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Examining Trends in Technology Teacher Openings in the United States Utilizing Artificial Intelligence

Session III: Supporting STEM Students

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Abstract

Technology and Engineering Education (T&EE) in the United States is rapidly evolving, driven by technological advances, changes in state and federal policies, and trends in the educational landscape. Reviewing each state's teacher database system for teacher openings in the 2023-2024 school year, this paper examines the trends seen with these teaching opportunities as well as regional disparities. These trends and disparities can help technology teacher preparation programs in understanding what movements are increasing in their respective regions. By examining this data, challenges are seen for technology teacher preparation programs, such as the continuing need for professional development and the ever-increasing shortage of qualified T&EE teachers in the United States. More importantly, the presenters will provide an overview of the analysis completed by ChatGPT. Demonstrations of how the presenters utilized ChatGPT to analyze the data and how others can create their own GPT to unlock endless opportunities with artificial intelligence. Recommendations for future research will also be presented.

Keywords: Technology and Engineering Education, Artificial Intelligence, ChatGPT, Teacher Shortage

Teacher Shortage

The Technology and Engineering (T&E) teacher shortage in the United States has been well documented throughout the previous decades (Volk, 2019; Moye et al., 2020; Love & Love, 2022). Not only is there a shortage of T&E teachers throughout the United States, but there is also a declining number of T&E teacher preparation programs (Volk, 2019). Volk (1993) noted there were 207 institutions in the United States which offered undergraduate industrial arts/technology education preparation programs in 1970. Conversely, Love and Maiseroulle (2022) identified approximately 60 institutions offering similar undergraduate preparation

programs. Each year, the American Association of Employment in Education (AAEE) conducts a nationwide survey to help identify the highest need areas of educational disciplines for the United States. The survey analyzes responses on the perceptions of leaders within school districts and colleges/universities with the supply and demand of disciplines. AAEE (2024) conducted their national survey with 455 responses, 174 being colleges/universities and 281 being public/private school districts. At the college/university level, the AAEE (2024) identified Technology Education as a field with a 'considerable shortage' with a score of 4.24 out of 5.00. At the school district level, the AAEE (2024) identified Technology Education as a field with 'some shortage' with a score of 3.97 out of 5.00. Several factors contribute to the teacher shortage, with one of the highest factors being a decrease in interested individuals entering the profession. Reasons for this include high stress environments and salaries have not maintained pace with inflation (Nguyen et al., 2024).

T&E Teacher Employment Opportunities in the United States

Each year since 2019, Maiseroulle has maintained a list of employment opportunities for T&E teachers across the United States to disseminate to members of the Kansas Technology and Engineering Education Association (KTEEA). To generate the list, a search across each state's official teacher opening database is conducted. Any opening for which a licensed T&E teacher in Kansas is qualified to obtain is then enclosed with the document. A detailed list of courses licensed T&E teachers in Kansas are qualified to teach can be found in Appendix A. In short, licensure for T&E teachers is for grades 6-12 and most courses within the technology systems identified by the Jackson's Mill (1980) model (i.e., Manufacturing, Construction, Communications, and Transportation). Most openings were easily identifiable as the titles for the positions were generalized. Examples of titles included 'Technology Education Teacher', 'Industrial Technology Teacher', and 'Industrial Arts Teacher'. While content specific job openings were included as long as the position includes courses related to licensure for Kansas T&EE teachers. For the purpose of this paper, only the 2023-2024 school year openings were utilized. A longitudinal study could be conducted with data available for the 2018-19, 2019-20, 2020-21, and 2021-2022 school years. However, data for the 2022-2023 school year was incomplete as the list of openings was last updated in February of 2023, whereas all other years the openings were updated in May of each year.

Findings

When reviewing the data for openings during the 2023-24 school year, openings varied by titles. Of the 643 openings 42% of those openings were content specific in nature (Table 1). Meaning the teaching opening was specific to an area of technology covered under the Kansas T&EE licensure model. These openings spanned across a wide range of technical subjects including, but not limited to, woodworking, welding, and carpentry. The second highest percentage of openings were 'Technology Education Teacher'. Interestingly, the term 'Technology Education Teacher' was a higher percentage (15%) than 'Technology and Engineering Education Teacher' (3%). With the field changing it's name from Industrial Arts to Technology Education in 1985 and subsequently changing from Technology Education to

Technology and Engineering Education in 2010 (Reed & LaPorte, 2015), it's intriguing to see how districts label their openings even with national initiatives have taken place.

