TechTrends
https://doi.org/10.1007/s11528-024-00954-1

ORIGINAL PAPER

Higher Education Faculty Perceptions of ChatGPT and the Influencing Factors: A Sentiment Analysis of X

Yoseph Mamo[1] · Helen Crompton[2] · Diane Burke[3] · Christine Nickel[3]

Accepted: 19 March 2024

Abstract

ChatGPT, an AI chatbot developed by OpenAI, was released in November 2022, sparking a significant surge in global awareness and utilization of generative AI across various domains. Although recent studies have acknowledged the significance of ChatGPT in the education sector, they have yet to focus on exploring faculty attitudes toward ChatGPT. We gathered a comprehensive corpus of tweets containing "#ChatGPT" and "#highered" between November 30th, 2022, and April 30th, 2023. We analyzed data by triangulating VADER, NRC lexicon, and ground coding. Findings suggest that 40% of the expressed sentiments were positive, 51% were neutral, and 9% were negative. The study also revealed the diverse range of emotions held by higher education faculty regarding ChatGPT, with trust and joy being the most prevalent positive sentiments and fear and anger being the most prevalent negative sentiments. This study shed light on faculty members' perceptions of ChatGPT, contributing to a better understanding of the impact, emotions, and incorporation of ChatGPT in the higher education sector.

Keywords ChatGPT · OpenAI · Sentiment · Perceptions · Attitudes

Lay Summary

- ChatGPT has over 100 million users, and the ChatGPT website receives an estimated 1 billion monthly visitors.
- The study investigated faculty attitudes toward ChatGPT by analyzing X (formerly Twitter) data.
- Sentiment analysis and coding show strong positive emotions of trust and joy among higher education faculty's attitudes toward ChatGPT.
- Faculty generally perceive ChatGPT as a tool that enhances creativity, student engagement, and inclusion.

✉ Yoseph Mamo
ymamo@odu.edu

Helen Crompton
crompton@odu.edu

Diane Burke
dmburke@odu.edu

Christine Nickel
cnickel@odu.edu

[1] HMS, Old Dominion University, Norfolk, VA 23529, USA

[2] STEMPS and RIDIL at ODUGlobal, Old Dominion University, Norfolk, VA 23529, USA

[3] RIDIL at ODUGlobal, Old Dominion University, Norfolk, VA 23529, USA

Introduction

Generative AI models have a long history in artificial intelligence, dating back to the 1950s with the development of Hidden Markov Models (HMMs) and Gaussian Mixture Models (GMMs: Cao et al., 2023). However, the November 2022 release of ChatGPT by Open AI has accelerated widespread global awareness and the use of generative AI in multiple ways (Metz, 2022; Reed, 2022; Tung, 2023). Higher education faculty are among those who have followed the release of ChatGPT with a great deal of interest (Dwivedi et al., 2023). Strong sentiments are being expressed, both positive and negative, about the use of ChatGPT in colleges and universities (e.g., Chronicle of Higher Education, 2023). Faculty find themselves in uncertain territory regarding the affordances and the challenges that generative AI presents. This uncertainty has caused a range of responses from faculty regarding their perception of ChatGPT. However, at this time no research has been done to determine how faculty perceive the use of ChatGPT. Nor has there been any research to determine the factors that cause those perceptions. In response to this paucity of research, scholars (e.g., Dwivedi et al., 2023; Haque et al., 2022; Leiter et al., 2023; Taecharungroj, 2023; Tlili et al., 2023) are calling for more investigation into the impact of ChatGPT in the education sector. The purpose of this study was to respond

Published online: 13 April 2024

to this call and explore higher education faculty perceptions regarding the use of ChatGPT and investigate what factors are causing these perceptions.

Literature Review

ChatGPT is an artificial intelligence chatbot created by Open AI and released in November 2022. As a large advanced natural language processing model pre-trained on a large dataset, ChatGPT can generate natural language that is coherent, contextually appropriate, and human-like. It uses a transformer architecture that merges the benefits of generative models with scalability enabling text production in any terminology and topic from a specified prompt (Aydın & Karaarslan, 2023). Currently, ChatGPT has over 100 million users and the ChatGPT website receives an estimated 1 billion monthly visitors (Milmo, 2023). The world-wide interest in this technology far surpasses any other modern technology in terms of adoption rates (Reuters, 2023). While relatively new, ChatGPT's affordances and challenges have been discussed, analyzed, praised, and disparaged by popular media, experts, and laymen alike, such as the Wall Street Journal (Hao, 2023).

Affordances of ChatGPT in Higher Education

Proponents of ChatGPT in higher education state that ChatGPT is a technology with rich potential to empower students and enhance their educational experiences and resources (Dai et al., 2023). Some of the general affordances of ChatGPT are the ability to promote lifelong learning, provide alternative ideas, be a creative source of inspiration, improve human capacity for knowledge access and development, form personalized learning pathways, encourage competence building, and serve as a conversational agent that can be used to simulate social interactions (Bozkurt et al., 2023). Furthermore, ChatGPT can provide affordances in specific content areas. For instance, in language learning, the generation of realistic dialogues can provide learners with authentic language use (George & George, 2023). ChatGPT's language translation capacity allows learners to input text in their native language and have it automatically translated into their target language (Jiao et al., 2023). ChatGPT can also generate writing prompts and provide feedback on written work, leading to improvement in learners' writing skills (Baidoo-Anu & Owusu Ansah, 2023).

Challenges and Limitations of ChatGPT in Higher Education

Although the potential for positive use of ChatGPT in higher education is high, there are concomitant challenges. One challenge is the concern regarding plagiarism and academic integrity. AI writing systems are designed to generate text based on a set of parameters or prompts. Students could potentially use these systems to cheat on their assignments by submitting text created by ChatGPT as their own work (Dehouche, 2021). Furthermore, ChatGPT, which is effectively a text generating machine, does not grasp the information it generates, nor does it judge whether it is accurate or relevant, possibly leading to the creation and distribution of false and misleading information (Mhlanga, 2023).

Large language models (LLMs), such as ChatGPT, can perpetuate and amplify existing biases and unfairness in society (Farrokhnia et al., 2023). Typically, LLMs rely heavily on training data, and when the data contain biases or anomalies, it could lead to unfair or biased results (Kasneci et al., 2023). Internal mechanisms and processes in generative AI models are not sufficiently open and transparent to users about how they work. Therefore, it is important to ensure that the decision-making processes of these models are transparent to users. ChatGPT and other generative models involve the collection and processing of personal data, which raises concerns about privacy and data security (Rahman & Watanobe, 2023). There is concern of the potential to depend excessively on ChatGPT as a tool, which could hinder the development of key professional and academic skills by both students and teachers (Kasneci et al., 2023).

Importance of Faculty Perceptions in Adoption of Technology

Although ChatGPT will impact all facets of life, many academics assert that teaching, learning, and academic research are likely to experience some of the most transformative impacts of ChatGPT (Dwivedi et al., 2023). It is well-documented that educators in the past have not made effective use of instructional technologies (Bingimlas, 2009; Gautreau, 2011; Keengwe & Kang, 2012). This lack of evidence supporting the effective integration of technology by educators has prompted researchers to call for the need to identify factors influencing faculty adoption of instructional technology (Bingimlas, 2009). One factor that is important to understand is how faculty perceive the integration of classroom technology tools (Burch & Mohammed, 2019). Perception is the process by which an individual selects, organizes and interprets stimuli into a meaningful and coherent picture of the world. It is a cognitive process by which people attend to incoming stimuli, organize, and interpret such stimuli into behavior (McDonald, 2012). Understanding how higher education faculty perceive ChatGPT can help to ensure more effective integration of this technology.

