Journal of Research in STEM Education
Vol 10, No 1-2, December 2024, 19-46
https://doi.org/10.51355/j-stem.2024.163

RESEARCH REPORT

Exploring Pre-Service Elementary Educator Anxiety for Facilitating Science Teaching Contexts Integrating 3D Modeling

Stuart Kent White[1], Timothy J Newby

Purdue University, USA

Abstract

Much of the research within K-12 STEM teacher education and integrated STEM instructional design (ID) involves illuminating how STEM subjects can be integrated to bridge gaps between methodological and pedagogical practices. ID involving the engineering design process within K-12 classrooms generally guides students through prototyping mechanical devices using everyday objects and/or 3D printing. One universal engineering process involved in STEM educational curriculum is modeling using computer aided design (CAD) software such as Tinkercad (a popular software in K-12 settings). This study focuses on the application of 3D modeling as a learning activity within an undergraduate biology course designed to prepare pre-service teachers to facilitate life science learning activities in their future classrooms. A mix methods approach was taken to explain the impact of Tinkercad modeling on anxiety for facilitating integrated STEM activities as well as pre-service teacher self-efficacy, confidence in, and competency for teaching integrated STEM. Analysis of student responses to survey questions, field notes, and informal interviews suggest that utilization of modeling software divorced of 3D printing, though conducive to reducing integrated STEM facilitation anxiety, has a limited effect on improving pre-service teacher self-efficacy, confidence in, and competency regarding leading integrated STEM learning activities targeted towards engaging learners in science exploration. However, participant comments on 3D modeling software usability, application within K-12 science learning environments, and perceived K-6 classroom strengths provide important commentary on likelihood of STEM resources such as Tinkercad being adopted into future classrooms.

Keywords: *Integrated STEM, Science education, 3D Modeling, Anxiety, Cross-Curricular Learning*

[1]Corresponding Author: High School M-Stem Education Manager. Campus: West Lafayette. IN 47907-2114, USA, white152@purdue.edu

To cite this article: White, S. K., & Newbya, T. J. (2024). Exploring pre-service elementary educator anxiety for facilitating science teaching contexts integrating 3D modeling. *Journal of Research in STEM Education, 10*(1-2), 19-46. **https://doi.org/10.51355/j-stem.2024.163**

ISSN: 2149-8504 (online)

Science education has traditionally been geared towards students exploring the world through inquiry-based learning. Much of how K-12 educators view science education harkens back to Dewey's notion of science needing to transition from "an accumulation of ready-made material [to] a method of thinking, an attitude of mind" (Dewey, 1910, p. 122). Today, this conception of thinking scientifically has been reimagined as engaging learners in "scientific inquiry situated in the context of technological problem solving" (Sanders, 2008, p. 21) within science, technology, engineering, and math (i.e., STEM education).

The most applied form of STEM education within science contexts involves facilitating knowledge transfer between SM (science and math) and TE (technology and engineering) (Xie et al., 2015) and implies the two subjects are brought together as a whole (i.e., integrated) (Council et al., 2014). Thus, integrated STEM is described as creating a learning environment where the major focus is on "building, modifying, and/or repurposing material objects, for playful or useful ends, oriented towards making a 'product' of some sort that can be used, interacted with, or demonstrated" (Martin, 2015, p. 31). Integrated STEM has also been defined as "an educative inquiry-based practice…that emphasizes creative, improvisational problem solving" (Bevan et al., 2015, p. 98) and as "the creative production of artifacts in their…physical and digital forms to share…with others" (Trust et al., 2018, p. 20). The common theme between these three conceptions of integrated STEM (and others like them) is the design, build, test framework of the engineering design process.

STEM education has become inundated by experts, politicians, and education stakeholders expressing opinions about how best to incorporate technology, engineering, and math into science learning within K-12 classrooms. Advocates for the status quo of each STEM discipline being taught as stand-alone content view "STEM education" as rebranding of traditional classroom practices to garner support for career fields of the future (Breiner et al., 2012). Others view STEM education as the natural blending of two or more of the STEM subjects during authentic, real-world, learning experiences (Kelley & Knowles, 2016). Irrespective of which side of the debate one stands, newly licensed K-6 educators enter their first classrooms with depressed confidence and heightened anxiety for leading science, engineering, and technology activities compared to other subjects (Novak & Wisdom, 2018; Raulston & Alexiou-Ray, 2018) primarily due to minimal understanding of pedagogical and methodological best practices (Dare et al., 2018; Douglass & Verma, 2022; Holincheck & Galanti, 2022).

Increased pressure on elementary educators to integrate science, engineering, and technology into K-6 classroom content has been a constant source of in-service teacher anxiety and reduced self-efficacy in elementary classrooms (Domingo & Garganté, 2016; Shernoff et al., 2017). Moreover, research involving grade 7 through 12 science teachers found that confidence in teaching engineering and technology is inextricably connected to familiarity with the tools and techniques applied in the engineering design process (Han et al., 2023; Smith et al., 2021)

ISSN: 2149-8504 (online)

especially surrounding 3-dimensional (3D) printing. Less research has been done to determine the relationship between pre-service elementary teachers' familiarity with specific engineering/technology tools such as Tinkercad (a 3D modeling software), including STEM teaching techniques for its use, and pre-service teacher concerns for future classroom application. The time-tested notion that K-12 educators teach in much the same way as they were taught (Ausubel, 1963) still dominates the educational research landscape as evidenced by Sandall et al. (2018), Shernoff et al. (2018), Dare (2018), and Han (2023) to name a few. Furthermore, the relative novelty of STEM education within K-12 the setting means current pre-service teacher undergraduates have little to no classroom experience to draw from. The reliance on past teacher examples results in novice teachers turning to worksheets, textbooks, and static models to supplement drill and practice activities and a hesitancy for venturing into the unfamiliar territory of Tinkercad modeling and 3D printing (Raulston & Alexiou-Ray, 2018; Sprague et al., 2022).

When scientific concepts, systems, and phenomenon are eventually "explored" in the classroom, teachers rely on cookbook confirmatory "lab" activities/experiments. One example of this confirmatory modeling approach to learning science is a drill and practice learning strategy which asks students to draw "inherited" genetic traits of a fictitious organism (e.g., Reebops). These 2-dimensional (2D) images are then used to explain inheritance patterns of unique features (i.e., number of humps, color of nose, and/or presence of proboscis). Students then share their organism images with the class, pointing out how their model satisfies a set of learned principles of inheritance.

Purpose of the Study

The aim of this study is two-fold. First, to determine the relationship between pre-service elementary teacher familiarity with Tinkercad modeling software and science focused STEM self-efficacy and anxiety. Second, to evaluate pre-service K-6 teachers' pre and post activity anxiety levels related to teaching two related STEM domains simultaneously: (a) science – patterns of heredity and (b) technology – digital modeling. With the advancement of digital imaging technology, many classroom teachers are being pressured to incorporate some form of digital imaging practice within their classrooms (Sprague et al., 2022). When anticipating the adoption of STEM learning activities in K-6 classrooms teachers face decisions about how to integrate the TE aspects into science and math topics (Clements & Sarama, 2023). The following research questions were identified to guide collection of quantitative and qualitative data to explain the impact prior 3D modeling experience has on pre-service teacher perceptions of teaching STEM lessons.

