Investigating Competencies in Electrical Engineering: Alignment Between Internet Media and Job Postings

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(Work in Progress) Comparing Frequencies of Electrical Engineering Competencies Recommended in YouTube Videos and Job Postings
(Student-Led Research on Engineering Education)

Abstract
This study will investigate the relationship between the technical and professional competencies for electrical engineering students outlined by job postings versus internet media on YouTube. On many internet media sites, advice surrounding the best skills to acquire to ensure relevancy in certain fields is very common and serves as a useful resource for those looking to build certain competencies for employment. The proposed approach would first involve collecting transcript data from video sources that enumerate recommended skills for jobs in electrical engineering on sites such as YouTube. We can then analyze and extract the core competencies recommended by each source using prompt engineering techniques to ensure consistency and expedite the process. Using this data, we can determine the similarity of the competencies recommended by internet media and the existing data on competencies requested from job postings by analyzing the frequency and emphasis of each of the competencies identified.

Introduction *Electrical Engineering Dataset*
The electrical engineering dataset that was created in the study by Feyijimi et al. [1] gives great insight into what employers are potentially looking for when it comes to acquired skills. Its innovative use of Large Language Models (LLMs) to expedite and standardize the process of extracting competencies from job postings inspired this paper. Because of its larger sample size, as well as its extraction of competencies emphasized in job postings, it can be used to gauge demand for certain skills in the electrical engineering hiring space.

YouTube Learning
Social media has become an increasingly important part of the everyday lives of billions of people [2]. People often share their ideas, thoughts, and opinions online, making it easier than ever to communicate with others. Because of the near ubiquitous adoption of social media, it is often used as a proxy for measuring public opinion, as seen in Nugraha et al. [3], where they explored public reactions to lockdowns from the Covid-19 pandemic on social media platform Twitter.

The social media platform YouTube has become a popular source to draw from, as the long-form content allows for in-depth discussion and vast amounts of data. Prior research on YouTube has focused primarily on sentiment analysis of user comments [4], but our study focuses on the advice given by industry professionals in the videos themselves.

Furthermore, YouTube serves as an educational tool for students entering the workforce. A study found that approximately 31% of Malaysian university students used YouTube for an hour or more daily for educational purposes [5]. This emphasizes the value of YouTube as a source of industry-relevant knowledge.

By comparing advice from YouTube to the requirements listed in job postings, we can assess the alignment between recommended skills and industry needs. This may help educators, students, and content creators better understand which competencies are emphasized or overlooked.

Chain of Thought (COT) Prompting
Chain of thought (COT) prompting has emerged as a significant technique in natural language processing (NLP), particularly in enhancing the performance of large language models (LLMs) such as GPT-4 [6]. This method involves guiding the model through a structured sequence of reasoning steps, which facilitates the accurate and coherent completion of complex tasks [6]. COT prompting is rooted in cognitive science theories, which suggest that breaking problems into intermediate steps enhances problem-solving and decision-making.

Methods
This study aims to investigate the relationship between the technical and professional competencies outlined by job postings for electrical engineers gathered from the dataset from previous work and the technical and professional competencies that have been extracted from our created YouTube video dataset. In addition, the study aims to test the efficacy of using LLM's to enhance and speed up extracting key terms and themes from video transcript sources. This study explores the use of COT prompting techniques when prompting LLM's to complete this process.

Data Collection
This section will detail the three-stage data collection process.

   Stage 1: Exploration and Identification of Relevant Search Terms: To identify the most effective search terms for locating relevant video content, various combinations of potential search terms were systematically tested. Each set of terms was entered into the YouTube search engine, and the results were evaluated based on relevance. YouTube was selected as a popular source for college-aged individuals [5]. In addition, YouTube provides ways for users to assess the applicability of the content (likes, dislikes, views) and falls outside of the typical curriculum for electrical engineers. This means that the advice provided is driven by consumer need. Finally, YouTube provides transcripts for the videos in a public format, making the content accessible to everyone. This is different than individualized platforms where there are algorithms and/or privacy restrictions that lead to user customized content feeds (e.g., LinkedIn, TikTok, etc.).
   We used several factors to determine the relevance of the videos, including age of the video, comment reviews, and inclusion of key project-related words. Table 1 details how these criteria were used to assess the relevance of the search results. As outlined, preference was given to more recent videos, with anything posted 6 or more years before the date of the search being excluded (age of video). Videos older than 6 years were excluded to ensure that the content being analyzed reflects the current landscape of electrical engineering. One of the contributors reviewed the comments left on videos to assess the quality and accuracy of the video's content (comment reviews). Videos with consistently negative reviews (~75% or more of the top 10 comments at the date of the search) were excluded from the data set. Finally, to ensure the videos were relevant to this study, videos that did not include any of the keywords for this project were excluded.

