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Exploring Perspectives on Pre-College Robotics Education: A Social Media–Based Topic and Emotion Analysis (WIP)

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Abstract

Background: Pre-college engineering education has been shown to increase students' interest in engineering pathways, and robotics education plays a key role in supporting technological engagement. However, existing research is largely context-specific, underscoring the need for large-scale analyses that capture broader patterns in how robotics education is discussed and experienced across diverse settings.

Purpose: This work-in-progress study leverages social media data to examine broad perspectives on pre-college robotics education by analyzing themes and emotional expressions in Reddit discussions. In particular, we ask: *What themes characterize online discussions about robotics education, and how are these themes associated with distinct emotional profiles?*

Methods: We collected English-language Reddit posts from 2023 to 2025 from subreddits associated with K–12 robotics education and robotics competitions (e.g., FLL, FTC, FRC). Posts were retrieved using education-related keywords such as *course, curriculum, student, programming,* and *competition*, resulting in a total of 4,214 posts. Topic modeling was conducted using BERTopic with OpenAI embeddings. Topic labels and summaries were generated using GPT-4o-mini. Sentiment analysis was performed using LLM-generated JSON outputs, with emotions aggregated at the topic level.

Results: Nine themes emerged from the topic modeling analysis, including Exploring Robotics Education Resources, Seeking Mentorship in Robotics Education, Troubleshooting Robotics Programming, Enchanted Robotics Class Concepts, Sharing Resources for Robotics Education, Challenges in Online Robotics Resources, Collecting Robotics Pins for Education, Future Tools for Robotics Education, and Dean's List and Robotics Involvement. The distribution of posts across topics was highly uneven. Across themes, discussions were characterized by high levels of curiosity and excitement, alongside varying degrees of frustration and anxiety, reflecting both enthusiasm for robotics education and challenges related to technical and instructional support.

Next Steps: Future work will focus on improving post classification and integrating qualitative analysis. More fine-grained or hierarchical topic modeling approaches will be explored to better handle noise inherent in heterogeneous Reddit discussions. In addition, human coding will be incorporated to distinguish posts from teachers, students, and parents, with particular attention to teacher perspectives, and to examine how instructional contexts and technical constraints shape emotional experiences in robotics education.

Introduction

In response to the shortage of Science, Technology, Engineering, and Mathematics (STEM) professionals needed to meet national demands for technological advancement, educational institutions have increasingly turned to robotics as a way to help pre-college students learn key STEM concepts and foster their interest in engaging with engineering [1]. Through hands-on experiences and teamwork, young students are introduced to the engineering design process and, in some cases, participate in regional and national competitions such as the FIRST LEGO League and the FIRST Tech Challenge. Providing young students with robotics experiences also creates opportunities to discuss related STEM topics in the classroom, thereby enriching their learning experience within the standard curriculum [1]. In both instructional and competitions settings, teachers play a critical role in facilitating these experiences [2]. Understanding their experiences in navigating robotics education is essential for providing effective support and increasing the likelihood of successful robotics learning outcomes.

As pre-college institutions increasingly incorporate robotics education into their curricula, teachers may face challenges in implementing robotics education in their classrooms. Teachers perceive the value that robotics brings to their students, yet they also point to challenges related to adding additional content to the curriculum under standardized testing pressures, as well as to their lack of technical knowledge in robotics [3]. Pre-college teachers are not typically trained in robotics education, and unfamiliarity with robotics content can negatively affect their self-efficacy and willingness to implement robotics education in their classrooms [4]. To navigate these challenges in the context of the newness of robotics education, or to learn how to support their students in competitions, pre-college teachers turn to online forums and discussion spaces such as Facebook communities and Reddit subreddits to share their experiences, identify potential opportunities, and ask questions within a network of other educators who are implementing robotics education and facing similar situations. Investigating discussions in these online forums can contribute to a better understanding of the experiences that pre-college teachers face when implementing robotics education, thereby clarifying how programs and collaborators could support this population in these efforts.