1. Do Tinkercad organismal phenotype modeling experiences reduce anxiety for facilitating science activities involving 3D modeling technology?

ISSN: 2149-8504 (online)

2. What impact does combining Tinkercad modeling software with organism phenotype representation have on the interplay between anxiety, self-efficacy, and perceived competency with K-6 technology and engineering design standards?

Review of Existing Literature

Today's elementary educators are expected to distill large amounts of content knowledge into measurable learning activities that capture short attention span students' interest long enough for them to initiate construction of usable knowledge (Stewart, 2021). This can be challenging for any K-6 teacher, more so when the pressure to incorporate STEM learning experiences and unfamiliar technology is placed on novice teachers. These challenges are predominantly attributed to inexperience with STEM activities and limited interaction with complex and costly technology (Clements & Sarama, 2023; Lawrence & Tar, 2018; Rapanta et al., 2021). These restrictions have had the unfortunate consequence of teachers placing greater emphasis on training students in technology use for information access rather than on technology as a tool to collect, report, and display information in cohesive units of knowledge (Reich, 2019; Strimel et al., 2016).

Knowledge and expertise

Research has consistently shown that depth of knowledge is more applicable during cross-curricular (i.e., integrating two or more subjects) learning activities than breadth of knowledge because mental supports are grounded by alternative understandings of content (Brown, 1975; Moreno-Bote et al., 2020; Turner et al., 2002). Moreover, new knowledge is linked to existing knowledge through retrieval practice links that facilitate knowledge transfer to other contexts (Karpicke, 2017). While the difference between in-service and pre-service teachers may be a teaching contract, the difference between an expert teacher and a novice is based on access to grounded pedagogical and methodological mental supports on which to attach new teaching knowledge. Macleod and Bodner (2017) point out that when comparing experts to novices, being an expert does not necessitate having a better recall of learned content (i.e., memory), just better ways for encoding, organizing, and retrieving knowledge that facilitates the finding of patterns and meaning more quickly and efficiently.

Transition from teaching science as a stand-alone (siloed) subject to an integrated STEM approach requires increased expertise on the part of the teacher. When teachers have a deep store of subject matter content knowledge and classroom experience from which to draw, they will find it easier to facilitate integrating topics from STEM subjects they are less confident with. Moreover, increased effort is being made to assist in-service teachers to transition current siloed classroom practices to integrated approaches (Dare et al., 2018; Sandall et al., 2018; Stubbs &

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Myers, 2016) and for pre-service teachers to develop entry level mastery of integrated STEM pedagogy (Hallström & Schönborn, 2019; Sandall et al., 2018; Wang et al., 2011).

One teaching strategy that relies on teacher expertise for success is the use of content specific conceptual and mental models (Ornek, 2008). These experiences are said to afford future classroom teachers' opportunities to work with a variety of STEM relevant models through an integrated approach. Experience with mathematical, computer, and physical models is said to improve subject-matter self-confidence by contributing to depth of knowledge development necessary for increased teacher self-efficacy (Hunt, 2013; Justo López et al., 2019; Ornek, 2008). K-6 pre-service teacher perceptions of their ability to relate concepts and ideas to specific contexts and organize information in a way that will facilitate students' retrieval and application is a major contributor to anxiety for facilitating integrated STEM lessons (Novak & Wisdom, 2018). Research by Novak and Wisdom (2018) identifies anxiety in-service and pre-service elementary teachers feel towards facilitating STEM education is due to inexperience with associated engineering processes such as rapid prototyping, 3D printing, and associated technology.

Modeling within STEM education

Literacy across multiple subjects remains a key aspect of pre-service elementary teacher knowledge acquisition within undergraduate education programs as students learn to transform knowledge into action and then effectively communicate that knowledge orally, visually, and/or in written formats (Raulston & Alexiou-Ray, 2018). One way instructors in undergraduate programs can provide pre-service teachers opportunities to demonstrate cross-subject competency is by challenging pre-service teachers to engage with digital models and modeling as students and as future teachers. Engaging with digital models from diverse subject areas as well as learning core pedagogy/methodology applications closely aligned with content specific phenomena, processes, and/or theories will aid future classroom integration practices (Schmidt & Huang, 2021). Concentrated engagement with subject specific digital models enables pre-service teachers to quickly connect theory with practice as they discover for themselves, affording them greater understanding of their own learning (Council et al., 2000). Moreover, working through theory and application "stuck points" during their own discovery process gives them the tools to support their future students' learning; often hampered by preexisting misconceptions, skill deficits, and decreased aptitude (Hunt, 2013; McDaniel & Einstein, 2005).

If K-6 pre-service educators are to develop self-confidence in facilitating engineering design curriculum they must engage in learning activities requiring them to design, build, and modify objects in creative, improvisational ways. Introducing an integrated STEM approach to learning activities within undergraduate pre-service teacher preparation programs is one promising way of affording future teachers the opportunity to communicate lesson objectives, concepts, and expectations using age-appropriate language and activities (Dare et al., 2018;

ISSN: 2149-8504 (online)

Ejiwale, 2013; Kelley & Knowles, 2016). In this way K-6 pre-service teachers become adept at student-centered inquiry-based science knowledge acquisition by simultaneously integrating technology, engineering, and/or math teaching methodologies, practices, and pedagogy into the creation of learning experiences that engage students with models and the modeling process (English, 2016).

Theoretical and Conceptual Framework

Integrated STEM learning activities that combine science, technology, and engineering are grounded in the principle that infusing the engineering design processes with scientific methodology results in physical models that can be iteratively refined during the investigative process (Bevan, 2017; Godhe et al., 2019; Martin, 2015). This has precipitated from numerous researchers who recognized that effective STEM instruction is not simply a matter of combining learning objectives from different subject matter courses, rather there needs to be thoughtful input into how best to organize learning so that it is authentic and coherent (Justo López et al., 2019; Kay & Knaack, 2007; Merrill, 2002; Ornek, 2008; Sims, 2006). Unfortunately, implementation of such applications as digital modeling has been hampered by traditional expectations related to content standardization and ill-defined STEM specific learning outcomes (Ashton, 2014; Holincheck & Galanti, 2023; Samara & Kotsis, 2023).

One contributing factor is a lack of understanding related to what integrated STEM education entails (Breiner et al., 2012; Sanders, 2008; Shernoff et al., 2017). Research continues to point out that most undergraduate K-6 pre-service educator programs view STEM in a manner that "reinforces a disconnection between the different STEM disciplines" (Struyf et al., 2019, p. 1388). Furthermore, Hallström and Schönborn (2019) indicate that teachers struggle with designing classroom activities where two or more of the STEM subjects (outside the SM and TE conceptualizations) are integrated in both meaningful and relevant ways.