Table 1

Teacher Employment Titles (N = 643)

Position Title	n (%)
Content specific (i.e., woodworking, welding, carpentry, IT, etc.) Teacher	269 (42)
Technology Education Teacher	93 (15)
Technology Teacher	68 (11)
Computer Science Teacher	48 (7)
Industrial Technology Teacher	47 (7)
STEM Education Teacher	44 (7)
Career and Technical Education Teacher	28 (4)
Technology & Engineering Education Teacher	19 (3)
Industrial Arts Teacher	18 (3)
Skilled and Technical Sciences Teacher	9 (1)

Note. Computer Science (in Kansas) encompasses various courses such as cybersecurity, programming, database applications, and coding so it is not included as a content-specific

Furthermore, it is important to note the states which had the highest number of openings (Table 2). As noted previously, only the state databases for teacher openings were utilized. Therefore, there could have been more openings in each state, but those openings could have been withheld from the respective state databases. For example, in Kansas, school districts are not mandated to provide opening information to the state database. Many school districts such as charter schools, private schools, and even larger districts don't provide opening information. Minnesota (n=40) and Kansas (n=40) equated to 12% of all national openings. Overall, the top ten states in terms of openings made up 41% of all openings in the United States.

Table 2

Top Ten States by Openings (N = 643)

State	n (%)
Minnesota	40 (6)
Kansas	36 (6)
New York	34 (5)

Georgia	28 (4)
New Jersey	25 (4)
California	25 (4)
Illinois	22 (3)
Pennsylvania	22 (3)
Texas	21 (3)
Colorado	21 (3)

When reviewing the regional disparities (Table 3), it was determined to analyze the regions utilizing the International Technology and Engineering Educator's Association (ITEEA) region layout. Region one (eastern) included the states of Connecticut, Delaware, Florida, Georgia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina, Vermont, Virginia, and West Virginia. Region two (east central) included the states of Alabama, Illinois, Indiana, Kentucky, Louisiana, Michigan, Mississippi, Ohio, and Tennessee. Region three (West central) included the states of Arkansas, Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, Oklahoma, South Dakota, Texas, Wisconsin. Region four (western) included the states of Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Region one had the most amount of openings, but also had the most amount of states included in the regional map (17). Conversely, region two had the least amount of openings with the least amount of states included in the regional map (9). Region three had the second most openings which included three of the top ten states with openings from Table 2 (Kansas, Minnesota, and Texas). Region four had the second most states included in the regional map (13), and equated to 19% of the openings nationwide.

Table 3

Employment Opportunities by Region (N = 643)

Location	n (%)
Region One (Eastern)	229 (36)
Region Three (West Central)	186 (29)
Region Four (Western)	123 (19)
Region Two (East Central)	105 (16)

