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# The Development of Techie Times

Brian D. Tedeschi
*Purdue University*

Julia K. Miller
*Purdue University*

Anne M. Lucietto
*Purdue University, West Lafayette, IN*, aluciett@purdue.edu

Nancy L. Denton
*Purdue University*

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**Mr. Brian D. Tedeschi, Purdue University, West Lafayette**

Brian Tedeschi is a current Graduate Student at Purdue University with research interests in STEM Education and informal learning environments. Brian received his Bachelor's Degree from Purdue University in Mechanical Engineering Technology and is currently working towards a Master's degree in Engineering Technology.

**Ms. Julia K. Miller, Purdue University, West Lafayette**

Julia Miller is a Grad Student pursuing a masters in Engineering Technology with a specialization in engineering/STEM education research at Purdue University. She received her undergrad degree in Mechanical Engineering Technology at Purdue University as well.

**Dr. Anne M. Lucietto, Purdue University, West Lafayette**

Dr. Lucietto has focused her research in engineering technology education and the understanding of engineering technology students. She teaches in an active learning style which engages and develops practical skills in the students. Currently she is exploring the performance and attributes of engineering technology students and using that knowledge to engage them in their studies.

**Prof. Nancy L. Denton P.E., Purdue University, West Lafayette**

Nancy L. Denton, PE, CVA3, is a professor of MET and associate head of Purdue University's School of Engineering Technology. She spent nine years on Vibration Institute's Board of Directors, and continues to serve on its Academic and Certification Scheme Committees. She is a Fellow and former Board member of ASEE, and a member of ASME.

# The Development of Techie Times


## Abstract

*Summer 2020 provided the motivation and opportunity to move summer outreach programs into the virtual world. Faculty and students in the Purdue University School of Engineering Technology moved face-to-face programs into a middle school program called Techie Times. This program was designed to provide students with an organized platform occurring just before the school year started, allowing them to learn at home, working with family, or independently.*

*The program was designed to take place nonconsecutively over eight days, covering five various STEM topics. Some of these activities were already a part of the middle school curriculum; others were not. That provided an opportunity to engage students and teach them principles that support various engineering technology curricula. Students were recruited from across the country. Students were placed into three cohorts sorted by biological age and then into smaller groups to enhance interactions. Volunteers moderated the smaller groups representing corporate engineering retirees, university professors, and others interested in helping. The volunteers were provided with information to support the principles being learned in the activity of the day. They asked the students to demonstrate what they did at home and then asked them questions about what they learned from the activity. In the older age groups, volunteers generated hypotheses and tested them to see if they worked, thus providing a challenge for the older and more experienced students.*

*This camp proved to be well-timed on the summer calendar. Parents expressed their pleasure in their students becoming a bit more disciplined as they transitioned from their summer activities to the upcoming school year. This paper will review the program's curriculum, observations by the parents/guardians, and feedback from the students. The program is an example of a well-transformed outreach program that engaged and enlightened students.*



Keywords: middle school, summer outreach, virtual, engagement, engineering technology


## Introduction

With the COVID-19 pandemic and limitations on large in-person gatherings, student summer camps were one of the activities that were directly affected. Summer college camps involve an extended stay on campus centered around student learning and community building. With the traditional in-person camp format not being possible, an alternative program approach was taken. The enhancement of virtual meeting platforms allowed for brainstorming on various ways to create a similar summer camp experience while practicing safe health measures. Out of this brainstorming came Techie Times, a STEM summer camp centered around doing activities from a home environment created.

Techie Times was developed by Purdue Polytechnic Institute Faculty, Graduate Students, and Undergraduate Students to create a new opportunity for camp participants to learn more about the STEM field, execute fun and engaging projects, and network with fellow students from around the country. The program was held from July 27th to August 5th, 2020, stimulating

STEM ideation before heading back into the school year. The program activities were completed all together at home, supported using virtual meeting platforms [1]. Techie Times was accessible to all participants, eliminating finances as a participation barrier. Participants were able to sign up and receive all the supplies necessary for the five various projects in a box, limiting the need for outside purchasing and leaving home. In addition to supplies, the box included specific instructions for the activities and guidance to resources such as the program's YouTube channel. The YouTube channel contained instructional videos to help supplement the written version via demonstrations and helpful hints.

## Literature Review

The program development team acknowledged that students differed by grade, location, educational system type, maturity, and experiences. All these factors raised various concerns and are summarized:

Grade. Students in different grades will have studied different materials. These students should be separated and the Common Core Standards [2] referenced because many states have adopted them to provide guidance on what should be covered in each grade level.