Related Work

ChatGPT has only been available since November 2022 providing only a short period time in which academic literature could be published regarding faculty perceptions of the use of ChatGPT. However, a review of the research reveals a few early articles that are relevant to this study.

Taecharungroj (2023) collected and analyzed tweets about ChatGPT in English from November 30 to December 31, 2022, with the purpose of identifying the perceptions of early general users of ChatGPT. The Latent Dirichlet Allocation (LDA) topic modeling algorithm was used to answer the question "What can ChatGPT do?" The results revealed topics that were grouped into three domains: general topics, functional domains, and potential impacts. The general topics included news reporting about ChatGPT, the technology behind it, and global reactions. The functional domains referred to five possible functions of ChatGPT, creative writing, essay writing, prompt writing, code writing, and answering questions. The potential impacts domain included two topics, impacting tech, and impacting humans. Taecharungroj specifically calls for more investigation into the impact of ChatGPT in the education sector to best prepare educators for the rapidly changing landscape of ChatGPT.

Haque et al. (2022), explored the sentiments of ChatGPT early adopters using 10,732 tweets from December 5, 2022, to December 7, 2022. These researchers used topic modelling and sentiment analysis to answer the following questions. "What are the characteristics of ChatGPT early adopters? What are the main topics that were discussed? What are the sentiments that were expressed about ChatGPT topics?" These researchers found that the USA, India, UK, Canada, and Germany were the top-5 countries in which people expressed their opinion of ChatGPT. The top 3 user occupations were software practitioners, academics, and students. Nine topics were identified as being discussed by early adopters. They are disruptions to software development, entertainment and exercising creativity, natural language processing, impact on educational aspects, chatbot intelligence, impact on business development, implications for search engines, Q &A testing, and future careers and opportunities. Results of users' sentiment regarding ChatGPT were reported by topic as positive, negative, and neutral. This study revealed that the adoption of ChatGPT for educational purposes reported both positive and negative perceptions among the users (52% positive, 32% negative and 16% neutral).

In another study, Leiter et al. (2023) expanded the literature about the perception of the use of ChatGPT by analyzing 330 K X tweets and more than 150 scientific papers from Arxiv and Semantic scholar through February 9, 2023. This data set included tweets from over 61 languages. The study sought to answer these questions. "How is ChatGPT viewed from the perspectives of different actors?" "How have perceptions changed over time, and what limitations and strengths were pointed out?" The results indicated that ChatGPT is generally perceived positively with emotion of joy being the most prevalent. Since its inception, the positive perception has decreased slightly and in languages other than English. In the analysis of data specifically related to education, the number of papers that see ChatGPT as a threat is almost equal to the number of those who view it an opportunity. These authors also call for more research, particularly calling for investigating the perceptions from specific user groups. These three studies all provide an overarching perspective as to how all users perceive ChatGPT.

Providing a more specific look at perceptions regarding ChatGPT used in an educational context, Tlili et al. (2023), focused on identifying the concerns of using ChatGPT. They used a three-stage instrumental case study, with a social network analysis of tweets, content analysis of interviews, and investigation of user experience the authors analyzed 2330 tweets, from 1530 X users from December 23, 2022, to January 6, 2023. In addition, interviews were conducted with 19 users who have been using ChatGPT in education to investigate how different stakeholders (students, educators, etc.) perceive the use of ChatGPT in education, especially their concerns. The study results revealed that the frequency of positive sentiments was almost twice as high as the negative ones. The content analysis of the interviews revealed that the users found ChatGPT very significant with a great value to revolutionize education; however, they raised several concerns calling for caution and the need for more guidelines about how to use ChatGPT safely in education. This study is helpful in providing a focus on the educational context. However, this study involved educators who worked in a variety of contexts.

Sullivan et al. (2023), conducted a study focused on higher education to provide a content analysis of 100 news articles from Australia, New Zealand, the United States and the United Kingdom. This may reflect some of the concerns shared by faculty but are not directly from faculty. The news text was coded to explore several themes in relation to the impact of ChatGPT on higher education, including university responses, academic integrity concerns, the limitations and weaknesses of AI tool outputs, and opportunities for student learning. The findings revealed that the public discussion and university responses about ChatGPT have focused mainly on academic integrity concerns and innovative assessment design. It also revealed a lack of a student voice in the conversation.

These extant studies provide some helpful background as to the perceptions of higher education faculty on ChatGPT,

but to date a study has not been conducted to explore faculty perceptions. It is important to note that the authors of all the studies cited above call for more investigation into the impact ChatGPT will have on how teachers teach, and students learn as artificial intelligence becomes more ubiquitous in our world.

Purpose of this Study

The purpose of this study is in response to the appeal from scholars (e.g., Dwivedi et al., 2023; Haque et al., 2022; Leiter et al., 2023; Taecharungroj, 2023; Tlili et al., 2023) to investigate the use of ChatGPT in higher education. The overarching research question for this study is: What are the perceptions of higher education faculty regarding the use of ChatGPT? Three individual sub-questions help to provide a more in-depth and specific understanding of higher education's faculty's perception of a technology that has the potential to revolutionize education (Malik et al., 2023).

1. What are the sentiments that are being expressed about ChatGPT by higher education faculty on X?
2. How have these sentiments changed over time?
3. What factors influence a faculty member to perceive ChatGPT in a specific way?

Method

In recent years, there has been a significant increase in researchers utilizing social media platforms, particularly X, to extract insights and gain a deeper understanding of emerging research topics, such as ChatGPT (Fiesler & Proferes, 2018). This study used a purposeful sampling procedure to select higher education faculty members who utilized X to discuss ChatGPT. A sentiment analysis was then conducted to classify faculty opinions about ChatGPT (Hutto & Gilbert, 2014; Liu et al., 2017). Subsequently, this study expanded beyond simple sentiment analysis by integrating emotional analysis, enabling the extraction of a diverse range of emotions from the tweets (Lyu et al., 2021; Mohammad & Turney, 2013). Finally, to extract insights and generate knowledge regarding factors that influence faculty perceptions of ChatGPT, we conducted grounded coding on the categorized emotional sentiments. Figure 1 provides an overview of the research methodology for this study.

Data Collection

The X Application Programming Interface (API) was utilized to gather a comprehensive corpus of historical tweets posted by X accounts from November 30th, 2022, to April 30th, 2023. Following the recommendation of Humphreys and Wang (2018) emphasizing the importance of selecting an appropriate platform and employing suitable sampling techniques for textual analysis, X was chosen as the platform due to its ability to facilitate virtual discussions and create issue-specific virtual town halls (O'Hallarn et al., 2018). Tweets were collected that included the keyword words "#ChatGPT" and "#highered". The hashtag "#ChatGPT" is commonly used on social media to engage in conversations related to artificial intelligence. There are three reasons for choosing the hashtag #highered. Firstly, it holds significance in academic discourse, particularly evident in discussions related to crisis management during the COVID-19 pandemic among faculties and administrators (Biddix et al., 2023). Secondly, an analysis of the top 10 hashtags in education revealed that #highered accounted for 36% of usage, which is 2.5 times higher than the second most popular hashtag, #highereducation. Thirdly, with access to the full X archive for data collection, we examined the top three hashtags (#highered, #highereducation, and #education) and found that #highered represented the majority of discussions among faculty and administrators (Barrie & Ho, 2021) R code was written to access terms get_all_tweets (query = "#ChatGpt #highered", lang = en, start_tweets = "2022-11-30T00:00:00Z", end_tweets = "2023-04-30T00:00:00Z", granularity = "day", n = 151). The search resulted in a total of 3559 comments, including original tweets and retweets.