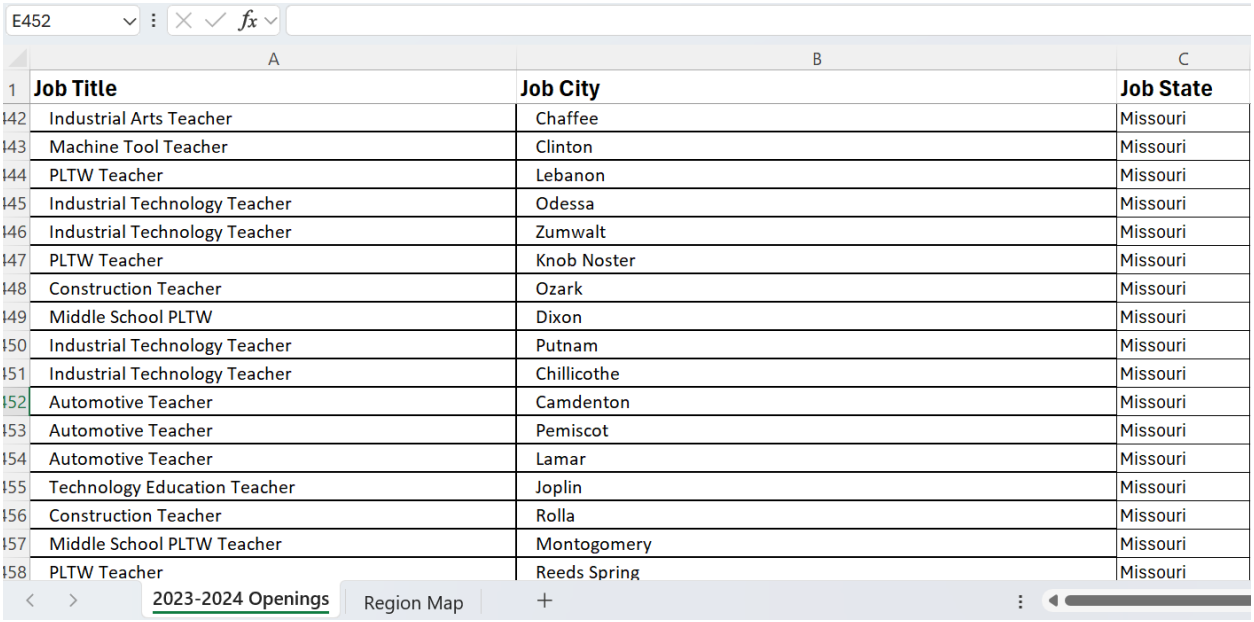
Methodology

Data was collected and stored into an Excel spreadsheet. Two separate sheets within the Excel document were created. One for openings in the United States and another for identifying the states for each region (Figure 1). This was so only one document was uploaded into ChatGPT. ChatGPT is an artificial intelligence natural language processing tool. This tool utilizes deep learning techniques to reach higher levels of linguistic understanding and capability (Drapkin, 2024). GPT stands for Generative Pre-trained Transformer and these models are pre-

trained utilizing large datasets of text data to help generate responses (Drapkin, 2024). ChatGPT is a subsidiary of OpenAI, which maintains the model. As of the writing of this paper, GPT-4 is the current paid version of ChatGPT and was the model used to analyze the data. GPT-4 was required as it allows the uploading of documents whereas the free version (GPT-3.5) does not. GPT-4 has more parameters than 3.5, meaning 4 is larger and is a more powerful model to use. Parameters are adjustable components of large language models which help transform inputs into outputs (Drapkin, 2024).

Figure 1

Screenshot of Excel Document for Data Analysis



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	A	B	C
1	**Job Title**	**Job City**	**Job State**
142	Industrial Arts Teacher	Chaffee	Missouri
143	Machine Tool Teacher	Clinton	Missouri
144	PLTW Teacher	Lebanon	Missouri
145	Industrial Technology Teacher	Odessa	Missouri
146	Industrial Technology Teacher	Zumwalt	Missouri
147	PLTW Teacher	Knob Noster	Missouri
148	Construction Teacher	Ozark	Missouri
149	Middle School PLTW	Dixon	Missouri
150	Industrial Technology Teacher	Putnam	Missouri
151	Industrial Technology Teacher	Chillicothe	Missouri
152	Automotive Teacher	Camdenton	Missouri
153	Automotive Teacher	Pemiscot	Missouri
154	Automotive Teacher	Lamar	Missouri
155	Technology Education Teacher	Joplin	Missouri
156	Construction Teacher	Rolla	Missouri
157	Middle School PLTW Teacher	Montogomery	Missouri
158	PLTW Teacher	Reeds Spring	Missouri

2023-2024 Openings | Region Map

Data was limited to three columns. Column A is titled ‘Job Title’, these were inputted exactly as what was labeled in the state databases. Columns B and C were designated for ‘Job City’ and ‘Job State’, respectively. Originally, the database had columns B and C combined with the state abbreviated (e.g., Clinton, MO), but ChatGPT was not recognizing this and would not analyze the data correctly. It’s important to properly format your data in Excel for ChatGPT to analyze it correctly and to avoid any errors. This includes eliminating any irrelevant spaces, rows, and columns (Solanki, 2023). It’s also important to define your titles of data. To do this, the beginning of each column was bolded and changed to a larger font. This row (row one) was also frozen so it would remain in place as the researcher would move down in the spreadsheet.