### *Geographic Location:*

The aspects of the educational process differ based on geographical location and socioeconomic status of the occupants in that region. Students from highly populated areas have more opportunities in the educational system to explore in-depth access to STEM versus students from more rural areas. This is related to the availability of qualified staff and resources in the rural school system. Socioeconomic status has an influence on how students pursue STEM.

While the opportunities for students in lower socioeconomic areas are less, they are more likely to pursue higher education and careers in STEM fields. [3] The importance of lessening the barrier of location and socioeconomics is important to continue to provide equal opportunity in STEM.

### *Educational System:*

Informal learning environments serve as supplemental classrooms for students across the globe. The types of supplemental programs have a diversity in focus interest and demographics. The content is generally more applied and practically focused. The types of program directly influence interest in STEM careers and boost self-efficacy in STEM based content. [4]

The classroom education system has a curriculum dictated by state and federal educational standards such as Common Core. This leaves less time and flexibility to teach subjects outside of the planned semester. While students learn STEM in the classroom, they prefer to learn aspects of the field in a hands-on, non-classroom format. [5]

### *Maturity:*

Academic maturity is an important factor in ensuring that the students learn content properly and are prepared to do so. A student's academic maturity has roots in their emotional and social maturity in a classroom setting. Anxiety and social maturity are factors that influence academic achievement. A study published in 2013 links social maturity and anxiety as factors that impact academics. In addition, it was found that anxiety increases in students that are from a rural geographic location. [6]

A student must have levels of maturity to be able to function in a formal or informal educational environment. By factoring in differing levels of maturity, an informal learning program can tailor the learning outcomes so that content is learned effectively.

***Life Experiences:***

Children are directly impacted by their guardians, through previous and current experiences. A meaningful factor to STEM academic achievement in students directly relates to the education of their guardian. Specifically, a female guardian's education has the most predicted impact on the academic achievement in STEM. [4, 7]

Female and underrepresented minority students experience inside and outside of the learning environment directly affect their interest in STEM. A study conducted in a Chatham County, Georgia showed that self-efficacy is important factor in STEM for both white and non-white students. While self-efficacy was equal for both sample groups, the study acknowledged target-improvement areas through intervention in the grade and middle school levels. [8]

Life experiences have a direct effect on how students learn content and the direction their professional life takes. It is important for an informal learning environment to keep in mind their target population during program creation.

***Knowledge Types and Oriented Students:***

Consideration of prior knowledge is key to the success of a program that serves a diverse population, where diversity is multifaceted. Ambrose informed the development team et al. [9] reviewing circumstances that may prove detrimental to student learning and hinder student engagement with the materials [10, 11].

The influence of prior knowledge concerning a new topic can and should be addressed for positive results. Meaningful learning experiences come from relating previous events and experiences to an unknown topic. Learning is built upon moving from known to unknown content and relating it to create further understanding. The issues identified by Ambrose et al. [9] include inactive knowledge, insufficient knowledge, and inaccurate and inappropriate knowledge. Each of these issues demonstrates areas of prior knowledge and experiences related to relate to learning outcomes.  Each is discussed a little more in-depth in the following section.

Inactive Knowledge. The principle of students having learned content before but being unable to build upon it when learning new concepts is referred to as inactive knowledge. While the students have learned it before, it does not aid when learning new concepts. The knowledge is present but is in a dormant state. For example, content learned from previous coursework must be applied in advanced courses but is only recalled. Students have demonstrated low-level competency previously but cannot apply said knowledge critically while their knowledge is inactive.

Insufficient Knowledge. The principle of not having enough relevant knowledge to effectively demonstrate competency or the performance expectations of all stakeholders is known as insufficient knowledge. Students' insufficient knowledge can occur from various areas related to personal or educational experiences with the given content. The most significant effect this has is that students often do not recognize the knowledge gap until applied in different situations. An example of this would be building on a concept from previous coursework in a series of consecutive courses such as mathematics. Students may perceive competence but lack the level necessary for desired outcomes.

Inaccurate and Inappropriate Knowledge. This is the concept of learning information that is either incorrect or not applicable to the learned content. While having the previous experiences drive learning is not a negative situation, having inaccurate or inappropriate knowledge is problematic. It can cause misunderstanding and misinterpretation that is detrimental to the learning process. It is difficult for any person to unlearn old information once viewed as accurate, impacting their learning ability within that concept [12].