Educational research has leveraged online networks and social media as rich learning spaces used by teachers, parents, and administrators, and has examined prominent discussion themes through the use of Natural Language Processing (NLP) techniques. Prior studies have applied NLP-based approaches to analyze online educational discourse. For example, BERT-based topic modeling combined with discourse and social network analysis has been used to examine how users discuss ChatGPT in educational contexts [5]. Latent Dirichlet Allocation (LDA) has also been employed to investigate discussion patterns among Reddit users in higher education–oriented subreddits [6].

Building on this body of work, this work-in-progress leverages NLP techniques to advance the existing literature on pre-college teachers' experiences with robotics education. To address these goals, we pose the following research question: ***What themes characterize online discussions about robotics education, and how are these themes associated with distinct emotional profiles?***

Methods

Data Collection and Clean

This study selected Reddit as the primary data source. Reddit is one of the largest user-generated content platforms globally, and its subreddits provide a structured environment for domain-specific discussions. We focused on five robotics competition communities: r/FLL (FIRST Lego League), r/FTC (FIRST Tech Challenge), r/FRC (FIRST Robotics Competition), r/vex (VEX Robotics), and r/lego (LEGO-News from a Studded World).

Data was collected using the Python library PRAW (Python Reddit API Wrapper) through targeted keyword searches. A query matrix consisting of 14 education-related keywords was constructed, including “course”, “class”, “curriculum”, “teach”, “learn”, “coach”, “student”, “beginner”, “kids”, “K–12”, “high school”, “kit”, “programming”, and “competition”. The data collection window spanned from August 1, 2023, to September 24, 2025, allowing us to capture emerging shifts in robotics education during the rapid expansion of generative AI technologies.

Following data collection, we conducted deduplication based on Reddit post IDs and performed outlier screening. The final analytical dataset comprised 4,212 unique posts, including post titles, full textual content, and timestamps.

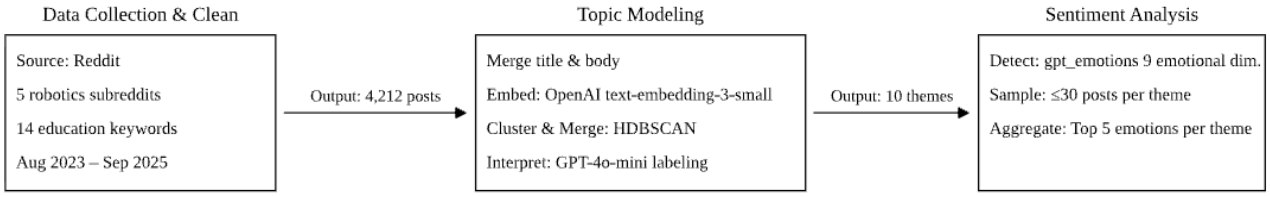
Topic Modeling and Sentiment Analysis

Data preprocessing began by merging each Reddit post’s title and body into a single text field to preserve complete contextual information, as titles often convey core questions while bodies provide elaboration. Posts with missing textual content were removed. The cleaned texts were then embedded using OpenAI’s text-embedding-3-small model, which maps each post into a 1536-dimensional semantic vector capturing latent meaning beyond surface-level wording. These embeddings were clustered using HDBSCAN to identify fine-grained, data-driven topics while treating semantically isolated posts as noise. To reduce topic fragmentation and enhance interpretability, semantically similar clusters were subsequently merged, yielding 10 core thematic dimensions. Finally, to improve the academic interpretability of the resulting topics, representative posts and keywords automatically selected from each cluster were input into GPT-4o-mini, which, guided by a domain-specific prompt, generated expert-oriented topic labels and concise summaries aligned with robotics education research.

Rather than relying on coarse-grained sentiment classification that merely distinguishes between positive and negative affect, this study implemented a gpt_emotions function to capture a more nuanced emotional spectrum. Specifically, textual data were decomposed into nine discrete emotional dimensions, including anger, anxiety, curiosity, disappointment, excitement, frustration, joy, neutrality, and pride. The output is a standardized JSON format providing continuous intensity scores (ranging from 0 to 1). To balance computational cost with cross-topic comparability, a stratified random sampling strategy was applied within each topic, with up to 30 posts selected for emotional analysis. Emotional scores were then aggregated and averaged at the topic level, retaining only the five highest-intensity emotions per topic. Finally, the resulting topic–emotion matrix was visualized using a heatmap.