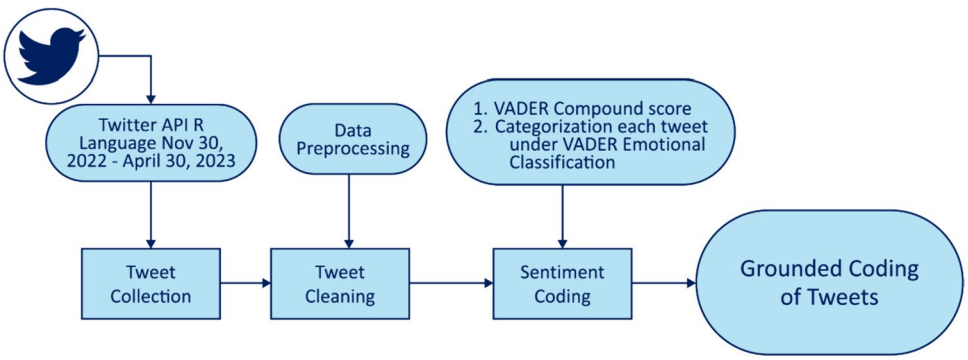

Fig. 1 Overview of the Research Methodology

Data Preprocessing

X data underwent preprocessing, manipulation, cleaning, formatting, and filtering to eliminate irrelevant content from the study. First, non-English language tweets were filtered out. Next, duplicate tweets from individual users were eliminated, and manual verification was conducted to identify bots based on account usage, sentiment, and social network characteristics (Rodríguez-Ruiz et al., 2020). Further, noise removal included removing tweets containing URLs and symbols and the removal of stop words such as "the," "a," and "to," which did not help to distinguish one tweet from another. Only distinct tweets from each user were deemed appropriate to be included. Lastly, tweets were annotated with tokenization and parts of speech. After applying data preprocessing techniques, a total of 2115 unique users' tweets were available for analysis.

Sentiment Analysis

Sentiment analysis is a new field of research born in Natural Language Processing (NLP) used to detect subjectivity in text and/or extract and classify sentiments and emotions (Liu et al., 2017). Sentiment analysis examines individuals' opinions and emotions concerning events, technology, social issues, and experiences (Mamo, 2023). Sentiment analysis aims to assess the level of positivity or negativity in written content related to a specific subject, such as social media posts, product reviews, news articles, and blogs (Berger et al., 2020; Humphrey & Wang, 2018; Kauffmann et al., 2020). The analysis of sentiment in user-generated content has received considerable attention in academic research across various disciplines such as marketing (Berger et al., 2020), management (Etter et al., 2018), and consumer behavior (Humphrey & Wang, 2018). There are two main approaches to performing sentiment analysis: (1) lexicon-based/dictionary-based and (2) machine learning approaches (Humphrey & Wang, 2018). This study chose to use the lexicon/dictionary-based sentiment analysis. This approach is widely recognized for its effectiveness in detecting sentiments (Shivaprasad & Shetty, 2017; Mamo, 2023). Humphrey and Wang (2018) contend that when the intended construct, such as positive and negative affect, is relatively well-defined, a lexicon/dictionary-based technique is the most suitable analysis method. Additionally, dictionary-based sentiment analysis is validated in various settings and provides transparent and easily interpretable results (Berger et al., 2020).

The Valence Aware Dictionary for Sentiment Reasoning VADER was used to analyze the sentiments in the 2115 tweets in the dataset in this study. VADER is the gold standard for lexicon-based sentiment analysis in short texts like X (Al-Natour & Turetken, 2020; Hutto & Gilbert, 2014; Mamo & Anagnostopoulos, 2023; Riberio et al., 2016) and is used across various types of textual content, including movie reviews, newspaper articles, X posts, and Amazon product reviews (Hutto & Gilbert, 2014).The VADER analysis assigned a polarity score for each of the domains of negative, positive, neutral, or compound. Among these polarity values, the compound score is particularly useful for measuring the sentiment in a document (Elbagir & Yang, 2019). A compound score greater than 0.05 indicated positive sentiment, a compound score less than −0.05 indicated negative sentiment, and compound scores within the range of -0.05 to 0.05 were considered neutral. In addition, the National Research Council Word-Emotion Association Lexicon, commonly referred to as the NRC Emotion Lexicon or EmoLex was used in this study. The NRC is a lexicon-based dictionary used in text analysis to identify specific emotional content in written social media posts. It provides annotations and associations with eight basic emotions, namely anger, fear, anticipation, trust, surprise, sadness, joy, and disgust. The NRC Emotion Lexicon was utilized to analyze text data and determine the presence or intensity of these emotions within the text (Lyu et al., 2021).

It is important to note that any type of quantitative model of languages is not globally the best method and needs to be validated (Grimmer & Stewart, 2013). Human validation is considered the gold standard, and researchers often manually double-check the validity of their classifications. To determine the threshold for categorizing the scores for this study, the distribution and reliability of the compound sentiment score produced by VADER sentiment dictionary were examined. Following the suggestion of O'Connor and Joffe (2020), a random sample comprising 20% of the data was manually coded by two co-authors who were not involved in the dictionary-based sentiment analysis classification. The coding was then reviewed by another co-author with expertise in big data and social media analytics. Subsequently, all co-authors engaged in face-to-face discussions to cross-check the manually coded sentiment and VADER scores. The outcome of the discussions yielded an agreement percentage of 90%, surpassing the acceptable reliability threshold recommended by Miles and Huberman (1994). Two authors discussed the remaining 10% of the lexicon-based results and resolved any inconsistencies in the value labeling.

Grounded Coding

With the data gathered from the sentiment analysis, grounded coding (Strauss & Corbin, 1995). was then used to identify the factors that influence faculty perceptions. For each faculty sentiment uncovered in the sentiment analysis, the earlier analysis provided a set of corresponding Tweets. The grounded coding design used a constant comparative

method to identify important text from the tweets that illustrated the factors that led to specific sentiments. Through an iterative, inductive process, codes were developed, and with a constant comparison of factors with factors, of factors with codes, and codes with codes. Codes were deemed theoretically saturated when all the factors fit with one of the specific sentiments. Two researchers coded and reached an inter-rater percentage agreement of 100% on the factors. "In vivo" (Saldana, 2015) coding was used within the grounded coding. In vivo coding involves using language from the original Tweet to ensure that the faculty members' intentions were accurately captured.

Results

RQ1: What are the Sentiments that are being Expressed about ChatGPT by Higher Education Faculty on X?

Research question one focuses on the sentiments expressed by higher education faculty on X regarding ChatGPT from November 30, 2022, to April 30, 2023. Analysis of the data revealed that 40% of the sentiments expressed were positive, 51% were neutral, and the remaining 9% were negative. The findings indicate the overall sentiment analysis, as illustrated in Fig. 2.

These results are similar to previous research regarding the distribution of ChatGPT sentiments. Haque et al. (2022) revealed that the adoption of ChatGPT for educational purposes reported 52% positive, 32% negative and 16% neutral sentiments. Tlili et al. (2023) reported that the frequency of positive sentiments was almost twice as high as the negative ones for those who have been using ChatGPT in education.