The knowledge types of students possess often reflected in their goal orientation and motivation within a classroom space. Svinicki [13] talked about how students' goal orientation and motivation influence their learning, either positive or negative. Svinicki speaks of two types of students, Performance Oriented and Mastery Oriented. Performance-Oriented is focused on grade achievement and course requirements over true content competency and understanding. These students are often less willing to take on challenges to avoid making mistakes, thus limiting the learning value gained from the classroom. Mastery Oriented students are interested in the content itself and want to learn with little regard to achievement and requirements. These students are often willing to take on challenges to gain understanding and competency with the content. Both types of students are present within a classroom space, thus creating a need to have a ‘nirvana’ educational environment. An educator should create an environment where risk-taking is encouraged and has little impact on course performance through grades, as students will be driven to learn more from a Mastery Oriented perspective.

The ways students contain the knowledge and their goal orientation directly affect their competency and motivation to learn new content. Various knowledge types affect how students build upon new content, and their goal orientation will drive how they use their knowledge types

to achieve learning outcomes. This program's planning members recognized this and aimed to achieve an inclusive classroom environment where all knowledge and motivation styles would be welcomed and accommodated. Additional factors also drive learning within the classroom—age, Student Engagement, Pedagogical approach, and virtual learning all impact how students learn.

### *Age and Student Engagement:*

One means to surmount these potential issues is grouping participants by age. Students have been seen to persevere when other students of similar maturity and intent are working together [14]. For Techie Times, perseverance and interaction are critical in the total engagement of the program. Inferior engagement from any stakeholder would result in a gap that ultimately impacts student learning outcomes.

### *Pedagogical Approach:*

It was essential to take an adaptive pedagogical approach to run the virtual camp. Acting as a quasi-formal learning environment, Techie Times was designed to adapt to various learning styles and participant types. The primary approach was meant to be more constructivist and allowed students to learn concepts and become knowledgeable through intentional projects.

Constructivism theory is based on Jean Piaget [15, 16], a Swiss psychologist. Fosnot [17] and Wadsworth [18] elaborate on this as the foundational theory for instructional constructivism. The theory's core principle is the active learning process in which knowledge is built upon and created from self-discovery and active means. Pillars of constructivism rely on learners creating their hypotheses and conclusions based on hands-on practice. In the constructivist sense, errors need to be encouraged and deemed meaningful since errors lead to reconstructing knowledge based on experiences [17, 18].

Duffy and Cunningham defined constructivism concerning design and content delivery [19]. The authors define constructivism as the active process in which knowledge is built and not acquired, and instructional methods are meant to support the construction of knowledge over traditional communication means. The authors describe how constructivism and collaborative learning are related to aiding the instructional and knowledge-building process. Group learning supplements content from different viewpoints, allowing individuals to develop accurate knowledge from other learners' views.

Fosnot focused on the constructivist perspective with a focus on learning and teaching science. Fosnot elaborated on this by explaining how children learn based on the work of Jean Piaget. Piaget explained that it is essential that learning is done actively by the learner, not communicated from another person. Children must have the opportunity to gain personal understanding through knowledge-building activities, not lecture-type sessions. The author elaborates that science learning environments need to involve playfulness, intentionality, and encouragement for further investigation [17].

### *Virtual Learning: The Good and the Bad:*

The COVID-19 pandemic moved all educational environments to a primarily virtual setting starting in March of 2020. Most students were heavily reliant on technology and limited to learning through computer screens to finish school. The virtual classroom continued into the 2020-2021 school year and has certainly evolved. While the move to online instruction was out of necessity, the effects could be long-lasting and impact students' current population as they progress through their academic careers.

A 2020 article described the potential impacts of COVID-19 on the school system. [20] The main conclusions showed heavier reliance on online learning tools and less on formal assessments, thus creating an achievement gap. Considering education is not a "one size fits all" program, students can easily be left to flounder without personalized instruction if nearly all help is based on instruction intended to benefit the entire class population.

A virtual learning environment poses barriers such as access to sufficient resources necessary from the student perspective. While much effort has lowered this through the distribution of internet hotspots and laptops by various school systems, the barrier still exists in many places worldwide. (When keeping up in school requires sitting in a hotspot parking lot with a borrowed laptop in all sorts of weather, it is inherently tricky!). Positives of virtual learning allow students to access content on a broader scale and offer increased learning flexibility at different rates.

