purpose, but others do not) or there may not appear to be a good reason to include some of the visuals.	The audience can't identify what purpose the visual elements serve in the overall communication or there appears to be no value added by the visuals.
Image type	Image choices are imaginative, clear, memorable, and compelling, easy to understand, and enhance the effectiveness of the work. Images are appropriate to audience.	Image choices are thoughtful, clear, easy to understand, and generally support the effectiveness of the work. Images are appropriate to audience.	Image choices relatively clear and easy to understand and partially support the effectiveness of the work. Images are appropriate to audience.	Image choices are unclear, difficult to make sense of, and minimally support the effectiveness of the work. Images are not appropriate to audience.
Supporting material	Supporting PTP research puts the visual elements into a clear context, which helps to foster a deeper understanding of the image's content.	Supporting PTP research fosters a good understanding of the image's content.	Supporting PTP research is not especially useful or informative in understanding the image's content.	There is little to no evidence that the student has made a connection between their PTP research and design choices.

Note. The rubric was adapted from the University of Houston-Downtown and Texas Rio Grande Valley's visual communications rubrics, both of which draw from AACU's Oral Communication VALUE Rubric (2018).

Many websites provide basic and complex information about each of the elements on the periodic table. The course website directed TCs to WebElements (www.webelements.com), Chemicool (www.chemicool.com), the Dynamic Periodic Table (www.ptable.com), and the University of Nottingham's Periodic Table of Videos (<http://www.periodicvideos.com>) to research their elements. The TCs were required to upload a digital version of their completed template to the university's course management program and to bring a hard copy to class on the due date. It is worth noting that the University of Nottingham and TED-Ed have collaborated on the Periodic Videos project (<https://ed.ted.com/periodic-videos>) to provide videos and lessons about each element and that the Dynamic Periodic Table also has lesson plans developed in partnership with the American Association of Chemistry Teachers and the American Chemical Society.

Stage 2: Research-Inspired Art Presentation

The culminating element-inspired art presentation was held during a regularly scheduled class. Each TC presented their work to the class using a document camera to exhibit it on the display screen. The TCs' presentations featured their elemental research and a formal presentation of their artwork with an opportunity to explain the inspiration behind their work and the research–artwork connection. Figure 2 shows a completed PTP template for the element Indium. In their design, the TC used the interesting fact that indium “screams” when

bent as the artwork's inspiration. For many TCs, the properties and uses of the elements served as inspiration for their elemental artwork—for example, using hydrogen as rocket fuel, americium in smoke detectors, cobalt to create a blue color in glass, and bromine in film (see Figure 3).

The art presentation works best as an in-person class event; however, instructors can also facilitate it effectively online. During the spring 2020 semester and beyond, when courses were forced to shift from face-to-face to online due to the COVID-19 pandemic, TCs presented their research inspired-artwork during class via Zoom.

Figure 2

Example of Completed PTP Template With Artwork

Periodic Tile Project	
The Periodic Table is a wonderful collection of diverse elements organized in a very logical manner. In this project, you will be assigned an element. Research your element to determine the basic information about your element listed below.	
Name of your Element: Indium	
Elemental Symbol: In	Atomic Number: 49
Atomic Mass: 114.818	State of Matter at Room Temperature: Solid
Discoverer: Ferdinand Reich and Hieronymus Richter	Place of Discovery: Freiberg Mines (Germany)
Year of Discovery: 1863	How did the element get its name/symbol? Name comes from the Latin "indicum" meaning violet or indigo
Common Uses for the Element: • Coat the bearings of high-speed motors • Make mirrors that are as reflective as silver mirrors • Make low melting alloys • Make flat-panel displays, touch screen devices and LEDs	Interesting Facts About the Element: • Gives a high pitched "scream" when bent • Very soft metal and can be scratched with your nail and cut with a knife • In its purest form it can be very sticky

Artistic Interpretation

Use what you learned through your research to develop an artistic representation of your element using crayons, markers, paint, regular/colored pencils, etc. Your artwork must fit within the 4' x 4' square below, be two-dimensional, and include the element's name, atomic number, symbol, and your first name and last name initial. Your artwork will be graded using the rubric on the following page.