Table 1. Detailing the criteria used to assess the relevance of search results

Criteria	Criteria	How Operationalized
Age of Video	Requiring recent videos to ensure up-to-date information	Exclusion of videos that posted 6 or more years ago before search date
Comment Reviews	Reviews of comments made on videos to gauge the quality and accuracy of the video's content from those viewing the video.	Videos with consistently (~75% or more of the top 10 comments at the date of the search) negative reviews were excluded.
Inclusion of Key Project-Related Words	Videos containing specific keywords pertinent to the project.	Exclusion of videos not relevant to the keywords. Keywords shown below in search term.

Following the evaluation, the single most effective search term was selected. We used the following term, as it was the most inclusive term yielding high quality results. No filters or options were selected when the search was completed.

"(Tips OR Tricks OR Recommendations OR Advice) AND Electrical Engineering AND (Job OR Employer OR Competitive) AND (Skills OR Knowledge OR Competencies) "

Using this term, a comprehensive search was conducted manually to gather links to 39 relevant videos. These links were systematically recorded in an Excel file for further analysis, and a list of these videos is included in Appendix A.

Stage 2: Transcript Retrieval: For each of the identified relevant videos, the transcript was extracted. By going into the video description and pressing "Show Transcript" a menu appears that makes it possible to access the generated video transcript. Then, the transcript was manually copied and pasted directly from YouTube into an Excel file. The retrieved transcripts were then processed to convert them into text from transcript form. This involved the removal of time stamps and correction of word spacing.

Stage 3: Transcript Evaluation: For this study, we built off ongoing work by members of the research team to adapt a framework to perform deductive thematic analyses [redacted; under review]. This method leverages a combination of prompt engineering techniques (PETs), natural language processing via large language models (NPL via LLMs; i.e., ChatGPT), and Bradley et al.'s framework on thematic analysis. Appendix B details the exact prompts used to extract relevant themes and ideas from the transcripts. Bradley et al.'s study outlined a method where several codes should be identified prior to coding, and using the definitions of those codes, examples from the texts should be highlighted and placed into a table [7]. To ensure that the large-language model used for the experiment was adept at performing this task, one of the contributors performed a manual coding of five random transcripts and compared them to the coding tables that the AI was able to produce. Table 2 details the list of codes identified prior to performing our coding analyses.

Table 2. Codes used to guide the deductive thematic analysis.

Code	Definition
Technical Competencies	
Electrical Systems	Understanding and working with the design, operation, and maintenance of electrical systems and equipment.
Mathematics & Physics	Proficiency in concepts from trigonometry, calculus, chemistry, physics, and electromagnetic principles.
Engineering Knowledge	Broad engineering principles, including thermodynamics, computer programming, and advanced specializations like signal processing and optics.
Hands-On Skills	Gaining practical experience through projects, internships, or experimentation.
Problem-Solving	Ability to analyze and solve real-world problems using engineering principles.
Professional Competencies	
Ethics & Safety	Commitment to ethical practices and safety in engineering for societal and environmental benefit.
Self-Reliance	Developing independence and self-motivation in academics and career planning.
Networking Skills	Building connections with peers and professionals to learn and grow.
Career Development	Securing internships or projects to gain relevant experience and prepare for professional opportunities.
Communication	Documentation, reporting, and collaborative efforts within engineering projects.
Investment Awareness	Awareness of the financial and time commitments involved in engineering.

Data Analysis

Frequency Analysis

The processed data was analyzed to determine the frequency of keywords that correspond to competencies that were included with the prompt. By analyzing the frequency of these competencies, we can determine which of them is most frequently recommended by YouTube videos. These frequencies will then be compared to the frequencies of competencies found in the electrical engineering job posting dataset to determine the similarity.

Preliminary Data Retrieval

The processed transcripts were individually analyzed using a conversational AI model, called ChatGPT 4o. Each transcript was copied and pasted into the AI with a specific prompt designed to extract preliminary data.

Data Recording and Refinement

The preliminary data retrieved from the AI analysis was recorded in an Excel sheet. This initial analysis provided a foundation for further refinement. This methodical approach ensured the collection of high-quality, relevant data through a combination of search term optimization, advanced transcript processing, and iterative AI analysis. The data was meticulously documented at each stage, facilitating a robust and reliable analysis for the project.

Preliminary Results and Discussion

Manual Coding and AI Coding Comparison When comparing the 5 manually coded transcripts with the AI coded versions, we found them to be over 90% similar, which was above the selected threshold for coding reliability of 80% [7]. However, this comparison was only between one human coder and the AI, which could skew the data as there are very few data points. Based on this limited dataset, we can assume that Chat-GPT is a reliable coder. In the future, we hope to increase the number of human coders to compare with Chat-GPT in order to ensure its reliability.