After all data was entered and formatted correctly, the document was uploaded to ChatGPT. This is similar to other applications, where to attach a document is an icon of a paperclip (Figure 2). Once the document was uploaded, the researchers needed to determine what to ask of ChatGPT to properly analyze the data in the Excel document. This is what is

known as ‘prompting’. There were several questions prompted to gather the needed trends and themes. There are two approaches to prompting. First, the researchers could have uploaded the document and ask each question one at a time. Second, the researchers could have uploaded the document and propose a single prompt with several questions at once. The researchers chose the latter approach (Figure 3).

Figure 2

Screenshot of ChatGPT Uploading a Document

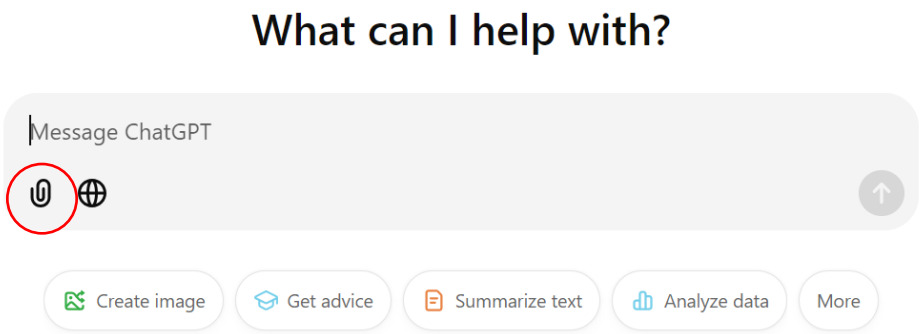
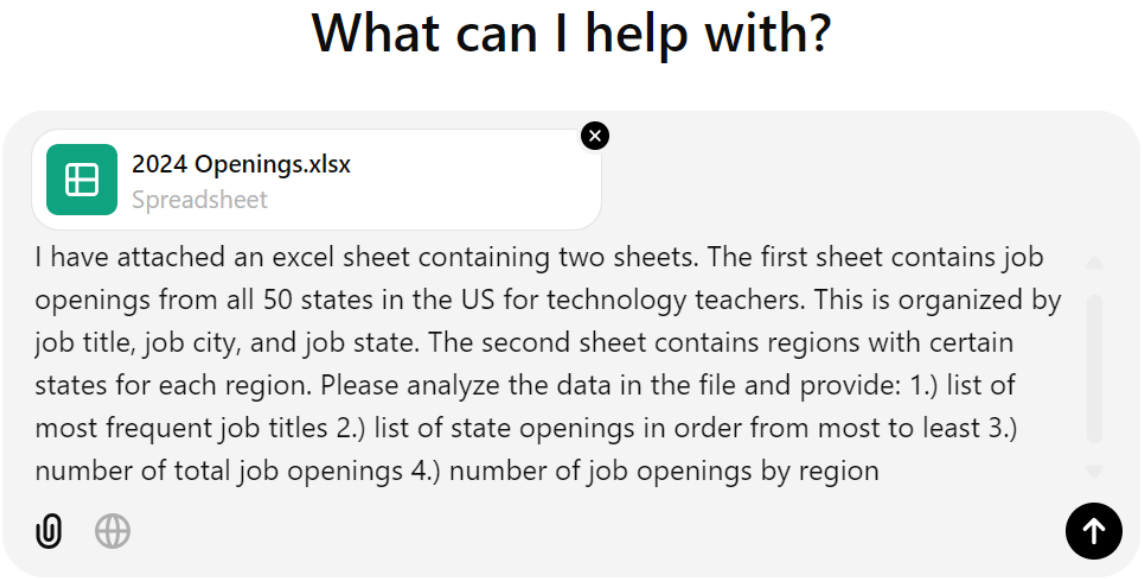