Given the Techie Time program's timing, the 2020-2021 school year was less than a month away for most students. The camp got students to start thinking in an educational mindset again while also stimulating new ideas for further exploration for the upcoming year. Besides, the virtual format allowed those in a virtual setting to prepare effectively and ensure proper access to technological needs.

**Questions Addressed**

Little guidance was available to aid in developing such a program necessitated by the quickly evolving environment. The authors brought diverse expertise ranging from over thirty years of award-winning outreach activities, teaching, and learning in the technical environment and success in teaching in the online environment, and volunteering with kids of all ages. Drawing on that expertise, they were able to address the following questions through program development and execution.

1. What demographic would benefit most from a virtual STEM camp program?
    a. How do you interact with participants using similar materials and a range of ages?
    b. How do you engage with these students who may be experiencing video burnout?
    c. What timing works best to achieve the goal of fun but an educational program?
2. How does the program timing affect the impact of the material and engagement?

**Methods**

One hundred fifty participants from around the United States were a part of the Techie Times program. The recruitment was done through online message boards for parents and the Purdue Polytechnic Marketing and Communications department. Within four days, the initial one

hundred spots were filled, so fifty additional spots were added. Hours were set based on participant interest and time zone. The participants' age ranged from six to fourteen, and the activities selected reflected the age demographic. Current programs such as Project Lead the Way (PLTW) offer STEM topics within the classroom and their program objectives were factors that contributed to the determination of the project set [21]. Having a balance between mechanical projects and electrical projects was an essential factor during the planning stages. Each activity covers a separate area within the STEM field and has principles related to it, offering a balance in topics. Table 1 lists the activities selected and a brief concept description. Each activity was intended to be completed in thirty minutes with little outside support (recognizing that the youngest participants would often need some help).

Table 1. Program Activities and Description.

| Activity | Description |
|---|---|
| Graphite Circuit | Using Paper, LEDs, a 9V Battery, & Graphite Pencils, students created a circuit of their design. This activity demonstrated basic electrical concepts. |
| CD Hovercraft | A CD in combination with a balloon, tape, and water bottle spout creates a pressure differential, thus having levitation. The activity demonstrated pressure versus area. |
| Coat Hanger Balance | A coat hanger with 2 cups attached via string allows for the demonstration of mass, volume, and density relationships. |
| Electromagnet | Using a small metal rod, copper wire, and an AA battery, students created an electromagnet capable of picking up a paper clip. *Concept is…* |
| Marble Roller Coaster | A cut in half pool noodle served as a track for a marble to travel. This activity demonstrates fundamental physics energy principles from Newton's Laws. |

Each activity was chosen based upon planning committee experience, either teaching or completing the activity. The overall goal was to balance activities that touch different concept areas and give the Techie Times experience variety. The activities were kept relatively the same for all age levels. The Graphite Circuit and Electromagnet activities were altered to allow for flexibility of battery choice, depending on availability and functionality, to benefit the 50 additional participants who did not receive complete camp kits.

Techie Times's format consisted of three synchronous sessions per day, each having a large and small group portion. The sessions occurred at noon, 3:00 pm, and 6:00 pm Eastern time. The three-session per day format was developed to account for the extensive reach of participants across the country and the participants' time zones. The specific timeslot and small group were

determined by participant birthdate. This allowed students to be closer in age to their fellow group members and more likely to have similar educational tendencies and backgrounds.

Consideration of Age. Research has recognized the presence of educational tendencies based on age. Having the groups narrowed by age allowed for similar traits to be recognized and addressed on a detailed level group by a group [14]. Age grouping allows participants to have a better experience amongst their peers and program volunteers to make changes based on the age shown.

Group Size: Small group settings allow children to develop academic and social skills in an educational setting. Young children often show difficulty with listening in a traditional classroom format [22]. The planning team recognized the importance of small group learning and aimed for a 10:1 student to volunteer ratio based on volunteer availability. Zoom ™ [1] was used as the official platform for Techie Times. The reasoning for this was availability through Purdue University and the planning team's prior experience using the software. The sessions were approximately forty-five minutes in length, with a significant group question and answer portion, a small group breakout session, and a large-group wrap-up. The session length was determined based upon the planning team's consensus and limited time barriers to participant involvement. The time length also limited screen fatigue and burned out which might be in place through the overabundant use of technology during the COVID-19 pandemic.