The percentage of faculty expressing neutral sentiments (50%) could be explained by the fact that ChatGPT is new, and most faculty are not familiar with the uses and challenges inherent with its use. Faculty may be with-holding judgement about their sentiments but may be willing to keep an open mind as they learn more about ChatGPT. The high percentage of positive faculty sentiments (40%) may be the result of the population of faculty who use tweeter to communicate. These faculty are most likely technologically savvy and would be more likely to embrace new tools to use in their research and teaching. These faculty would represent the innovators and adopters willing to take risks and embrace change (Rogers, 2003).

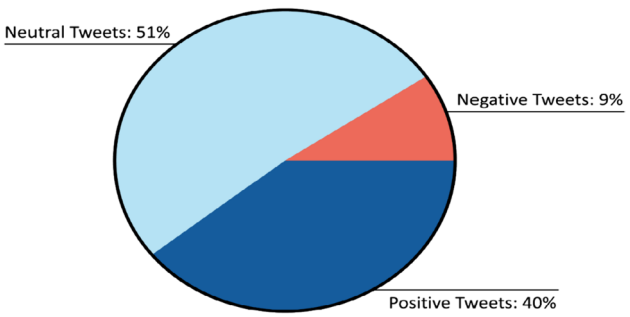

Fig. 2 Sentiment Analysis: Distribution of Natural, Positive, and Negative Sentiments

The low number of faculty who reported negative sentiments (9%) could be explained by the fact that faculty who are not as technologically engaged may not use X as a communication tool. There may be a greater percentage of faculty who hold negative sentiments regarding ChatGPT, but they are not using X to express their concerns.

The NRC emotion lexicon was utilized to identify and explore the specific emotions expressed by faculty. This analysis revealed that trust was the most frequently expressed emotion with a count of 1083, followed by anticipation with 533 occurrences. Joy, surprise, and fear also have relatively high counts, with 373, 334, and 298 respectively. On the other hand, anger, sadness, and disgust have lower counts, with 115, 118, and 98 respectively. Overall, the analysis indicates that positive emotions are more prevalent in the text than negative emotions (Fig. 3).

As the percentage of negative perceptions in the data set only amounted to 9% of the tweets, it is not surprising that those sentiments expressing negative perceptions (anger, fear, disgust, and sadness) were less. However, the negative perceptions expressed by faculty may hold significant validity and need to be acknowledged and further investigated. The sentiments of anticipation, surprise and trust can be considered neutral as they may not necessarily express either positive or negative sentiments. As the neutral tweets comprised 51% of the dataset, it is not surprising that these sentiments made up a significant number of the total.

The final sentiment that was expressed, joy, is most closely aligned with the positive responses. Again, the number of tweets expressing joy match closely with the percentage of positive tweets (40%). However, this is not a perfect alignment, as the sentiments of anticipation, surprise and trust depending on the perspective of the faculty member, could be labeled positive.

RQ2: How have these Sentiments Changed over Time?

Research question two investigated the changes in sentiments regarding ChatGPT over time. The first analysis of the data provided a picture of the frequency of tweets aggregated daily from November 30, 2022, to April 30, 2023. As shown in Fig. 4, the highest number of mentions was on January 5, with 396 tweets, followed by January 6 with 215 tweets, and January 13 with 89 tweets. To provide insights into the volume of discussions and engagement surrounding

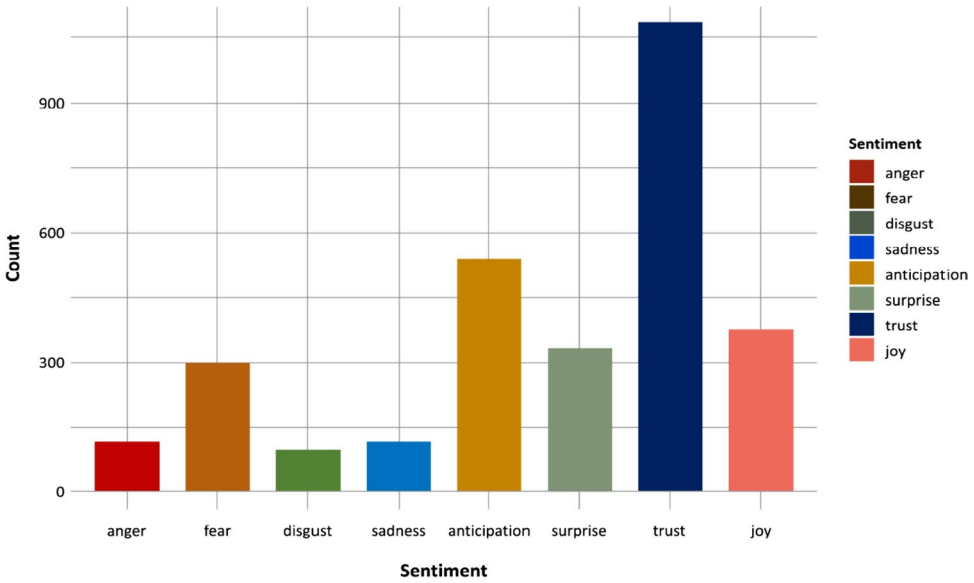

Fig. 3 Analysis Using NRC Emotion Lexicon

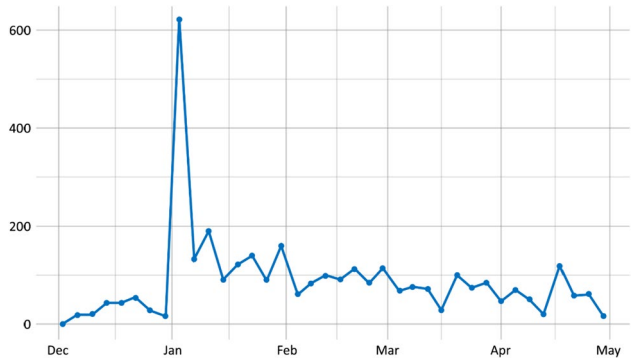

Fig. 4 Exploring the Usage Frequency of X: #ChatGPT and #highered Analyzing Daily Aggregated X Counts on X: November 30, 2022, to April 30, 2023

the hashtags #ChatGPT and #highered, the tweet counts for each month are as follows: In December 2022, there were 234 tweets; this number significantly rose to 1,478 tweets in January 2023. In February 2023, there were 725 tweets, indicating a sustained interest in the topic. March 2023 saw a slightly lower count with 626 tweets, and in April 2023, the number decreased further to 496 tweets.

This trend analysis of the daily frequency of tweets since the release of ChatGPT provides a picture that shows an increasing interest in ChatGPT in the beginning and a decline as faculty became more familiar with this tool. It is interesting that there are no tweets in the first three days after the release of ChatGPT. However, once this tool was written about in media and social platforms, the number of people tweeting increased dramatically, indicating a high initial interest among higher education faculty. This initial high interest was followed by a decline in the number of tweets, but this does not necessarily indicate a decline in interest. The fact that ChatGPT currently has over 100 million users and the ChatGPT website receives an estimated 1 billion monthly visitors is indicative of the continued interest in this tool (Milmo, 2023).

A second analysis of the data looked at the changes in positive and negative sentiments over time from November 30, 2022, to April 30, 2023. Figure 5 illustrates these changes. The analysis revealed that positive sentiments reached their peak in February 2023, with a mean value of 1.296. However, there was a slight decrease in April 2023, with a mean of 1.110. In March 2023, the mean value was 1.097, and in January 2023, it was 1.082. The lowest mean value was observed in December 2022, with a value of 0.906.