Elementary education majors identify intrinsic attributes such as working with children, making social contributions, shaping the future of children, and prior teaching experiences as motivating factors for becoming K-6 teachers (Bilim, 2014) while STEM content-specific teachers maintain a considerably different self-identity (Avraamidou, 2014). One articulated reason for the difference between K-6 teacher and STEM discipline teacher identity is elementary teachers' commonly held feelings of uneasiness, worry, and/or nervousness towards teaching science and by extension STEM lessons (Novak et al., 2022; Novak & Wisdom, 2018).

Widely accepted research findings have established a connection between teacher anxiety and interest in science education (Deci et al., 1994; Deci & Ryan, 1985), competence towards science, technology, and engineering standards (Novak et al., 2022; Novak & Wisdom, 2018), and teaching self-efficacy (Enochs & Riggs, 1990). As educational technology has evolved from blackboards and chalk to interactive digital animations, K-12 educators have found themselves

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forced to constantly adapt to newer ways of providing learning opportunities for their students. Over time learners have become more adept at interacting with technology in a variety of ways and in multiple settings (Afzal et al., 2023) partially due to evolving teachers' perceptions of technology's usefulness in achieving learning objectives.

Adapting pedagogy and methodology in response to each newly identified educational technology can contribute to already existing subject matter anxieties. If K-6 educators are to move beyond merely dabbling in educative technology to explore it's use in facilitating learning they must have opportunities to individualize the technology and explore ways of integrating it into best practice (Domingo & Garganté, 2016; Lawrence & Tar, 2018; Rapanta et al., 2021). While in-service K-6 teacher's evolution of instructional practice and technology integration is grounded in professional development opportunities backed by extensive classroom expertise, pre-service elementary teachers require purposeful guidance as they assimilate new ways of thinking and "doing", especially as it relates to developing STEM activities that integrate educational material from multiple domains (Raulston & Alexiou-Ray, 2018; Reich, 2019; Tondeur et al., 2012).

When it comes to technology use in the classroom, one common approach to mastery development involves modifying existing skill with an inherent reward following a period of struggle as successive ability levels are achieved (Ahmad et al., 2020). The progressive development through periodic struggle is grounded in constructivist theory of going from not knowing how to do something to being progressively adept or skilled as learners practice with concepts, and experience different instructional strategies (Ertmer & Newby, 2013). Moreover, it is important to recognize content knowledge mastery is predominantly modeled by a teacher's existing ability and skill level, which prior research has directly tied to feelings of anxiety, self-efficacy, and competence (Deci et al., 1994; Deci & Ryan, 1985; Enochs & Riggs, 1990; Novak et al., 2022; Westerback, 1984). Thus, prior experience with digital modeling technology should afford teachers a foundation on which to assist learners through challenges, roadblocks, and limitations with sincere positive affirmations. Moreover, learners' gain content mastery and develop internal reward mechanisms that in turn contribute to teacher competence (Mojavezi & Tamiz, 2012).

Huitt and Hummel (2003) state that as teachers model assimilation of learning strategies from one scenario to another they are scaffolding knowledge construction desired from learners. It is through the modification of preexisting learning strategies that teachers will successfully incorporate integrated STEM challenges using discovery-/inquiry-based learning activities. The advantage of K-6 educators developing technology skills while simultaneously learning STEM content is an increased confidence in their ability to assist learners constructing course specific content knowledge and/or skills from a shared entry point (Caprara et al., 2006).

The complex interconnected relationship between anxiety, self-confidence, self-efficacy, and expertise is exemplified in Figure 1. Changes to any one of these characteristics has corresponding effect on the other three (e.g., increases in expertise leads to increased self-confidence and self-efficacy while at the same time decreasing in anxiety).

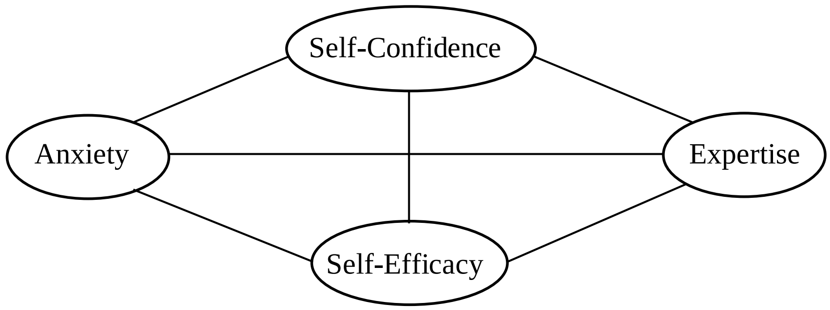

Figure 1. Interconnected Nature of Anxiety, Self-confidence, Self-efficacy, and Expertise

A teacher's belief in their capacity to facilitate the finding of patterns and meaning is one factor contributing to self-efficacy in producing expected student performance (Caprara et al., 2006). Teacher self-efficacy and self-confidence have a complementary relationship as trust in one's ability to produce expected student performance has a positive effect on one's capacity to facilitate the expected student performance (Ball et al., 2017; Mojavezi & Tamiz, 2012; Thorndike, 1927). If we define teaching expertise using a continuum of increased ability to encode, organize, and retrieve their memories of successfully facilitating student performance then improved ability for finding patterns and meaning from learning activities will lead to increased self-efficacy and self-confidence. On the other hand, increased levels of anxiety tend to lower self-confidence and self-efficacy which in turn hinders development of expertise (Novak et al., 2022).

Methodology and Research Design

A convergent parallel mixed methods approach (see Figure 2) was taken to explain the impact Tinkercad modeling software use in a pre-service teacher life science course has on anxiety, confidence, self-efficacy, and interest in teaching STEM in future K-6 classrooms. Quantitative and qualitative data related to intrinsic motivation, anxiety, efficacy beliefs, and STEM standards competence were collected and analyzed. Numerical data in the form of pre- and post-surveys bookended recording of small group observation field notes and informal interviews. Observation notes were recorded while participants discussed the modeling process in peer groups during the use of Tinkercad modeling software. Statistical analysis of quantitative data and themes discovered from qualitative data were later organized around student statements while using modeling software to create 3D representations of constructed marshmallow "organism" models. Comparisons were then made between quantitative and qualitative data to identify patterns in conversations, experiences, and expressions across multiple lab groups and laboratory sections.