Figure 3

Examples of Research-Inspired Elementary Artwork



In both face-to-face and online art presentations, classmates were encouraged to ask questions about the artwork and express what they liked about each piece of elemental artwork. After the presentations, the artwork was set up around the classroom, and TCs participated in a gallery walk. Like a conference poster presentation, the gallery walk is an opportunity for TCs to view each other's work up close. I provided sticky notes to the TCs and invited them to leave critical and constructive feedback for their peers using the following guidelines: (1) comment on specific aspects of the artwork that you liked, (2) ask questions about parts of the artwork that you did not understand, and (3) make specific recommendations for improvement. Unfortunately, this part of the project was not experienced when students presented in online environments.

Stage 3: Combining Artwork to Create a One-of-a-Kind Periodic Table

Stage 3 of the PTP involved combining the TCs' elemental artwork to create a one-of-a-kind periodic table. Prior to the pandemic, the tiles were combined on a large table in the classroom designated for science methods courses and left on display for several weeks. The display enabled TCs across multiple course sections to admire their work and the work of their peers. The display also served to encourage other science methods instructors to integrate this project into their science methods sections. During the pandemic, digital versions of tiles were stitched together into a single document that was shared during class and emailed to each of the TCs.

Although standalone pieces of elemental artwork are eye-catching and thought-provoking, seeing the artwork together as parts of the entire periodic table is guaranteed to stop people in their tracks (see Figure 4). As of this writing, the university is returning to face-to-face

learning, and various activities, including a student art show, are resuming on campus. I look forward to mounting the TCs' artwork to show it in the annual university student art show and then put it on display in the College of Public Service, which houses the education department and teacher preparation program. Thus, the PTP can serve as a creative inspiration to students across campus and future teacher candidates.

Figure 4

Elemental Artwork Combined Into a Complete Periodic Table of Elements



As noted previously, if you are planning to provide hard copies to students, I would suggest that the art template be printed on cardstock because it is more durable, which will help when displaying the artwork individually and collectively. If, however, you are interested in a more permanent display, you could consider mounting the artwork onto actual 4' x 4' ceramic tiles using a glue sealer such as Mod Podge. If mounting the artwork onto a ceramic tile, use regular printer paper for the template because paper adheres to tile better than cardstock.

Project Comments and Feedback

Quantifying the impact of the PTP was difficult because a project-specific, pre-post survey was not given to the students. Neither the blinded university course evaluations nor the internal science methods end-of-course surveys distinguished between different assignments and activities and their impact on TCs. Additionally, it is difficult to determine the long-term impact of this project and whether TCs used the science-art integration experience from the PTP during their student teaching and beyond. However, themes regarding this project were gleaned from formal and informal discussions with TCs.

Additionally, TCs took it upon themselves to cite PTP as one of their favorite activities from the science methods course and expressed their appreciation for the opportunity to showcase their creativity. General comments regarding PTP included the following.

- “The periodic tile was my favorite assignment because it allowed me to be creative.”
- “My favorite assignment was the periodic tile! I had never done an assignment like it. I loved putting my representation of the element on the tile.”
- “The periodic tile. I think it’s interesting on how you get to know the symbol and what it does or what product has that chemical.”
- “Periodic Tiles! I enjoyed the art aspect!”
- “The periodic tile project; it was so unique, engaging, and fun.”
- “My favorite assignment was the tile because I got to be a little creative.”
- “Periodic tile project—it gave me a great idea for my classroom.”
- “My favorite assignment was the periodic tile project. It involved art, and I love to draw!”

Impact on Science Content Knowledge

In discussion and feedback, many TCs came away with a greater appreciation for and a better understanding of the elements and the periodic table beyond, as one student put it, “just something to memorize and use only in a chemistry class.” As noted previously, chemistry is one of the more challenging topics for TCs to grasp. However, TCs explained that the PTP, coupled with minilessons and PhET Interactive Simulations (<https://phet.colorado.edu/>), helped them understand subatomic particles (protons, neutrons, and electrons) and their connection with concepts like the atomic number and atomic mass of elements. Thus, the PTP becomes an enhancement to the science content. After quantitatively researching and learning about elements and the periodic table, TCs were able to qualitatively depict their knowledge through artwork (Merten, 2011). One TC explained that they “never realized that the periodic table is kind of cool,” and another TC added that this project “really piqued my curiosity, and now I want to know more about the different elements.”