These results indicate an initial expression of positive sentiments as ChatGPT was introduced with a high number of positive sentiments in February. This was followed by a decline, and then by another rise. This trend could possibly be explained by the fact that when ChatGPT was introduced there was significant media interest and the idea of generative AI produced excitement and promise. However, once faculty began to further explore the intricacies of ChatGPT, they became more familiar with the challenges along with the positives. This reality check may have tempered the positive responses among faculty. However, as time went on and faculty had the time to further explore what ChatGPT could and could not do it is possible that they became more confident in their understanding of how they could use this new tool and their sentiments began to be more positive (Kulviwat et al., 2007).

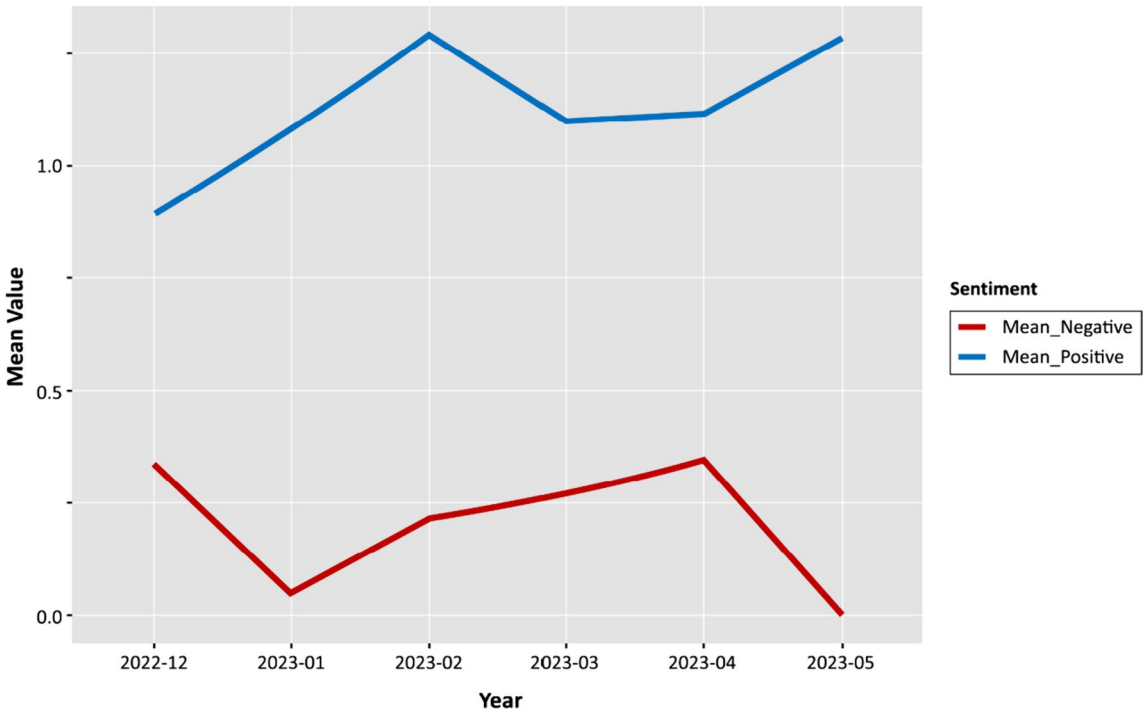

Fig. 5 Tracking Positive and Negative Sentiment Changes Over Time

RQ3: What Factors Influence a Faculty Member to Perceive ChatGPT in a Specific Way?

Grounded coding of the individual tweets provided evidence of the factors that influenced faculty perceptions. Through the grounded coding, tweets were identified that illustrated the factors that led to each of the eight sentiments. From that grounded coding, it appears that there were a variety of factors connected with each of the sentiments. This section is organized by those eight sentiments.

Fig. 6 Factors Connected with Anger

Anger

The grounded coding revealed four main factors connected with anger. These are shown in Fig. 6. These codes reveal financial and political concerns, in addition to those more specific to educational disciplines and practice.

Anger over job security was an emerging theme. This is connected with concerns that faculty may be replaced by AI tools, such as ChatGPT that can write lesson plans or describe difficult concepts in meaningful ways. Faculty were very expressive with comments about ChatGPT as a "Time saver???!!! Or job destroyer!!!???". It appears there are mixed emotions as people are recognizing the potential for AI to take on various tasks that can be helpful, but that could put people out of work. Scholars often note that those basic jobs that AI can do should be embraced allowing people time to take on more important roles that AI cannot do (Shaw et al., 2019). However, an argument could be made that in many poorer or developing countries, some people rely on these lower-skilled jobs to be financially secure.

Faculty talking about political pressures were not as clear as to what specifically those political pressures were. For example, one faculty member tweeted "Political pressures, disruptive technologies, like #AI #chatgpt, mega-corporations warp #highered's time-space continuum". There is perhaps a concern that this technology has had a profound effect on higher education in that it may be politically motivated in some form.

The other two codes focused on the practicalities of education: plagiarism and claims that ChatGPT would threaten writing. Both factors appear several times in the tweets and across sentiments. Cheating and plagiarism are often used interchangeably. However, connected to anger, plagiarism was most used. This anger appeared to be focused on the

way ChatGPT obtained output text from across the internet and did not identify where it gained that information. The threat to writing was also found in disgust and sadness. These negative sentiments appear to come from the way ChatGPT can quickly, easily, and effectively produce a variety of texts from a basic prompt and a concern that students will rely on AI rather than learning and producing their own text.

Fear

The sentiment of fear revealed five codes that can be found in Fig. 7.

Job security and plagiarism also were used to describe fear. This may be expected in that the anger regarding ChatGPT possibly causing these issues can then lead to fear, or vice versa. Nonetheless, there were a few nuances of these issues connecting to fear from class concerns to the wider university, such as "Universities fear a cheating epidemic after more than one million visits to ChatGPT during the winter exam season." Comments such as these also show faculty fears of the reliability of tests in higher education and described fear of assessment threats. The research indicates that writing papers are a common form of assessment in determining what knowledge a student has gained from a class (Rawlusyk, 2018). The ability of ChatGPT to take faculty assignment descriptions and produce papers is a valid fear. ChatGPT can even write in a certain style if asked to do so and can mimic an undergraduate/graduate expected output. Faculty can have great difficulty deciphering what text is created by humans or by AI. Faculty described having to consider new forms of assessment where students are less likely to use ChatGPT to cheat on tests.

As the Internet first emerged, there was considerable concern about students copying and pasting information from the Internet (Garg & Goel, 2023). This appears more of a concern with ChatGPT as it is harder to trace where the program has gathered the information from as it synthesizes text and makes new collections of text. Faculty fears of disruption were often connected to students using ChatGPT to cheat on assessments, by often handing in the work by AI claimed as one's own work. Removal of these common traditional practices appears to be causing fear with tweets such as "Some educators see ChatGPT as a sign that AI will soon lead to the demise of the academic essay, a crucial tool used in schools at every level."

Disgust

Disinformation and bias brought a tone of disgust to faculty tweets. Of the negative feelings that faculty have towards ChatGPT, bias only appeared in the disgust sentiment. Disgust comments include, "Maybe the scariest thing about the artificial intelligence writing program, #ChatGPT, is that it has a leftist bias built in". Bias has been a concern across the literature with a variety of empirical findings showing political bias favoring liberal politicians to conservatives (McGee, 2023). Chen et al. (2023) examined the different bias aspects of ChatGPT and found that as it was pre-trained with human data, ChatGPT has many learned behavioral biases, including (1) conjunction bias, (2) probability weighting, (3) overconfidence, (4) framing, (5) anticipated regret, (6) reference dependence, and (7) confirmation bias (Fig. 8).