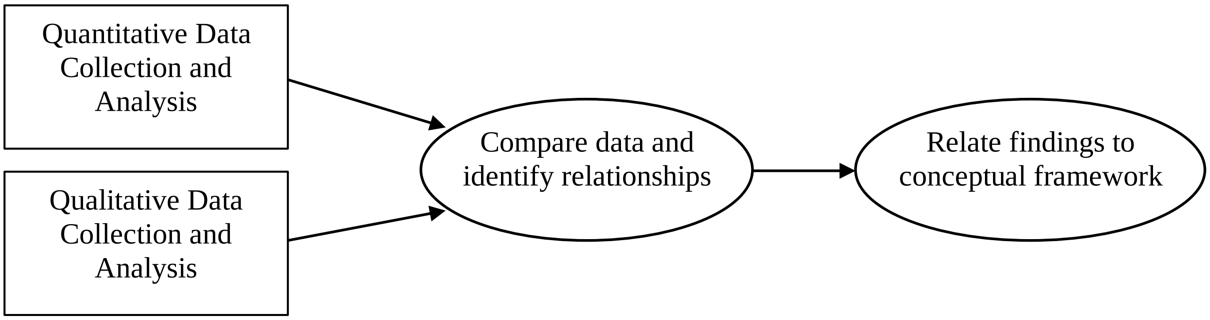

Figure 2. Experimental Design Flowchart

Once all qualitative and quantitative data was collected, analyzed and compared, conclusions were drawn from the data to illuminate the impact of Tinkercad modeling software expertise on the interplay between STEM activity facilitation anxiety, self-efficacy, and perceived competency with K-6 technology and engineering standards. Student conversations while interacting with modeling software and informal interviews were further analyzed to explore impact of organism modeling on reducing STEM technology literacy anxiety and promoting understanding of foundational genetics principles.

Participants and Context

Participants of this study are undergraduate pre-service elementary teachers enrolled in a biology for non-bio majors. The fact that they will one day be expected to teach K-6 grade students a wide variety of subject makes them ideal for exploring anxiety for teaching, competence, self-efficacy, and confidence. The non-biology major course specifically connects learning activities with teaching methodology. Moreover, course activities that focus on illustrating organismal phenotype (i.e., observable characteristics of an organism) can easily be restructured into a 3D modeling project assignment and incorporated across multiple sections of the course (N=128 in the spring of 2023).

Students in this course are either in their freshman (2nd semester) or sophomore year (4th semester) of the Elementary Education Program (Pre-K through Grade 6) at a large mid-western R1 university in the USA. Because participants are early in their undergraduate program, they are less likely to have extensive classroom experience to draw from and more likely to express anxiety for the unknown and lack of confidence in their teaching ability. Moreover, most participants are female (n=124) and in their freshman year (n=115). Thus, all data was grouped together as a single population rather than identifying subgroups.

The Biology for Elementary Teachers course (BIOL20600) was developed around two primary goals of the course: 1) preparing preservice elementary teachers with biology content knowledge necessary for teacher-licensure and 2) exposure to life science learning activities directly transferable to future elementary classrooms. Moreover, students in the course are introduced to appropriate pedagogy, technology, and reflective practices aligned with age-appropriate science content knowledge for conducting scientific inquiry with K-6 learners. Additionally, participants work collaboratively throughout the semester in learning communities of three or four students to complete laboratory-based activities and are encouraged to continue collaboration outside of class. These collaborative activities take the form of proofreading one another's assignments, engaging in asynchronous discussions, and providing constructive peer feedback.

Procedures and Materials

Each of the BIOL20600 lab sections completed a lab activity where they created "Reebops" from genetics determined by a coin flip and using marshmallows, toothpicks, push pins, small nails, and pipe cleaners (see Figure 3a and 3b). Next, they were assigned the task of creating 3D images of their "Reebop" model using Tinkercad software. A 5E Learning Cycle for inquiry-based science teaching is employed throughout the semester as a model for science instruction. During the Engagement Phase of the Reebop genetics module, students completed pre-activity surveys prior to engaging with Tinkercad modeling software through a tutorial on how to manipulate objects in the design work-plane. During the Exploration Phase, each student "played" with Tinkercad modeling features as they created their 3D model of their corresponding physical Reebop marshmallow model. During the Evaluation Phase students presented their designed Reebop phenotype 3D models and related how their model exemplified key phenotypic features of their physical models. The Evaluation Phase was followed by students completing post-activity surveys.

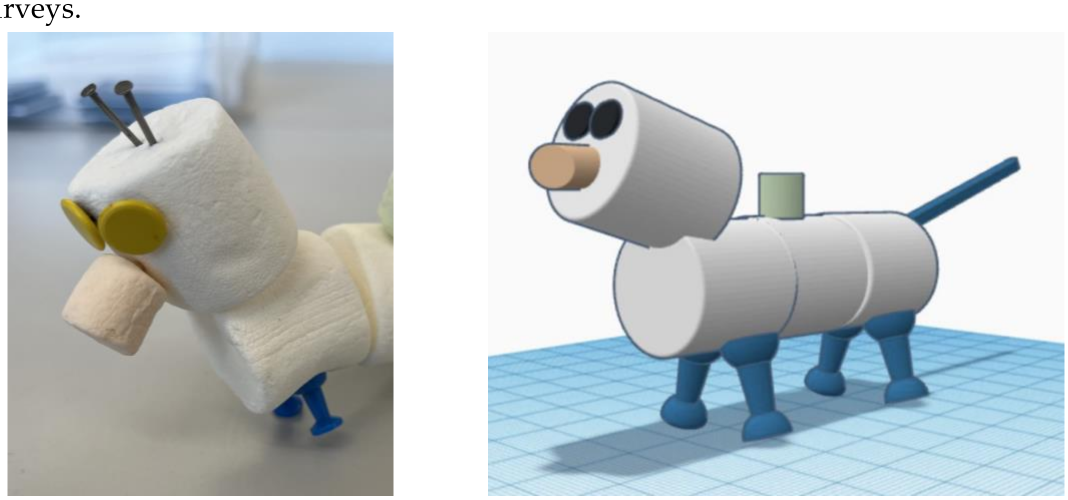

Image a) Physical model   Image b) 3D digital model

Figure 3. Physical and Digital Reebop Models

Data Sources

All students were encouraged to complete the Interest in Science questionnaire adapted from the interest/enjoyment subscale of the Intrinsic Motivation Inventory (Deci et al., 1994; Deci & Ryan, 1985) to assess undergraduate student interest in learning science and doing science projects (see Appendix A). The interest in science sub-scale includes five Likert-type items with an interest in science score being calculated by averaging the five items of the scale. Cronbach's alpha test of internal consistency and reliability is reported as α=.86 (pre) and α=.79 (post) (Novak & Wisdom, 2018).

Teaching anxiety was measured using the Science Teaching Anxiety Scale (STAS) developed to assess pre-service elementary educator anxiety towards teaching science and science projects (Novak et al., 2022; Novak & Wisdom, 2018) (see Appendix B). Modifications were made to the original mathematics anxiety scale (MAS) questionnaire changing items such as "Math does not scare me at all" and "I seldom panic during a math test" to "Teaching science does not scare me at all" and "I seldom panic while teaching a science lesson." This scale allowed for the effective shift of anxiety assessment from math to science with negligible impact on validity of the instrument with an internal consistency and reliability of α=.85 (pre) and α=.87 (post) (Novak & Wisdom, 2018).