Moreover, the PTP motivated TCs to explore and make connections related to the elements’ physical and chemical properties through their research. For example, TCs who researched members of the alkali metal family (e.g., Li, Na, or K) or noble gas family (e.g., He, Ne, or Kr) found it interesting how all their elements’ properties were similar. This led to several discussions on why Hydrogen (H) is placed where it is on the periodic table, how the periodic table is organized overall, groups or families of elements vs. periods, and concepts like periodicity. Although these topics are beyond what TCs seeking EC–6 certification are required to know, TCs felt that a clearer understanding of these concepts filled in some knowledge gaps and would aid them in teaching chemistry-related topics in the future.

As noted previously, it is difficult to quantify the impact of PTP, particularly because a project-specific, pre–post survey was not administered. That being said, TCs were asked to reexamine their comfort or confidence levels at the end of the semester. This end-of-course survey revealed the percentage of TCs who reported feeling “very comfortable and/or confident” with content related to physical science increased from 7% to 22%. Although far from definitive, this is evidence that the PTP may have had a positive impact on TCs’ content knowledge and confidence in their ability to teach science.

Pedagogical Impact

The previously discussed comments show that TCs enjoyed making interdisciplinary connections through the PTP. They appreciated the opportunity to express what they learned creatively by connecting science with art—“two disciplines,” according to one student, “that I would not have thought about linking but complement each other very well.” In the same end-of-course survey, TCs’ perception of science and art as disciplines that can be “easily integrated” increased from 6% to 12%. One student noted that they liked “getting away from having a quiz or writing another paper. I appreciated using art to express what I learned, and my students will too.” Several TCs also noted that this was an opportunity to explore the fine-arts-related competencies they also need to know for their certification exam. The research also led TCs to make other interdisciplinary connections, particularly with social studies, by learning about various elements’ history (Stokes, 2001). According to one TC, the social studies connection made the periodic table “much more interesting and ‘real’ because of the people and places associated with different elements.”

TCs also noted that the idea of developing rubrics and using performance assessments was daunting for up-and-coming teachers. One TC commented that “performance assessments always seemed so complicated. Quizzes and tests are much easier to grade.” However, students acknowledged that performance assessments, such as the PTP, create avenues for multiple modes of student expression by enabling their students to express their ideas visually (Flynn, 2008; Stoll & Schultz, 2019). A common theme in discussions was how TCs appreciated the simplicity of the PTP, particularly the template, with many planning to use it as a model for performance-based assessments with their students. As noted previously, TCs also enjoyed the fact that the rubric did not include a score related to artistic skill. Many felt the lack of judgment allowed them to be more creative than they might otherwise have been: “Allowing us to be artistically creative was like how we were encouraged in the course to be scientifically creative through inquiry.”

Conclusions and Implications

The Periodic Tile Project is an ideal performance assessment for science methods courses and postsecondary science content courses. I hope that the project description and TCs’ responses will inspire other science methods instructors and science teacher educators to integrate science and art as part of their coursework. Additionally, I hope that the TCs’

science–art integration experience through the PTP inspires them to actively create interdisciplinary connections with their students to support children’s learning in multiple subject areas and to create more meaningful learning experiences.

The science–art integration created enthusiasm, motivated TCs to study the elements, and enhanced both content and teaching methods (Merten, 2011). Frazier and Caemmerer (2014) described the results of their inclusion of art into science, saying that it “fostered ownership, engagement, and creativity” (p. 43), and we found the same to be true of the application of elemental knowledge to our students’ artwork. The individual artwork and one-of-a-kind periodic table were beautiful. However, the project’s most significant implications came from (1) developing and supporting TCs’ chemistry-related content knowledge, (2) enhancing the science methods coursework to include additional interdisciplinary strategies that enable TCs to integrate science concepts into instructional schedules that often prioritize reading and math (Allaire et al., 2020), (3) helping TCs realize how the specific disciplines of art and science complement and reinforce each other, and (4) aiding TCs to understand how to develop simple yet powerful performance assessments. Although not ideal for every lesson, this simple format can be easily replicated and adapted for students to explore other topics—planets in the solar system, types of cells, famous scientists, and different plants or animals—and express their knowledge creatively.

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