Plagiarism appeared yet again in the disgust code. However, this was turned to disgust regarding not just the AI program, but on students' abilities to cheat. A faculty member wrote, "Students who are otherwise mediocre can show brilliance when it comes to finding ways to cheat, and ChatGPT will undoubtedly be harnessed by students to cheat." Literature reports a variety of creative and imaginative ways that students are using ChatGPT to cheat (e.g., King & ChatGPT, 2023). The study that King wrote with ChatGPT notes that students can add spelling mistakes to AI text to fool programs into thinking that the text was written by a human. Students could also use the abilities of ChatGPT to write in the tone and format of what an undergraduate or graduate student would with a prompt of "Act as an undergraduate student and write a ….". This would tell ChatGPT to write in the style of a student.

Threats to writing were similar to issues discussed in the prior negative sentiments. Feelings and beliefs of bias, disinformation, and threats to curriculum content brought comments of disgust, such as "ChatGPT is not yet fit to do the things people are asking it to do; that's why we're having an adverse reaction to it." This sentiment is interesting as ChatGPT is recognized by the majority of tweets as

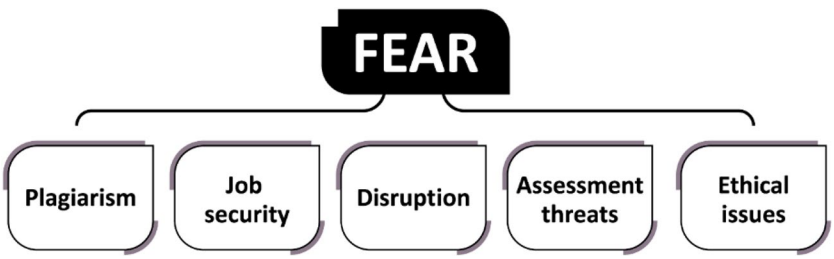

Fig. 7 Factors Connected with Fear

Fig. 8 Factors Connected with Disgust

Fig. 9 Factors Connected with Sadness

having extensive capabilities that are used for both positive and negative impacts.

Sadness

The grounded coding revealed four factors connected with sadness, shown in Fig. 9. They suggest a sense of concern about ChatGPT, the potential for disinformation, tools associated with AI, job security, and the future.

Similar to anger and disgust, threats to writing and plagiarism were emerging themes for the sadness sentiment. Faculty expressed sadness about plagiarism and the power of ChatGPT to mimic human writing, predicting that AI will lead to the demise of writing. These findings support other studies where faculty suggest that the use of AI signifies the decline of critical writing skills and critical thinking (Amani et al., 2023) and that depth, assessment of credibility, and reasoning are current weaknesses of ChatGPT (Borji, 2023; Farrokhnia et al., 2023; Rudolph et al., 2023).

At the same time, there was a sadness about the validity and reliability of the tools developed in the hopes of protecting academic integrity from AI intrusion. In addition, faculty were concerned about the potential for enforced use of AI detection tools. "Turnitin will introduce its #AI detection tool…The speedy launch and lack of an opt-out have academics worried." Moreover, faculty were uneasy about the disinformation that may occur with the use of ChatGPT, a threat identified in the extant literature (Mhlanga, 2023). These concerns seem to mirror barriers Rogers (2003) found in technology adoption. For example, adoption barriers for ChatGPT could include perceptions that ChatGPT is not better than what supersedes it.

The factor, Job Security, also appears related to the impact of technology. Faculty may be uncertain of just how disruptive ChatGPT will be to course assessments and the development of courses, leading to anxiety that ChatGPT will make their job obsolete. The job security factor is also found in the anger and fear sentiments in this study and is supported by similar findings in the research (Haque et al., 2022).

Anticipation

The sentiment of anticipation revealed six factors, as seen in Fig. 10.

In general, tweets that expressed anticipation were positive in nature. Emerging factors within the anticipation sentiment were the transformative aspect of ChatGPT. One faculty called it a "harbinger of a tectonic transformation of almost all aspects of academia". Other factors for anticipation were ChatGPT's added value and inclusivity, with faculty calling for higher education to harness AI and think about how machine learning can improve learning and teaching processes. Faculty tweeted about how ChatGPT can renew and energize discussions about changing assessments, teaching academic integrity, and supporting student use in a career context.

The anticipation of ChatGPT reflects frequently touted benefits of the AI, but also points to the potential of this innovation becoming driven by student needs (Dai et al., 2023). Tweets that call for teaching critical AI literacies and focusing on "envisioning human + AI synergies" suggest that faculty recognize that empowering students to use ChatGPT requires that great effort is put into developing effective training and appropriate pedagogy (Dai et al., 2023).

Surprise

The grounded coding revealed three factors connected with surprise, shown in Fig. 11.

The surprise sentiment seems to fit in positive, negative, and neutral categories. A positive surprise sentiment

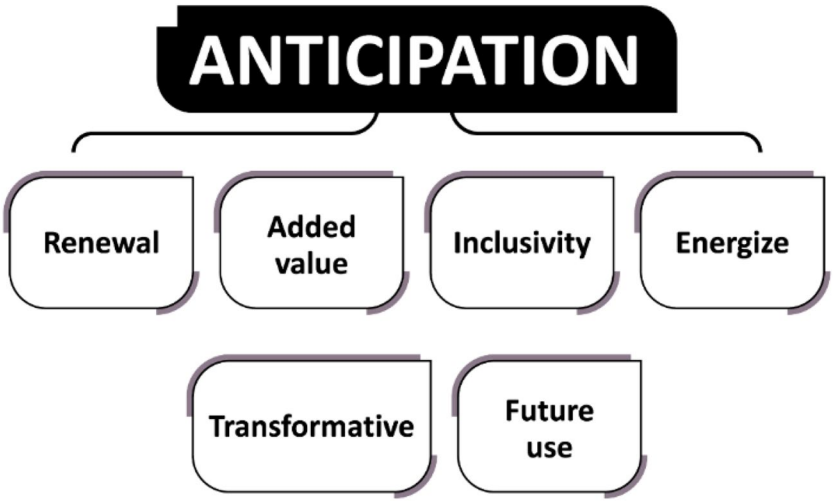

Fig. 10 Factors Connected with Anticipation

Fig. 11 *Factors Connected with Surprise*

can be found in tweets about ChatGPT's capabilities and faculty desire to learn more about them. Many of the tweets seemed encouraged about the potential of ChatGPT to provide extraordinary opportunities for academia, including new tools for teaching and learning, or predicted it as a catalyst for transforming the way we assess learning. At times tweets expressed an intense surprise, "Omg I think #chatgpt just blew my mind". These reactions resonate with other sentiment studies (Taecharungroj, 2023) and reaffirm affordances suggested by advocates of ChatGPT (Bozkurt et al., 2023; Dai et al., 2023).

Other tweets in the surprise sentiment fall in the neutral or negative categories. One tweet expressed amazement at the capabilities and tools provided to students, but with a tone of fear: "It's scary how good it is." Another tweet recognized the need to embrace extraordinary opportunities but suggested that it will likely take place "amid the panic" of AI revolutionizing higher education. These tweets expressed positive surprise with the addition of concerns, a pattern also found by Leiter et al. (2023) and may indicate that some faculty have a more balanced perspective on the impact of ChatGPT.

Trust

Faculty appear to recognize ChatGPT as progress in the ongoing evolution of AI technology. While some tweets have a tone of warning, others suggest that academics who frequently consider learning in a digitally manipulated space are "not panicking", as described by one faculty member, because ChatGPT is "simply the latest in a progression of tech already on our radar" (Fig. 12).