Elementary science preservice teachers' self-efficacy and outcome expectancy was assessed using the Elementary Science Teaching Efficacy Belief Instrument (STEBI-B) developed to measure elementary pre-service teachers' constructs of self-efficacy (Enochs & Riggs, 1990) (see Appendix C). Averages of the self-efficacy and outcome expectancy scores were obtained with self-efficacy Cronbach's α=.79 (pre) and α=.89 (post) while outcome expectancy Cronbach's α=.70 (pre) and α=.41 (post) (Novak & Wisdom, 2018).

Competence in technological and engineering design science standards were evaluated using the three Novak and Wisdom (2018) developed five-point Likert-type questions asking preservice teachers how confident they were that they could teach the competencies, identify problems and potential technological/engineering solutions, and understand the design process and role of troubleshooting (see Appendix D). These questions are in line with Next Generation Science Standards (NGSS) with which course content is aligned. The technology and engineering standards exhibit a Cronbach's α=.89 (pre) and α=.86 (post) (Novak & Wisdom, 2018)

Throughout the modeling process, lab section teaching assistants (TAs) and course instructor recorded student communication field notes for each table group. TAs were provided training on recording field notes prior to Tinkercad modeling activity. Once the Tinkercad modeling activity was over, BIOL20600 students then self-identified as being willing to participate in an informal interview session to explore their experience with Tinkercad modeling. During these interview sessions, students were asked about their experience using Tinkercad modeling software, their confidence in teaching integrated STEM activities, and their likelihood of repeating Tinkercad modeling activities in their future classrooms. The decision for informal interviews sessions was based on the number of participating students (n=25) and limitations for scheduling interview time blocks close to the end of the semester and compatible with participants and interviewee schedules. The decision to limit the number of students interviewed to 25 was done because only one of the researchers was available to conduct the interview.

Data Analysis

All quantitative data was collected and analyzed using pre-determined scoring procedures associated with each instrument (see appendix for details on scoring): Student pre- and post-test interest in science, perceived competence in K-6 Science and Engineering Practices standards, anxiety toward teaching science, and science content knowledge. Once all survey instruments were scored, SPSS software was used to run statistical analysis of scored responses. Table conversations fieldnotes and interview responses were deductively analyzed to identify 1) key procedural modeling aspects, 2) modeling concerns, 3) questions posed by students, and 4) indications of design thinking. After one table group's field notes were analyzed using the four pre-determined parameters, discrepancies were discussed and rectified prior to coding of remaining table group fieldnotes. Table group codes were then compared across table groups to identify patterns of behavior and development of expertise. This two-step process provided researchers a better understanding of student learning experiences and attitudes toward 3D modeling projects beyond the survey data. Finally, a constant comparative analysis was used to determine emerging patterns and themes from informal interviews, lab table discussion fieldnotes, and survey data. The data was identified as independent elements and similarities and differences across the three data sets were illuminated and explored.

Validity, Reliability, and Trustworthiness

Because the surveys targeted specific aspects of pre-service teacher perceptions, deductive coding of table-talk conversations and informal interview sessions was implemented rather than inductive coding. Once the coding process was complete, qualitative and quantitative data sets were analyzed for details relevant to motivation, anxiety, self-efficacy, and self-confidence. Neutrality of findings was maintained by section TAs and course staff collecting raw data as part of the course lesson improvement process. This was also instrumental in minimizing researcher bias during content mining of conversations and informal interviews. Initial conversational questions TAs asked participants during Tinkercad modeling fieldnote collection were as follows:

- What challenges did you experience and how did you address those challenges?
- What could be done to better to support student learning?
- How could the learning activity be improved?

ISSN: 2149-8504 (online)

Furthermore, researcher bias for any particular response was further minimized by placing the discussion and subsequent coding of feedback considering improving existing learning experiences.

Results

It was assumed there would be differences between pre-/post-activity responses on each survey instrument (e.g., science teaching anxiety, outcome expectancy, teaching efficacy, standards confidence). This was confirmed by table talk during the modeling process and the evaluation phase of the learning activity. Student comments initially involved complaining about not knowing how to use Tinkercad software. However, as students persisted, and learned how to manipulate the available Tinkercad building blocks their conversations turned to

"Wow, how did you do that?"
"I can't figure out how to add the toothpicks."
"Where do you find the toothpicks?"
"They are in the household objects section, let me show you."

Perceived differences between pre- and post-survey data resulted in z-scores being computed for each post-activity item to determine significance ($H_o = M_{pretest}$).

Table 1.
Means and Standard Deviations of Indicators Measuring Anxiety Toward Teaching Science.

Item	**Pretest (N = 94)**		**Post-test (N = 74)**	
	M**	**SD**	**M****	**SD**
Teaching science does not scare me at all.*	3.35	1.104	3.12	1.110
It would not bother me at all to teach topics in elementary Earth and Space Science.*	3.01	1.187	2.89	1.165
It would not bother me at all to teach topics in elementary Life Science.*	2.73	1.049	2.72	1.117
It would not bother me at all to teach topics in elementary Physical Science.*	2.98	1.067	2.86	1.151
It would not bother me at all to teach topics in elementary Technological and Engineering Design.*	3.85	1.164	3.42	1.182
I seldom panic while teaching a science lesson.*	3.34	1.063	3.14	1.114
I am usually at ease while teaching a science lesson.*	3.23	1.159	3.01	1.129
I am usually at ease interpreting and communicating science concepts.*	3.18	1.047	2.95	1.081
Teaching science makes me feel uncomfortable, restless, irritable and impatient.	2.12	1.046	2.18	1.052
Teaching science usually makes me feel uncomfortable and nervous.	2.32	1.090	2.31	1.084
I get a sinking feeling when I think of teaching a difficult science concept.	2.51	1.268	2.36	1.067

My mind goes blank, and I am unable to think clearly when planning a science lesson.	2.20	1.053	2.14	1.102
Preparing students for a science test would scare me.	2.19	1.050	2.11	0.930
Walking into a school and thinking about teaching a science lesson makes me feel uneasy and nervous.	2.16	1.081	2.15	1.043

*Indicates items that were reverse scored
**Lower values indicate lower anxiety, and higher values indicate higher anxiety levels about teaching science; possible score range 1-5

While post-activity responses measuring anxiety toward teaching science (Table 1) varied from the pre-activity responses, only one item was found to indicate any degree of significance (e.g., items 5). Initial statistical analysis of the Novak and Wisdom (2022) science anxiety teaching scale data indicates normal distribution by the fact each item's mean, median, and mode fall near the center of the distribution and the graphical distribution is essentially symmetrical. The one exception to this is Item 5 pre-test being positively skewed (M=3.85, median=4, mode=5). Additionally, all but one of the post-test means were lower than pretest means indicative of reduced anxiety about teaching science, technology, and engineering design. The largest pre-/post-test score gap came in item 5 (Δ=.43; p=.029) indicating statistical significance in anxiety reduction for teaching topics related to technology and engineering design.