Figure 3

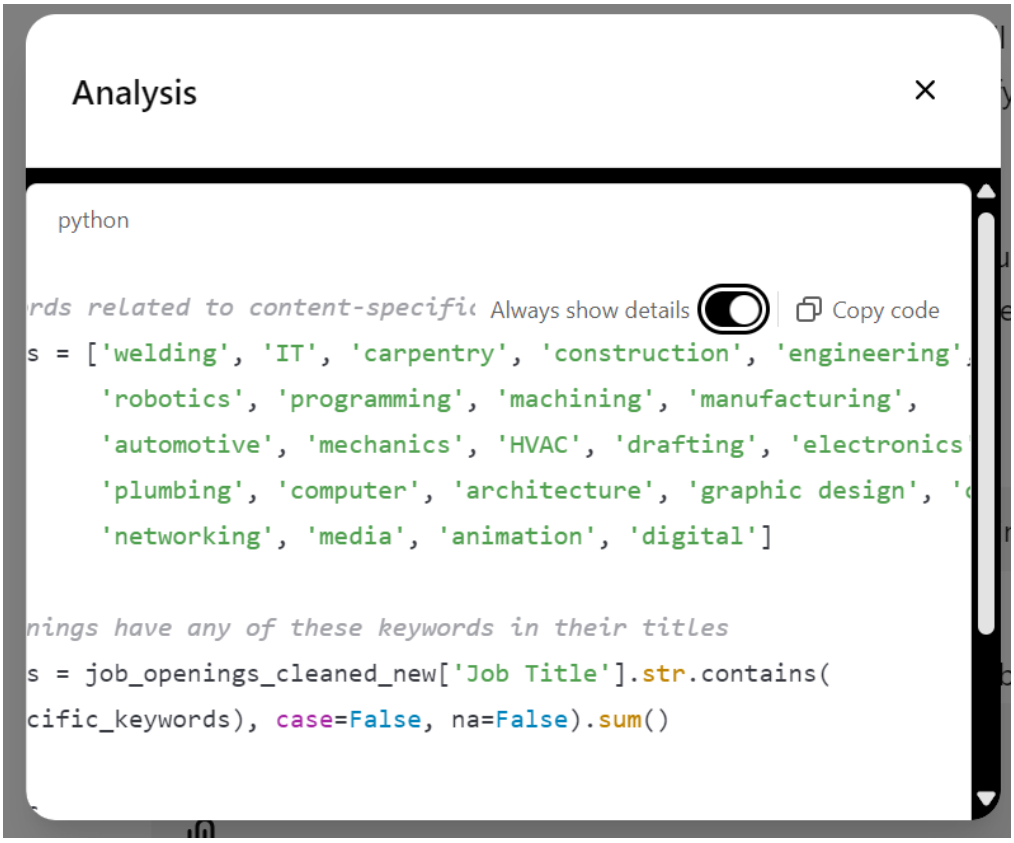
Screenshot of ChatGPT with a Document and Prompt



Once the GPT analyzed the data and answered the four questions within the prompt, there were further questions prompted to help further analyze the data. Since the system answered the prompt of listing the most frequent job titles, it was needed to see how many jobs were content-specific jobs (e.g., welding, woodworking, etc.) and not generalized listing (e.g., technology education, industrial technology, etc.). To analyze this, the prompt, "How many openings had a content specific (i.e., welding, IT, carpentry, etc) title?" was asked. Upon further inspection, ChatGPT was able to analyze all data and included titles the researchers didn't ask in the original prompt (Figure 4). This further analysis included terms such as programming, architecture, HVAC, and animation.

Figure 4

Screenshot of Further Analysis in ChatGPT



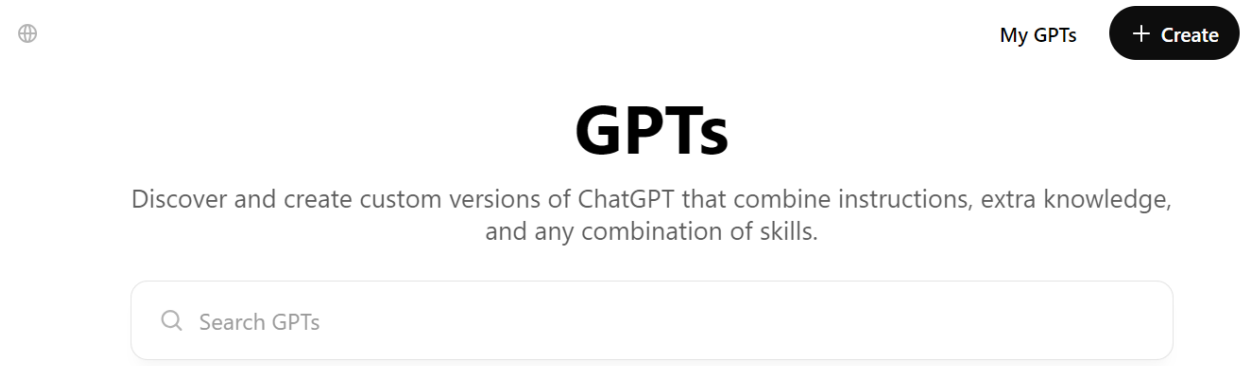
Future Developments and Recommendations for Research