Table 3: Frequency of codes for both human and AI for 5 selected comparison transcripts.

Code	Frequency	
	Human	AI
Electrical Systems	21	23
Mathematics & Physics	8	10
Engineering Knowledge	12	13
Hands-On Skills	12	12
Problem-Solving	10	11
Ethics & Safety	4	5
Self-Reliance	6	5
Networking Skills	21	25
Career Development	13	11
Communication	20	23
Investment Awareness	9	9

Electrical and Computer Engineering Competencies

As demonstrated in Table 3, we found that the codes that were identified in the transcripts were weighted equally between the technical competencies and professional competencies outlined in the identified codes. Findings detail that Communication, Electrical Systems, and Networking Skills were the most emphasized.

This demonstrates that information and advice on YouTube equally weigh the value of technical and professional competencies. This is surprising given the focus of engineering curriculum on technical skills. At the same time, there has been a rise in emphasis on developing professional skills for engineering students. Given how we selected the videos, these are among the top blog posts viewed related to support electrical engineering students seeking jobs. It is possible other videos may be accessed on this topic (e.g., generic advice on job interviews; topic area specific [power electronics, robotics], etc.) and that other platforms may be more used by those seeking electrical engineering jobs (e.g., TikTok platform, blog posts, LinkedIn, etc.). At the same time, YouTube is a prevailing resource for college-aged individuals, and these findings suggest that

they value advice surrounding both technical and professional competencies, with an emphasis on communication, electrical systems, and networking skills.

Future Work
The next step in this study is to continue the use of ChatGPT to analyze the entire dataset. From this we will learn the frequency of certain competencies recommended by YouTube videos. In addition, we seek to examine the content of the videos (e.g., who made them; when they were posted; views per competency, etc.) This data will then be compared with existing data gathered from job posting sites and analyzed. This is important because it provides new information as to the alignment between media on YouTube and the requests from job postings. This could help future students and employers better understand which sources they should listen to and which skills they should improve or emphasize.

References

[1] T. Feyijimi, N. Hunsu, and S. Bork, *Exploring and Analyzing Competencies in Electrical Engineering: A Natural Language Processing and Thematic Analysis Approach,* Unpublished MS Thesis, 2024.

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[5] S. Moghavvemi, A. Sulaiman, N. I. Jaafar, and N. Kasem, "Social media as a complementary learning tool for teaching and learning: The case of YouTube," *Int. J. Manag. Educ.*, vol. 16, no. 1, pp. 37–42, 2018.

[6] J. Wei et al., "Chain-of-thought prompting elicits reasoning in large language models," *Adv. Neural Inf. Process. Syst.*, vol. 35, pp. 24824–24837, 2022.

[7] E. H. Bradley, L. A. Curry, and K. J. Devers, "Qualitative data analysis for health services research: Developing taxonomy, themes, and theory," *Health Serv. Res.*, vol. 42, no. 4, pp. 1758–1772, 2007.

Appendix A

Table A1. The videos and transcripts included in the study.

4 Things You Should Know About ELECTRICAL ENGINEERING	https://www.youtube.com/watch?v=k0K9KWYh5SU
Advice For Electrical Engineering Freshmen	https://www.youtube.com/watch?v=IYIr74pqnKY
Most Important Skills for Electrical Engineering	https://www.youtube.com/watch?v=tAumFg7o-Kw
Most Important Electronics Engineering Skills To Learn	https://www.youtube.com/watch?v=QFT3hS9XYxQ
If I Were Looking For A Tech Job In 2024 I'd Do This	https://www.youtube.com/watch?v=fOnUAAUXC1E
Which Electrical Engineering Subfield is For You?	https://www.youtube.com/watch?v=GaXyzcm9HLY
What I Made as an Electrical Engineer	https://www.youtube.com/watch?v=iI5ZCfEPiFI
Here's why an electrical engineering degree is worth it	https://www.youtube.com/watch?v=g9GuTXzOpUE
Skill set to be developed for ECE / EEE students | Dream Job	https://www.youtube.com/watch?v=eUDysdIEHHE
4 Years of Electrical Engineering in 26 Minutes	https://www.youtube.com/watch?v=ngo3ZTrT69A
Advice from an Electrical Engineering (BSEE) student from drkit.org	https://www.youtube.com/watch?v=DIyL2yUC5fI
Ask an Electrical Engineer - Jobs and Careers Edition | Part 1	https://www.youtube.com/watch?v=l76wOsgeQNI&t=303s
Top 5 Best Skills For Electrical Engineering Resume | @henryharvin	https://www.youtube.com/watch?v=20ILLTiUIvU
How to Become an Electrical Engineer	https://www.youtube.com/watch?v=6A5zIKnARDw
So You Want to Be an ELECTRICAL ENGINEER | Inside Electrical Engineering	https://www.youtube.com/watch?v=H7q7ArJ5lXY
BEFORE Becoming An Electrician.. Here's What You MUST Know!	https://www.youtube.com/watch?v=hPo39C9yrQw
Top 7 Skills for Every Engineer 🔥 | Skills All Engineers Must Learn	https://www.youtube.com/watch?v=Gosc-y77oww
Traits you should have if you're considering Engineering	https://www.youtube.com/watch?v=kAJuEPJ_mkw