Table 2.
Means and Standard Deviations of Indicators Measuring Outcome Expectancy.

Item	**Pretest (N = 84)**		**Post-test (N = 66)**	
	M**	**SD**	**M****	**SD**
When a student does better than usual is science, it is often because the teacher exerted a little extra effort.	3.48	0.685	3.61	0.834
When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach.	3.98	0.728	3.79	0.808
If students are underachieving in science, it is most likely due to ineffective science teaching.	3.40	0.808	3.19	0.821
The inadequacy of a student's science background can be overcome by good teaching.	3.89	0.640	3.85	0.680
The low science achievement of some students cannot generally be blamed on their teachers.*	2.87	0.818	2.84	0.828
When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher.	3.57	0.765	3.75	0.636
Increased effort in science teaching produces little change in some students' science achievement.*	3.00	1.151	2.91	1.026
The teacher is generally responsible for the achievement of students in science.	3.58	0.698	3.63	0.832
Students' achievement in science is directly related to their teacher's effectiveness in science teaching.	3.33	0.869	3.52	0.804

If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.	3.52	0.768	3.81	0.743

*Indicates items that were reverse scored
**Lower values indicate lower outcome expectancy and higher values indicate higher outcome expectancy levels; possible score range 1-5

Post-activity responses measuring outcome expectancy (Table 2) varied from the pre-activity responses, however, one item was found to indicate any degree of significance (e.g., items 10). Statistical analysis of outcome expectancy data indicated all items were negatively skewed. Moreover, items 1, 6, 8, 9, and 10 showed an increase in outcome expectancy while items 2, 3, 4, and 7 showed a decrease in outcome expectancy, with item 5 showed no change. Furthermore, responders' perception that parental comments related to their child showing more interest in science at school was probably due to the performance of the child's teacher was significant (p=.02) with a pre-/post-survey gap for item 10 of Δ=0.35.

Table 3.
Means and Standard Deviations of Indicators Measuring Teaching Efficacy

Item	**Pretest (N = 84)**		**Post-test (N = 66)**	
	M**	**SD**	**M****	**SD**
I will continually find better ways to teach science.	4.26	0.623	4.25	0.823
Even if I try very hard, I will not teach science as well as I will most subjects.*	3.27	0.936	3.22	1.042
I know the steps necessary to teach science concepts effectively.	3.25	0.834	3.63	0.775
I will not be very effective in monitoring science experiments. *	3.74	0.852	3.54	1.049
I will generally teach science ineffectively. *	3.85	0.843	3.75	1.059
I understand science concepts well enough to be effective in teaching elementary science.	3.67	0.948	3.82	0.815
I will find it difficult to explain to students why science experiments work.*	3.50	0.898	3.31	0.988
I will typically be able to answer students' science questions.	3.64	0.771	3.67	0.805
I wonder if I will have the necessary skills to teach science.*	2.55	0.827	2.67	0.944
Effectiveness in science teaching has little influence on the achievement of students with low motivation.*	3.19	0.950	3.24	1.016
Given a choice, I will not invite the principal to evaluate my science teaching.*	3.44	1.022	3.07	1.159
When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better.	2.42	0.853	2.57	1.048
When teaching science, I will usually welcome student questions.*	1.57	0.664	1.81	0.783

*Indicates items that were reverse scored
**Lower values indicate lower teaching efficacy, and higher values indicate higher teaching efficacy levels; possible score range 1-5

Post-activity responses measuring teaching efficacy (Table 3) varied from the pre-activity responses. Two were found to indicate any degree of significance (e.g., items 3 & 13). Statistical analysis of outcome expectancy data indicated items 1-8, 10, and 11were negatively skewed while items 9, 12, and 13 were positively skewed. Moreover, items 3, 6, 8, 9, 10, 12, and 13 showed an increase in teaching efficacy and items 1, 2, 4, 5, 7, and 11 showed a decrease in teaching efficacy. Furthermore, responders' confidence in teaching science concepts effectively increased significantly (p=<.001) with a pre-/post-survey gap for item 3 of Δ=0.24. Responders also indicated a significant increase in willingness to welcome student questions about science content (p=.01) with a pre-/post-survey gap of Δ=0.38.

Table 4.
Means and Standard Deviations of Elementary Technology and Engineering Design Standards Confidence.

Item	**Pretest (N = 94)**		**Post-test (N = 74)**	
	M**	**SD**	**M****	**SD**
Teach elementary students how to identify problems and design potential technological/engineering solutions.	2.48	1.114	2.73	1.114
Teach elementary students how to outline the design process of technological/ engineering solutions using science concepts.	2.35	1.095	2.70	1.119
Teach elementary students how to explain the role of troubleshooting in solving a technological/engineering problem	2.28	1.072	2.71	1.144

**Lower values indicate lower confidence, and higher values indicate higher confidence; possible score range 1-5

Post-activity responses measuring confidence toward technology and engineering standards (Table 4) varied from the pre-activity responses, two of the three items were found to indicate significance (e.g., items 2 and 3). After completing the modeling activity, responders indicated an increased confidence in teaching students how to outline the design process using science concepts (p=.023) and how to explain the role of troubleshooting in solving problems (p=.01).

Prior to the modeling activity, 37 responders indicated they would choose to teach science to elementary students: with 24 saying no and 23 unsure (N=84). After the modeling activity, 27 responders indicated they would choose to teach science to elementary students: with 23 saying no and 16 unsure (N=66). Prior to the modeling activity, 60 responders felt the majority of science instruction time should be spent in activity-based learning, with 20 feeling time should be equally distributed between textbook-/activity-based learning (N=84). After the modeling activity, 46 responders felt most of the time in science instruction should be activity-based learning, with 16 indicating time should be equally divided between textbook-/activity-based learning (N=66). Prior to the modeling activity, 44 responders felt their effectiveness as a future elementary teacher was on par with a "typical" elementary science teacher while 36 considered themselves above average (N=84). After the modeling activity, 37 responders indicated they were on par with the average elementary teacher while 27 considering themselves above average (N=66).

Table 5.
Means and Standard Deviations for Pre-/Post-test Data, Pooled t-test, and Significance

Variable	Pooled Pretest		Pooled Post-test		Pooled t-test	Sig
	M	SD	M	SD		
Science interest (5 items)	3.02	0.552	3.09	0.610	-1.592	.187
Anxiety about teaching integrated STEM (14 items)	2.80	0.556	2.67	0.447	3.802	.002
Teaching efficacy (13 items)	3.26	0.710	3.28	0.624	-0.359	.726
Outcome expectancy (10 items)	3.46	0.344	3.49	0.371	-0.590	.570
Standards competency (3 items)	2.37	0.101	2.71	0.015	-6.594	.022

Scores were calculated by averaging the total number of items; possible score range 1-5

Discussion

Taken as a whole, pooled quantitative analysis of pre and post surveys found in Table 5 shows that science interest, efficacy, and outcome expectancy did not experience significant change while anxiety and standards competency did see significant improvement after completing Tinkercad modeling activity. Student engagement during the Tinkercad modeling activity supports the notion that participants had an increased interest in science through their devotion to modeling accurate representations of their Reebop's and persevering through stuck points. This is illustrated in a conversation between one pair of lab partners as they created their Reebop 3D models.