The researchers have been in the development of creating their own GPT. In year's past, to create the job opening list, the researchers would have to go to each individual state database in May and record each opening. The GPT that is in development would analyze each state's database and provide an updated list of all openings with the simple prompt, "what are the

current openings as of today?". To develop a new GPT, there are several steps in the process. First, while in ChatGPT, there is an option to select from existing GPTs or to create your own (Figure 5).

Figure 5

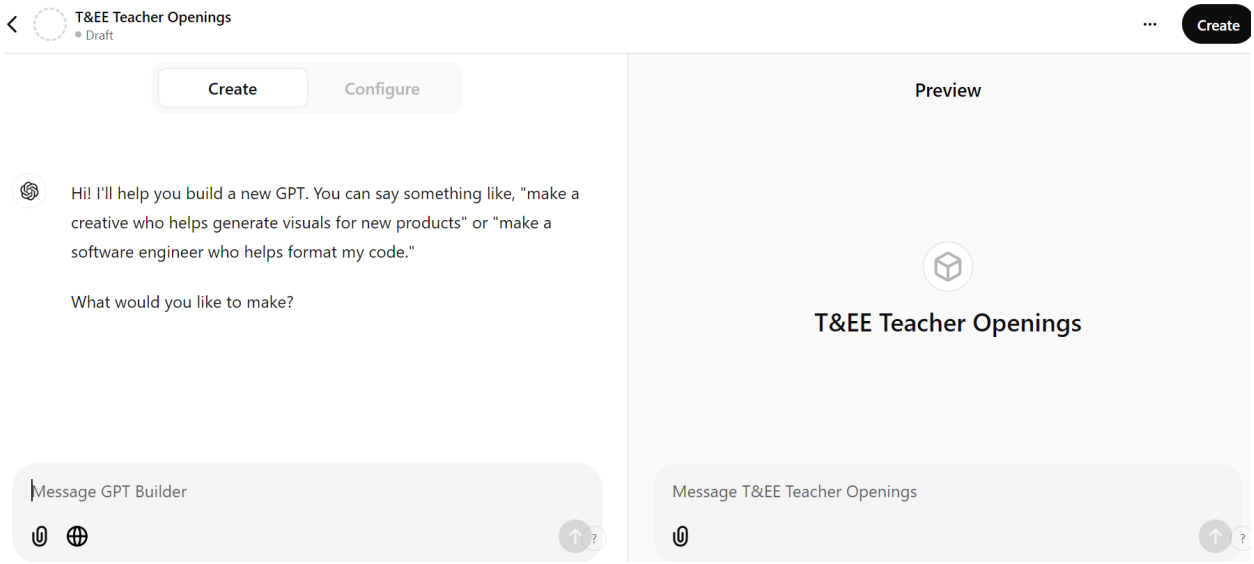
Screenshot of Option to Create GPT



After selecting the "create" option in the upper righthand corner, the system will provide the user with a new screen which is split into two. The left selection is the screen in which the user will develop the options for the new GPT and the right selection is the screen to preview the new GPT (Figure 6).

Figure 6

Screenshot of T&EE Teacher Openings GPT in Development



By selecting the "configure" option in the left selection screen, the user has several options to choose from. This includes the simple options of naming the GPT, adding a description to the GPT, as well as the advanced options of instructing the GPT as to what it should be accomplishing. In the "instructions" option, the user can enter exactly what the GPT should do in

the operation after it is prompted. This is where the researchers are currently experimenting with the system. Each state database URL is currently being entered into the "instructions" system with the exact directive to search the URL for openings. This is where the matter of listing each possible job opening title becomes time-consuming. For the GPT to accurately pull all the openings, each potential opening title must be entered.