Similar to other research (Bozkurt et al., 2023), faculty seem to accept ChatGPT as something that is not going away and consider its potential for promoting discourse of academic integrity and optimizing learning processes. One tweet highlighted the need to "focus on the principles and ethics surrounding its use. We need to work towards responsible implementation". The subject of academic integrity appears to be connected with thoughts on how we can use ChatGPT to optimize learning. Some faculty suggested that teachers need to help students learn how it can be used in courses. Faculty tweeted about "focusing on the process, not the product", adapting our own teaching, and being transparent about ChatGPT with students, all of which suggest a sense of faculty trust. These tweets seem to indicate that faculty see the potential benefits of ChatGPT and that they and their colleagues have the capacity to integrate ChatGPT effectively.

Accessibility and inclusion were also used to describe trust. One tweet used the Ship of Theseus paradox as a metaphor for the changing landscape of learning due to AI technologies. The faculty maintained that discussions in academia should shift to "how we support students to make a new ship", meaning supporting students in the creation of their own work with AI. This tweet supports the idea that ChatGPT is and should be student-driven (Dai et al., 2023). AI tools in education have the potential to create a more inclusive learning environment by providing support to

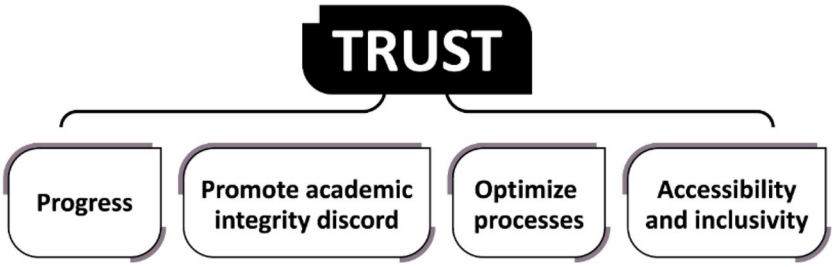

Fig. 12 Factors Connected with Trust

students, including accessibility features, language translation, and diverse resources and perspectives (Bahrini et al., 2023). Again, faculty seem to generally trust that the potential affordances for supporting student learning and student perspectives will become a reality with ChatGPT.

Joy The final sentiment, joy, most fully expresses the positive category of faculty tweets about ChatGPT. The grounded coding revealed six factors connected with joy, shown in Fig. 13.

Stakeholders in higher education frequently call for more authentic, creative, and engaging activities and assessments (Baidoo-Anu & Owusu Ansah, 2023; Janse van Rensburg et al., 2022; Rae, 2022). Joy sentiments in this study appear to respond to these appeals, suggesting that faculty are joyful about the potential for AI to, at least partially, meet these challenges. One tweet suggested that the introduction of ChatGPT may be a catalyst to eliminate conventional grading and "implement more authentic and humane ways to document learning". Other tweets concurred that ChatGPT could invigorate our current teaching strategies by "breaking away from the traditional essay" and introducing creative approaches to evaluation and student engagement, including incorporating effective use of AI in future career contexts.

Similar to the trust sentiment, some tweets in the joy sentiment proposed embracing technology as a vehicle for promoting discussions on academic integrity. Other tweets expressed the value of learning processes by highlighting ChatGPT's potential to enhance learning for students with special needs, a finding that supports other studies in which AI affordances connected to accessibility and inclusion are suggested (Bozkurt et al., 2023; Dai et al., 2023).

While faculty have many valid concerns about the adoption of ChatGPT in higher education, the tweets found in the joy sentiment suggest that a large number of stakeholders in higher education recognize the promised affordances of ChatGPT and view it in a positive light.

Implications

This study's findings hold relevance for both higher education stakeholders and policymakers. The research offers faculty a nuanced understanding of their attitudes toward ChatGPT and AI technologies in educational settings. Recognizing the predominantly positive sentiment toward ChatGPT can encourage educators to explore its potential for fostering creativity, enhancing student engagement, and improving accessibility in their teaching practices. This fosters a more informed and responsible integration of AI technologies into their teaching methodologies. Additionally, identifying specific areas where faculty perceive potential benefits of ChatGPT informs future research and development endeavors in educational technology. Furthermore, understanding the spectrum of emotions, including concerns

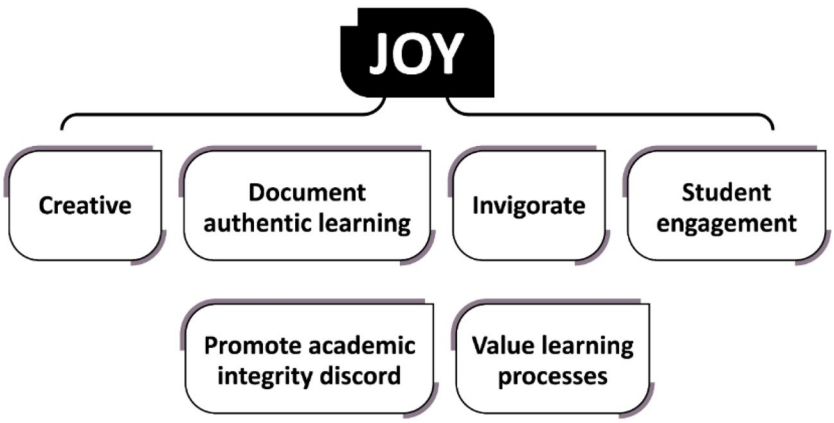

Fig. 13 Factors Connected with Joy

about plagiarism, ethical implications, and job security, empowers faculty to address these issues proactively.

Policymakers can leverage this information to formulate policies and guidelines that support the ethical and effective integration of AI tools like ChatGPT into educational institutions. By addressing plagiarism and job security, policymakers can create an environment that fosters innovation and technology adoption while safeguarding academic integrity and faculty well-being. This insight guides efforts to optimize AI technologies to better align with the needs and objectives of faculty and students, ultimately enhancing teaching and learning outcomes. By aligning the development of AI technologies with faculty needs and preferences, educational institutions can foster an environment conducive to innovation and pedagogical excellence.

Limitations and Future Research

As this study only shows a snapshot of information from X, the findings from this study cannot be generalized to all higher education faculty. Furthermore, only tweets written in English were included which bias the findings towards those countries and contexts that use English. To achieve broader generalizability, future research should explore other platforms such as LinkedIn, Facebook, Instagram, YouTube, and TikTok and incorporate surveys and interviews in diverse languages. It is important to note that this study was conducted within a 5-month timeframe of ChatGPT's release. This provides an important emerging reaction to ChatGPT during this initial period, but this also limits the understanding of faculty perceptions over a longer duration. Finally, while the VADER sentiment analysis was utilized, based on lexicon-based and rule-based approaches, it is important to acknowledge that the accuracy of dictionary-based methods can vary depending on the characteristics and quality of the data. Future researchers can explore alternative methods such as AFINN, SenticNet, Bing Liu Lexicon, SentiStrength, Opinion Lexicon, or develop machine learning models to analyze sentiment in textual data.