> Kaileigh: Hey, how did you add the legs to your Reebop? I found the push pin object, but how did your tilt it?
> Kelsey: You just click on the pin and then the arrow pointing in two directions.
> Kaileigh: Oh. Thanks. This is pretty easy once you figure out how to do all the manipulations. This would have been easier if they showed us how to do it in the first place.
> Kelsey: I know! It took me forever to figure out how to make all the marshmallows the same size. Stu showed me I could just type in the size by clicking on the little box.
> Kaileigh: Seriously! That's all you had to do? . . . Dang, that makes ensuring the traits are accurate so much easier. Now my [Reebop's] eyes look better.

Most discussions of using Tinkercad modeling within future elementary classrooms involved using it with engineering projects. Terra shared that she could "see how it can be used in creating models of the Reebops, this would probably be too complicated for many elementary students, except for maybe 5th or 6th graders. I want to work with kindergarten or maybe 1st grade so . . . I don't think it would work for my students." Murphey indicated that "once you got the basics of how to manipulate the shapes, change colors, align, and group them it was fun to create different things. I can see this being helpful for engineering, but not sure I would use it for science." Annalee on the other hand was more enthusiastic about using Tinkercad, stating "it was pretty cool to see the Reebop come to life. I sent a screenshot to my parents. This is definitely something I will use in my classroom to let students create similar images to Reebops. I think they would have fun creating the marshmallow object and then doing Tinkercad. I feel more confident [teaching it] now that I have done it for myself."

Research Question 1 Findings

The first research question of "do Tinkercad organismal phenotype modeling experiences reduce anxiety for facilitating science activities involving 3D modeling technology" is supported both quantitatively and qualitatively. Anxiety for using Tinkercad modeling software decreased after completing the Reebop modeling activity (See Tables 1 and 5). However, all students did not have the same experience. Thor indicated that "it was difficult to make an accurate representation of the marshmallow Reebop, everything in the 3D model was uniformed . . . you couldn't squish the objects to make them look like the real marshmallows . . . so I don't know how realistic this is. Tinkercad has limitations . . . I wanted it to look more real." Addison said "I didn't like this activity. I get that it is STEM related but why not just do the marshmallow activity? I think elementary kids will have more fun with [the] hands-on aspect of putting marshmallows together and taking it home."

Transferring idiosyncratic student experiences into classroom practice means teachers must recognize that while some students struggled more than others, each student indicated that using Tinkercad got easier, and some students used the software to create more than one image of their Reebop model. Arabella shared that she "went back to [her] dorm and kept playing around with Tinkercad after lab. [She] created a whole family instead of doing the post lab questions." This suggests that as classroom teachers provide learners with engaging 3D modeling activities, no matter what the underlying context may be, students will demonstrate differing levels of success which can be supported in a variety of ways.

Most students had not used any form of modeling software prior to the activity and shared how it was challenging for them to begin with but got easier over time. Benji, Jacob, and Lucy had each worked with modeling software and the engineering design process previously in their high school robotics clubs. Benji shared that "using Tinkercad is a good starting point for elementary kids because it has a lot of basic shapes that they can just put on the work-plane and begin designing. This makes it easier to teach simple engineering principles." Lucy connected Tinkercad modeling to a previous lab activity involving ecosystem design explaining that "students could take the different animals and place them on the work-plane like they want to arrange them in their aquarium."

Experiences like Benji, Jacob, and Lucy point to the use of 3D modeling as a more creative way than just drawing 2D pictures. The use of Tinkercad software affords learners the ability to see their design in 3 dimensions rather than 2 dimensions." Moreover, Jacob suggested "[teachers] could use Tinkercad to help students learn about shapes because they can change the point of view and see other sides of the object."

Research Question 2 Findings

The research question regarding "what impact does combining Tinkercad modeling software with organism phenotype representation have on the interplay between anxiety, self-efficacy, and perceived competency with K-6 technology and engineering design standards" can be further illustrated in the following situation. Roselyn and Grace had unique experiences with Tinkercad as they only accessed Tinkercad using an iPad while others used laptops or desktop computers to complete the activity. Roselyn found it challenging to complete the activity because "I had a hard time working the controls. Other people could use their mouse pad on their laptops to access things, change the shape, or even rotate it. I had to use my fingers on the screen, and it kept messing everything up. Eventually I just gave up and submitted what I had. It doesn't look like my Reebop at all . . . but I tried." Grace had a similar experience sharing "it was really hard to connect things together and make sure they were lined up correctly. Every time I tried to do something new it would mess up what I just did. It is probably easier if you use a laptop or computer but I only have an iPad so I did the best I could."

Conclusions

Using Tinkercad modeling software without the addition of 3D printing appears to reduce anxiety for facilitating STEM learning activities. However, it also appears that the context of the modeling activity matters when it comes to connecting the use of Tinkercad outside the concept of engineering. There appears to be an inherent bias for connecting 3D modeling software with the engineering design process. It is difficult for students to transfer digital 3D imaging to the science focus used in the context of this study. Many comments pre-service teachers made about using 3D modeling in their future classrooms addressed using Tinkercad along with engineering activities. This begs the question of how could an integrated STEM lesson be created at the K-12 level where the 3D modeling activity bridges the gap between science and engineering such that CAD modeling becomes more closely connected to understanding science or math content rather than a tool for engineering?

Evaluation of participant responses suggests bridging knowledge transfer gaps between science and engineering can be addressed by connecting digital modeling to creation of a experimental apparatus rather than an organism. Moreover, the educational impact of digital modeling within science contexts may be better served by applying digital modeling software to visually abstract topics or "inventing" organisms suited for specific habitats, ecosystems, or environments. Utilization of Tinkercad with more creative types of activities such as creating an insect would be more in line with the rapid prototyping aspects of the engineering design process digital 3D imaging software is geared towards.

Pre-service teachers indicated that learning to use Tinkercad was beneficial in developing confidence in their ability to teach future elementary students about engineering and doing STEM lessons with this type of technology. However, there was mixed reactions with how appropriate its use was in their future classrooms. This is probably due to the vastly different age-groups within an elementary school and pre-service teacher preference for teaching specific grade levels—some focusing on upper elementary (4-6) and others on lower elementary (K-3). Application of Tinkercad modeling software (and digital 3D imaging) that directly relates to anticipated future classroom age level might be more instrumental in promoting confidence in its use. Moreover, while marshmallow "Reebops" are age appropriate when working with learners developing an understanding of genetics, application of digital modeling appropriate for elementary students may focus on more simplified structures and objects such as basic shapes and everyday objects students are familiar with.