Volunteers: Volunteers led the small breakout sessions from the Purdue community. High school students to retired engineers comprised the group of volunteers responsible for executing small breakout sessions based on the day's current project. These volunteers were primarily based within the Purdue community and had experiences tied to STEM. The recruitment method of volunteers was primarily word of mouth and intentional selection based upon prior experiences. Each planning team member reached out to potential candidates and shared information about the program. The volunteers were given a lesson plan but frequently went above what was expected based on the participants' interaction and the volunteers' level of experience.

**The Program Results**

A Qualtrics survey developed by the planning team was developed to gain feedback from both the participants and their guardians. The survey was sent out via email upon completing the program's last day and available for two weeks after the program.

The student survey asked seven questions directly related to their experiences within Techie Times. The questions asked participants to rank their favorite programs, report on how many sessions and activities they completed, and offer open-ended feedback. The survey had thirty-three responses, with all of them answering the survey entirely. Students generally felt good about all the activities, with ninety-five percent of respondents citing they completed between

three and five activities. Students openly responded to the program and offered positives and negatives from their experiences. Students liked the small group format and noted relationship building as their favorite part of the program. Besides, students mentioned that the projects were fun and offered variety in the experience. The most abundant response to improvement suggestions was creating more instructional videos, having more detailed instruction sets, and having more project demonstrations during the session.

The parent and guardian survey were similar in format, allowing for a balance of open-ended feedback and direct information to gauge specific program metrics. The parental survey differed slightly in that the questions were geared to understanding the level of parental participation and learning what parents believed their students enjoyed most. The open-ended questions addressed the parents' insight into what needed improvement and finding out if their students had attended any other camps that summer—parental responses to multiple-choice questions about what projects their students enjoyed lined up with the participant responses. Parents most notably liked the engaging format and the ease of access for the projects. Areas of improvement related to signup processes, differences between the website schedule and actual session times, and kit delivery. Open-ended responses and anecdotal feedback were exceptionally positive regarding volunteers' patience and efforts to make sure each participant could stay engaged.

**Discussion/Conclusion**

Demographics: Students interested in exploring topics and coursework in STEM would best suit Techie Times in future iterations. Using core concepts, the program can impact a broad age group through various projects based on their current grade level.

Timing: The program timing best lies in the late summer months, with sessions at flexible but set times throughout the morning and afternoon. This will maximize the program's knowledge being directly applied in the classroom setting while helping students get back into a set routine. Future iterations of the program can address video-burn out by offering a mix of programs in-person while also creating more flexibility in how the program can be executed. Based on student and parent feedback, the program executed the content well, given the short planning and execution window provided for the summer 2020 version of Techie Times. The relatively minor issues in the areas of scheduling and shipping will be quickly addressed.

Overall, the program was well-received by the participants and their guardians alike. Guardians were elated with the camp itself and the summer camp-type experiences in a virtually distanced method. The participants liked the variety of projects and the supplemental instructional videos to help understand the projects and create them. The session's small group aspect was liked by participants, as it offered another perspective from a volunteer and gave the participants opportunities to share their experiences and learning outcomes with fellow participants cooperatively. (Some of the older participants set up various means of communicating to continue to interact). The volunteers often noted and commented on the involvement of their groups and stimulated that from all participants. One of the biggest fears as a planning team was the ease of use of Zoom™ and technology. There were few struggles with this, and Zoom™, the central platform, was well received by both the volunteers and the participants.

While the projects were well received, the feedback was explicitly directed towards the Graphite Circuits and the Electromagnet. Participants and those helping them shared that it was difficult to get these projects to work despite instructions on paper and video, even using the kit's supplies. Since these two projects were electrical concept-based, it is essential to note this for Techie Times' future iterations. More detailed instructions, more "if you do this, … problem" notes, and possibly more troubleshooting videos can be developed to reduce these challenges. This being the first iteration of the camp, one set of projects was selected for all the age groups to have consistency and ease of access for supplies. Various projects can be selected with future planning to challenge various age groups and create a unique experience per session. The sessions themselves can be developed to tie deeply into learning outcomes and relationships to current affairs and projects. Having age-specific project sets will also allow for more consistency with the Common Core and Project Lead the Way standards for STEM, further supplementing in-class instruction.

With the COVID-19 pandemic continuing to affect all areas of society, it is crucial to adapt summer camp experiences to give participants equal STEM learning opportunities. Techie Times was formed from analyzing this gap and was well received, given the short planning and execution timeframe. The program's format, along with the collaboration from members of the Purdue University community, allowed for eight days of STEM learning that had significant and likely lasting impacts on the participants and offered them a perspective into potential learning avenues and career choices.

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