Previously, gathering this data has been arduous and time-consuming. In addition, keeping it up to date has been almost impossible as it is everchanging. A snapshot of the data can be taken on a yearly basis, but openings can be posted and then removed for varied reasons which may not show up. Utilizing GPTs to collect and analyze the data will automate this task, allowing for different research pursuits. Currently, the researchers have collected the data from state websites which may not list all state openings, but a GPT may allow them to identify other websites with related job openings.

For further research recommendations on the "current openings" topic, it is recommended that a longitudinal study be conducted with all the previous year's openings list. This would be a study with five years' worth of data available to analyze. This will help develop more detailed trends in openings overall as well as trends within respective regions in the United States. It is also recommended to look at the potential in developing GPTs to further help the profession. Such as developing trends for ITEEA and other professional-related conferences in determining directions.

Other research focuses are also recommended. A GPT may be used to collect current positions and position titles related to the profession. This may identify how each state categorizes, or ignores, Technology & Engineering Education. Looking even deeper, a comprehensive list of course offerings could be gathered. This list may provide further insight into the needs of regions within the US as well a detailed look at how the profession names its content. A study of this data may identify how practitioners' vocabulary differ from state to state. This differing vocabulary may be a limiting factor as they seek to promote the content.

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Appendix A – List of Courses for T&EE Licensure in Kansas

Middle School Courses	
Computers	Exploration of Technology Labs
Media Technology	Manufacturing
Computer and Information Science	Industrial Safety/First Aid
Audio/Visual Production	Material and Processes
Printing Technology	Architecture and Construction
Keyboarding	Power, Energy, and Transportation Technology
Word Processing	

High School Courses	
Agriculture Welding I & II	Research and Development for energy
Agriculture Fabrication	advanced electricity & electronics
Sheet metal Technology	Principles of applied engineering
Carpentry I & II	Materials science in engineering
Woodworking principles	Engineering design
Remodel & Building Maintenance	Digital electronics
HVAC technology	Robotics
Plumbing technology	Computer integrated manufacturing
Pipefitting technology	Civil engineering and architecture
Skilled mechanical crafts	Aerospace engineering
Electrical & security systems	Emerging technologies
Drafting	Environmental science
Architecture design	Applied biochemistry
Computer aided drafting	Pharmacology
Production blueprint reading	Applications in biotechnology
Introduction to industrial technology	Biotechnical engineering
Furniture and cabinetry fabrication	Bioengineering
Advanced materials technology	Biomedical innovations
Interior architectural design	Health information
Graphic Design	Pharmacy technician
Computer applications	Foundations of information technologies
Graphic design fundamentals	Cybersecurity I & II
Audio/video production fundamentals	Information support services I & II
Digital media technology	Network systems I, II, & III
Computer graphics	Database Applications
Media technology	Data systems/processing
Web page design	Computer programming
Teaching as a career	Computer science I & II
Teaching internship	Computer science principles
Educational leadership	Computer coding
Educational research and innovation	Interactive media
Teaching observation	Game design

Mass production I & II	Animation
Hand and power tools	Internet marketing
Aviation fundamentals	GIS technology
Aviation systems	GIS spatial applications
Tooling I & II	Production methods I & II
Aerostructures I & II	Introduction to welding
Composites I & II	Welding Processes I & II
Part design	Automated Integrated Systems
Assembly design	Computer aided machining I & II
Wireframe and surfaces	AC electronics
Aerospace drawings	DC electronics
Meteorology	Unmanned aircraft systems
Mechanical power transmission systems	Flight training
Hydraulics & Pneumatics	Digital electronics
Introduction to energy	Automotive information
Energy, power, and Society	Introduction to transportation
Wind energy operations	General automotive service I, II, & III
Fundamentals of electricity and electronics	Brakes I & II
Automotive collision I & II	Drive train technology
Automotive refinishing I & II	Alternative power
Workplace experiences	Small engines & Powertrains I & II
Engine performance I & II	Engine mechanical repair
Steering & suspension I & II	Diesel engine technology
Mobile HVAC	