Figure 1 depicts the three-phase analytical pipeline, including Reddit data collection and cleaning, topic modeling via embedding and clustering, and emotion-based sentiment analysis, culminating in a topic–emotion heatmap visualization.

Figure 1. Research Workflow for Reddit-Based Topic Modeling and Sentiment Analysis



Results

Topic Modeling

Topic modeling results identified nine substantive themes and one noise topic. The distribution of posts across topics was highly uneven, indicating that discussions were dominated by a small number of core concerns. Table 1 presents the topic modeling results for robotics education discussions on Reddit.

Table 1. Topic Modeling Results for Robotics Education Discussions on Reddit (N = 4,212)

Topic Label	Post Count	Percentage (%)
Exploring Robotics Education Resources	2,323	55.2%
Seeking Mentorship in Robotics Education	330	7.8%
Troubleshooting Robotics Programming	299	7.1%
Enchanted Robotics Class Concepts	18	0.4%
Sharing Resources for Robotics Education	8	0.2%
Challenges in Online Robotics Resources	6	0.1%
Collecting Robotics Pins for Education	6	0.1%
Future Tools for Robotics Education	6	0.1%
Dean’s List and Robotics Involvement	5	0.1%
Noise	1,213	28.8%

The most prevalent topic was *Exploring Robotics Education Resources*, comprising 2,323 posts (55.2%). This topic centered on accessing learning materials, programming resources, and entry pathways for beginners, reflecting widespread interest in foundational robotics education. The second most frequent topic, *Seeking Mentorship in Robotics Education*, included 330 posts (7.8%) and focused on mentorship, coaching, team dynamics, and advice-seeking within robotics communities. The third topic, *Troubleshooting Robotics Programming*, consisted of 299 posts

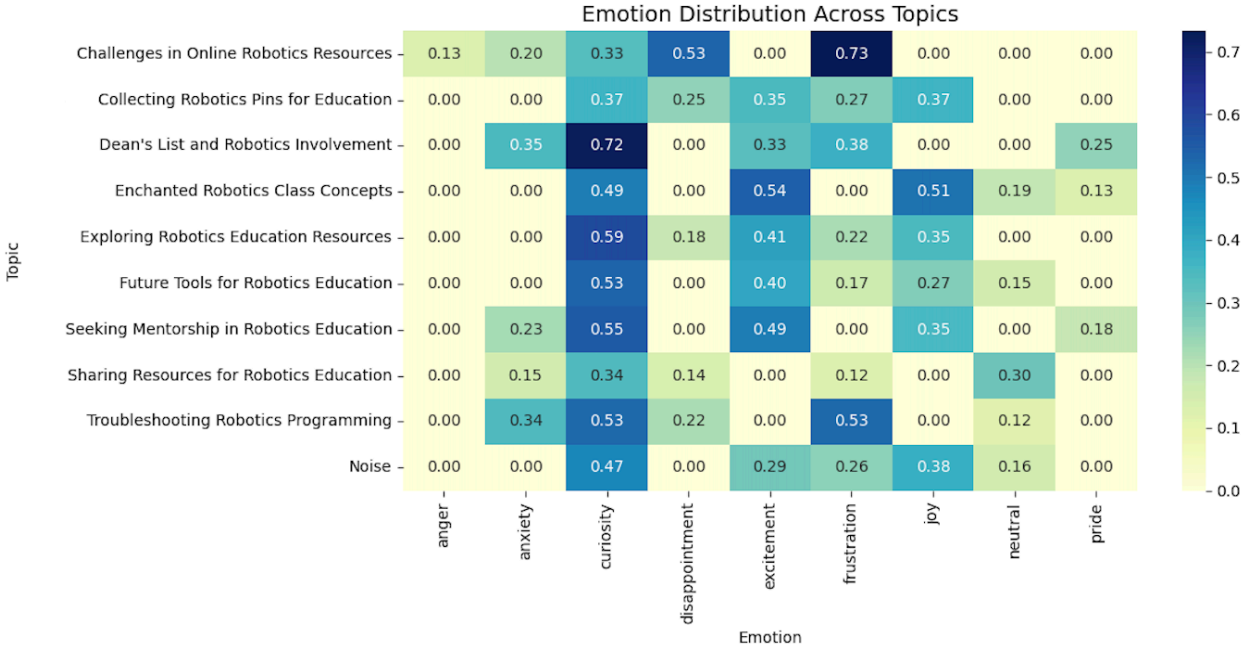
(7.1%) and captured discussions related to debugging, programming challenges, and technical problem-solving in robotics competitions.