10 advice for electrical engineering students	https://www.youtube.com/watch?v=j_yAJFodUeU
Advice to get into ELECTRICAL ENGINEERING? #shorts #ytshorts #techjobsin2minutes	https://www.youtube.com/watch?v=No3RxHaqjnM
Effective Strategies for Finding Job Openings as an Electrical Engineer	https://www.youtube.com/watch?v=VVMQFusLLKQ
Exploring Careers in Electrical Engineering	https://www.youtube.com/watch?v=8oZ1Ti4iViE
Advice for Prospective Electrical Engineering Students	https://www.youtube.com/watch?v=kKFX2ZvwpME
Building a Strong Resume as an Electrical Engineer: Tips and Examples	https://www.youtube.com/watch?v=curvbr8Ogts
What You Can Do with an Electrical Engineering Major	https://www.youtube.com/watch?v=MWKY0L_PFlc
Tips for an Electrical Engineering Interview #EE #electrical #engineering #interview	https://www.youtube.com/watch?v=zrRUMy19zIg
Electrical Engineer job Requirements	https://www.youtube.com/watch?v=9bz0L93h7H0
Ask an Electrical Engineer - Jobs and Careers Edition	Part 2	https://www.youtube.com/watch?v=miyZ031KRo8
Supercharge Your Electrical Engineering Career By Doing This…	https://www.youtube.com/watch?v=Qwqw2HsLzCA
Electrical Engineer Job Description	Electrical Engineer Roles and Responsibilities and Duties	https://www.youtube.com/watch?v=WtKmIji9kIk
eevBLAB #78 - Engineering Student Job Advice	https://www.youtube.com/watch?v=KJEmBtvZrPU
What's The BEST Skill ? Electrical Engineering Skills Ranked	https://www.youtube.com/watch?v=bXpG5tAz8YE
Career Insights: Choosing to become an Electrical Engineer	https://www.youtube.com/watch?v=kG-SJl79ifs&t=19s
The most asked interview questions for Electrical Engineers	Part 1	https://www.youtube.com/watch?v=llbmwVWsRog
Electrical Engineering Student - 6 Things We Wish We'd Known	https://www.youtube.com/watch?v=YXPnvV8Ia0M
Mastering Electrical Engineer Interviews: Tips and Insights	https://www.youtube.com/watch?v=mCUx1C6PlfA
Electrical Engineer: Approach to Communication with Team Members & Stakeholders	https://www.youtube.com/watch?v=HkGWKa9h1aY&t=41s

| CV for Electrical Engineer Common Mistakes to Avoid | https://www.youtube.com/watch?v=-IML4I4HMng |

Appendix B

This appendix details the PETs used to perform deductive thematic analysis using ChatGPT, using a modified version of the framework developed by the research team [redacted; under review].

Instructions:

- The following competencies, along with their definitions should be used as codes in the following coding analysis.

Table 2. Codes used to guide the deductive thematic analysis (repeated from in-text).

Technical Competencies	
Electrical Systems	Understanding and working with the design, operation, and maintenance of electrical systems and equipment.
Mathematics & Physics	Proficiency in concepts from trigonometry, calculus, chemistry, physics, and electromagnetic principles.
Engineering Knowledge	Broad engineering principles, including thermodynamics, computer programming, and advanced specializations like signal processing and optics.
Hands-On Skills	Gaining practical experience through projects, internships, or experimentation.
Problem-Solving	Ability to analyze and solve real-world problems using engineering principles.
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Networking Skills	Building connections with peers and professionals to learn and grow.
Career Development	Securing internships or projects to gain relevant experience and prepare for professional opportunities.
Communication	Documentation, reporting, and collaborative efforts within engineering projects.
Investment Awareness	Awareness of the financial and time commitments involved in engineering education.

- Conduct a coding analysis of the following YouTube transcript, using the codes outlined above.
  [Insert transcript]
- Look for ideas and wording that pertains to the given codes in the YouTube transcript.

Metrics:

- **Quotes:** Provide each quote that represents each instance of a theme in tabular form, with the first column occupied by the code and the second column occupied by the various quotes that represent the give code. Multiple quotes are possible per

code. Only provide quotes that are present in the text. Review the table after it is generated to ensure the quotes are present in the text.

- **Frequency:** Report the frequency of each theme category to understand their distribution. Report your findings in tabular form.