Using Tinkercad to create 3D images of marshmallow models did contribute to a slight increased interest in teaching science, teaching efficacy, and outcome expectancy. While the numerical increase was not significant, results are in line with those described by Novak and Wisdom's (2018) study combining modeling and 3D printing within an undergraduate pre-service teacher methods course. It appears that use of 3D modeling software, such as Tinkercad, alone is instrumental in significantly reducing anxiety and increasing engineering standards competency but 3D modeling coupled with 3D printing has a larger impact on STEM teaching interest, self-efficacy, and outcome expectancy. Thus, learning experiences that combine digital modeling with 3D printing are better suited for integrating science, technology, and engineering in an integrated STEM context than teaching science as a standalone subject using unfamiliar technology.

Limitations

This study explores only the role of modeling software as one aspect of anxiety towards integrated STEM activity facilitation within K-6 educations settings. As such the findings are not directly transferable to other integrated STEM technologies (i.e., 3D printing and rapid prototyping). While the goal has been to explain the interplay between pre-service elementary teacher STEM activity facilitation anxiety, self-efficacy, and perceived competency and expertise

ISSN: 2149-8504 (online)

in K-6 technology it does not address the preceding or subsequent steps in the engineering design process. Moreover, a more rigorous methodological protocol may result in significantly different results, identifying a different impact on reducing anxiety, increasing self-efficacy, and/or improving competency.

Another limitation within this study is the inexperience of Freshman undergraduates with the field of education. This is especially evident in their naiveté towards classroom expectations. Thus, their responses to survey questions must be analyzed considering this—such that while indicative of their perceptions, they cannot be used as an accurate measure of actual anxiety experienced once in front of the classroom. Each learning experience within undergraduate course work and classroom experience over the course of the pre-service teacher program will contribute to reducing anxiety and this is just one off many experiences they will have before their first contracted workday.

Disclaimers

All participants are guaranteed immunity by using pseudonyms chosen from authors extended family – Kaileigh and Kelsey (daughters); Terra and Annalee (daughters-in-law); Murphey, Addison, Roselyn, Lucy, Arabella, Grace (granddaughters); Thor, Benji, and Jacob (grandsons). Furthermore, with all participants being pooling into a single population, male and female names do not represent gender of participants. This research project was conducted with IRB approval and was not conducted using any research funding sources.

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ISSN: 2149-8504 (online)

Appendix A

Science Interest Instrument (Deci et al., 1994)

Please read the following questions and choose the answer that best tells how you really feel.

	Not True	Slightly True	Moderately True	Mostly True	Very True
1. I find science enjoyable	1	2	3	4	5
2. Science is just not interesting to me	1	2	3	4	5
3. I like doing work in my science class	1	2	3	4	5
4. I like learning new things about science	1	2	3	4	5
5. In general, I find working on science projects to be interesting	1	2	3	4	5

ISSN: 2149-8504 (online)

Appendix B

Science Anxiety Teaching Scale (with Engineering Concepts) for Pre-Service Elementary Teachers (Novak et al., 2022)

Directions: This inventory consists of statements about your attitude toward teaching science. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the choice that most closely corresponds to how each statement best describes your feelings. Complete your responses for all statements. Thank you for your time.

		Not True	Slightly True	Moderately True	Mostly True	Very True
1	Teaching science does not scare me at all.	1	2	3	4	5
2	It would not bother me at all to teach topics in elementary Earth and Space Science.	1	2	3	4	5
3	It would not bother me at all to teach topics in elementary Life Science.	1	2	3	4	5
4	It would not bother me at all to teach topics in elementary Physical Science.	1	2	3	4	5
5	It would not bother me at all to teach topics in elementary Technological and Engineering Design.	1	2	3	4	5
6	I seldom panic while teaching a science lesson.	1	2	3	4	5
7	I am usually at ease while teaching a science lesson.	1	2	3	4	5
8	I am usually at ease interpreting and communicating science concepts.	1	2	3	4	5
9	Teaching science makes me feel uncomfortable, restless, irritable and impatient.	1	2	3	4	5
10	Teaching science usually makes me feel uncomfortable and nervous.	1	2	3	4	5
11	I get a sinking feeling when I think of teaching a difficult science concept.	1	2	3	4	5
12	My mind goes blank and I am unable to think clearly when planning a science lesson.	1	2	3	4	5
13	Preparing students for a science test would scare me.	1	2	3	4	5
14	Walking into a school and thinking about teaching a science lesson makes me feel uneasy and nervous.	1	2	3	4	5

Scoring items: Items 1-8 should be reverse scored

ISSN: 2149-8504 (online)

Appendix C

STEBI Form – (Initial Instrument)

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA= STRONGLY AGREE, A=AGREE, UN=UNCERTAIN, D=DISAGREE, SD=STRONGLY DISAGREE

1.	When a student does better than usual is science, it is often because the teacher exerted a little extra effort	SA A UN D SD
2.	I will continually find better ways to teach science	SA A UN D SD
3.	Even if I try very hard, I will not teach science as well as I will most subjects	SA A UN D SD
4.	When the science grades of students improve, it is often due to their teacher having found a more effective teaching approach	SA A UN D SD
5.	I know the steps necessary to teach science concepts effectively	SA A UN D SD
6.	I will not be very effective in monitoring science experiments	SA A UN D SD
7.	If students are underachieving in science, it is most likely due to ineffective science teaching	SA A UN D SD
8.	I will generally teach science ineffectively	SA A UN D SD
9.	The inadequacy of a student's science background can be overcome by good teaching	SA A UN D SD
10.	The low science achievement of some students cannot generally be blamed on their teachers	SA A UN D SD
11.	When a low-achieving child progresses in science, it is usually due to extra attention given by the teacher	SA A UN D SD
12.	I understand science concepts well enough to be effective in teaching elementary science	SA A UN D SD
13.	Increased effort in science teaching produces little change in some students' science achievement	SA A UN D SD
14.	The teacher is generally responsible for the achievement of students in science	SA A UN D SD
15.	Students' achievement in science is directly related to their teacher's effectiveness in science teaching	SA A UN D SD
16.	If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher	SA A UN D SD
17.	I will find it difficult to explain to students why science experiments work	SA A UN D SD
18.	I will typically be able to answer students' science questions	SA A UN D SD
19.	I wonder if I will have the necessary skills to teach science	SA A UN D SD
20.	Effectiveness in science teaching has little influence on the achievement of students with low motivation	SA A UN D SD
21.	Given a choice, I will not invite the principal to evaluate my science teaching	SA A UN D SD
22.	When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand it better	SA A UN D SD
23.	When teaching science, I will usually welcome student questions	SA A UN D SD
24.	I do not know what to do to turn students on to science	SA A UN D SD
25.	Even teachers with good science teaching abilities cannot help some kids to learn science	SA A UN D SD