Less frequent topics reflected more specialized dimensions of robotics education. *Enchanted Robotics Class Concepts* (18 posts) represented creative and imaginative approaches to robotics instruction. *Sharing Resources for Robotics Education* (8 posts) focused on the exchange of notes and learning materials among educators and learners. *Challenges in Online Robotics Resources* (6 posts) highlighted difficulties related to accessing and navigating online platforms for robotics learning. *Collecting Robotics Pins for Education* (6 posts) reflected cultural practices within robotics education. *Future Tools for Robotics Education* (6 posts) addressed emerging technologies and platforms anticipated to support robotics instruction. Finally, *Dean's List and Robotics Involvement* (5 posts) explored the relationship between robotics participation, academic performance, and institutional recognition. A noise topic was identified, containing 1,213 posts (28.8%) that did not form coherent thematic clusters.

Sentiment Analysis

Discussions across robotics education topics were characterized by high levels of curiosity and excitement, alongside varying degrees of frustration and anxiety. Figure 2 illustrates the distribution of emotional categories across identified discussion topics based on emotion scores derived from Reddit posts related to robotics education.

Figure 2. Emotion Distribution Across Topics in Robotics Education Discussions on Reddit.



Topics including *Exploring Robotics Education Resources, Enchanted Robotics Class Concepts, and Future Tools for Robotics Education*, were primarily driven by curiosity, excitement, and joy. These emotional patterns indicate learning- and exploration-oriented engagement, strong interest in robotics resources, positive affect associated with creative and imaginative

instructional approaches, and cautious optimism toward emerging educational tools and technological ecosystems.

Negative emotional patterns were most pronounced in *Challenges in Online Robotics Resources*, where frustration and disappointment dominated alongside residual curiosity, pointing to widespread dissatisfaction stemming from platform usability and access barriers. By comparison, *Sharing Resources for Robotics Education* was characterized by curiosity, neutrality, and weak disappointment, suggesting information-focused exchanges with limited emotional investment.

Other topics exhibited complex emotional profiles. *Seeking Mentorship in Robotics Education* was characterized by curiosity, excitement, joy, and anxiety, suggesting that while participants actively pursue guidance and growth opportunities, they also experience uncertainty related to team management and role expectations. *Troubleshooting Robotics Programming* showed a combination of curiosity, frustration, and anxiety, highlighting the emotional strain imposed by technical complexity and repeated debugging. Similarly, *Dean's List and Robotics Involvement* reflected curiosity, frustration, anxiety, and pride, indicating the coexistence of institutional pressure and achievement-related affirmation. In contrast, *Collecting Robotics Pins for Education* displayed a relatively balanced emotional distribution with low-intensity positive and negative emotions, reflecting community-oriented engagement and identity affiliation.

Future Works

Future research will focus on improving post classification and incorporating qualitative analysis. First, a substantial proportion of posts were classified as noise during topic modeling. Although this reflects the high heterogeneity of Reddit discussions, future work could adopt more fine-grained or hierarchical topic modeling approaches to better differentiate and refine noise content, thereby reducing information loss. Second, posts may originate from teachers, students, or parents, whose emotional expressions and concerns may differ. Future studies will incorporate human coding both to validate the accuracy of AI-generated topic and emotion classifications through dual-rater coding of a stratified sample, and to identify author roles, with particular attention to teacher perspectives. In addition, qualitative analyses of posts with strong emotional tendencies will be conducted to examine how instructional contexts, technical constraints, and institutional factors shape learning experiences in robotics education.

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