Conclusion

This study explored higher education faculty perceptions of ChatGPT and investigated the factors causing these perceptions. Although previous studies have acknowledged the significance of ChatGPT in the education sector, they have yet to focus on exploring the perception of ChatGPT among faculty members. X data was gathered and analyzed using lexicon-based sentiment analysis and ground coding techniques. The study found positive sentiments were more prevalent in the tweets than negative sentiments. The study also revealed the diverse range of emotions held by higher education faculty regarding ChatGPT, with trust and joy being the most prevalent positive sentiments and fear and anger being the most prevalent negative sentiments. Faculty members generally perceive ChatGPT as a positive advancement in AI technology, recognizing its potential in areas such as creativity, student engagement, optimal learning, accessibility, and inclusion. However, it is vital to acknowledge that concerns were expressed regarding issues such as plagiarism, ethical considerations, and job security. In conclusion, this study provides insights into faculty perceptions of ChatGPT which can aid in better understanding how best to support faculty in incorporating this technology into their practice.

Acknowledgements The authors would like to thank Steffan Dussault and Kris Nario for support in the design of the graphics.

Funding There was no funding received for this study.

Data Availability The datasets analysed during the current study are available from the corresponding author upon reasonable request.

Declarations

Competing Interests We declare that there are no competing interests to disclose.

References

Al-Natour, S., & Turetken, O. (2020). A comparative assessment of sentiment analysis and star ratings for consumer reviews. *International Journal of Information Management,54*, 102132. https://doi.org/10.1016/j.ijinfomgt.2020.102132

Amani, S., White, L., Balart, T., Arora, L., Shryock, K. J., Brumbelow, K., & Watson, K. L. (2023). Generative AI perceptions: A survey to measure the perceptions of faculty, staff, and students on generative AI tools in academia. *arXiv*. https://doi.org/10.48550/arXiv.2304.14415

Aydın, Ö., & Karaarslan, E. (2023). Is ChatGPT leading generative AI? What is beyond expectations? *Academic Platform Journal of Engineering and Smart Systems, 11*(3), 118–134.

Bahrini, A., Khamoshifar, M., Abbasimehr, H., Riggs, R. J., Esmaeili, M., Majdabadkohne, R. M., & Pasehvar, M. (2023). ChatGPT: Applications, opportunities, and threats. In *2023 Systems and Information Engineering Design Symposium (SIEDS), IEEE,* (pp. 274–279). https://doi.org/10.1109/SIEDS58326.2023.10137850

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. Available at SSRN: https://doi.org/10.2139/ssrn.4337484

Barrie, C., & Ho, J. C. T. (2021). AcademictwitteR: An R package to access the Twitter Academic Research Product Track v2 API endpoint. *Journal of Open Source Software,6*(62), 3272.

Berger, J., Humphreys, A., Ludwig, S., Moe, W. W., Netzer, O., & Schweidel, D. A. (2020). Uniting the tribes: Using text for marketing insight. *Journal of Marketing,84*(1), 1–25. https://doi.org/10.1177/0022242919873106

Biddix, J. P., Park, H., Collom, G. D., Bailey, M. R., & Park, H. W. (2023). Discourse about higher education on Twitter in early phases of COVID-19: A crisis management social network analysis. *Education and Information Technologies,28*(8), 9957–9983.

Bingimlas, K. A. (2009). Barriers to the successful integration of ICT in teaching and learning environments: A review of the literature. *Eurasia Journal of Mathematics Science & Technology Education,5*(3), 235–245. https://doi.org/10.12973/ejmste/75275

Borji, A. (2023). *A categorical archive of ChatGPT failures*. arXiv. https://doi.org/10.48550/arXiv.2302.03494

Bozkurt, A., Junhong, X., Lambert, S., Pazurek, A., Crompton, H., Koseoglu, S., ... & Romero-Hall, E. (2023). Speculative futures on ChatGPT and generative artificial intelligence (AI): A collective reflection from the educational landscape. *Asian Journal of Distance Education, 18*(1), 53–130.

Burch, Z. A., & Mohammed, S. (2019). Exploring faculty perceptions about classroom technology integration and acceptance: A literature review. *International Journal of Research in Education and Science (IJRES),5*(2), 722–729.

Cao, D., Luo, W., & Nie, G. (2023). Global DSGE models, review of economic dynamics. https://doi.org/10.1016/j.red.2023.01.001

Chen, Y., Andiappan, M., Jenkin, T., & Ovchinnikov, A. (2023). A manager and an AI walk into a bar: Does ChatGPT make biased decisions like we do? [Preprint]. SSRN. https://doi.org/10.2139/ssrn.4380365

Chronicle of Higher Education (2023). *Opinion | how will AI change higher education?* https://www.chronicle.com/article/how-will-artificial-intelligencechange-higher-ed

Dai, Y., Liu, A., & Lim, C. P. (2023). Reconceptualizing ChatGPT and generative AI as a student-driven innovation in higher education. *33rd CIRP Design Conference*.

Dehouche, N. (2021). Plagiarism in the age of massive generative pre-trained transformers (GPT-3). *Ethics in Science and Environmental Politics,21*, 17–23. https://doi.org/10.3354/esep00195

Dwivedi, Y. K., Kshetri, N., Hughes, L., Slade, E. L., Jeyaraj, A., Kar, A. K., Baabdullah, A. M., Koohang, A., Raghavan, V., Ahuja, M., Albanna, H., Albashrawi, M. A., Al-Busaidi, A. S., Balakrishnan, J., Barlette, Y., Basu, S., Bose, I., Brooks, L., Buhalis, D., … Wright, R. (2023). So what if ChatGPT wrote it? Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy. *International Journal of Information Management,71*, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

Elbagir, S., & Yang, J. (2019, March). Twitter sentiment analysis using natural language toolkit and VADER sentiment. In *Proceedings of the International Multiconference of Engineers and Computer Scientists* (Vol. 122, No. 16). https://www.iaeng.org/publication/IMECS2019/IMECS2019_pp12-16.pdf

Etter, M., Colleoni, E., Illia, L., Meggiorin, K., & D'Eugenio, A. (2018). Measuring organizational legitimacy in social media: Assessing citizens' judgments with sentiment analysis. *Business & Society,57*(1), 60–97. https://doi.org/10.1177/0007650316683926

Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2023). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International,1–15*, 1. https://doi.org/10.1080/14703297.2023.2195846

Fiesler, C., & Proferes, N. (2018). Participant perceptions of Twitter research ethics. *Social Media and Society, 4*(1), 1–14. https://doi.org/10.1177/2056305118763366

Garg, M., & Goel, A. (2023). Detection of internet cheating in online assessments using cluster analysis. In N. Sharma, A. Goje, A. Chakrabarti, & A. M. Bruckstein (Eds.), *Data management, analytics and innovation* (pp. 85–95). Springer. https://doi.org/10.1007/978-981-99-1414-2_7

Gautreau, C. (2011). Motivational factors affecting the integration of a learning management system faculty. *The Journal of Educators Online,8*(1), 1–25.

George, A. S., & George, A. S. H. (2023). A review of ChatGPT AI's impact on several business sectors. *Partners Universal International Innovation Journal,1*(1), 9–23. https://doi.org/10.5281/zenodo.7644359

Grimmer, J., & Stewart, B. M. (2013). Text as data: The promise and pitfalls of automatic content analysis methods for political texts. *Political Analysis,21*(3), 267–297.

Hao, K. (2023). What is ChatGPT? What to know about the Ai chatbot. *The Wall Street Journal*. https://www.wsj.com/articles/chatgpt-ai-chatbot-app-explained-11675865177

Haque, M. U., Dharmadasa, I., Sworna, Z. T., Rajapakse, Roshan, & Ahmad, H. (2022). I think this is the most disruptive technology: Exploring sentiments of ChatGPT early adopters using Twitter data. https://doi.org/10.48550/arXiv.2212.05856

Humphreys, A., & Wang, R. J. H. (2018). Automated text analysis for consumer research. *Journal of Consumer Research,44*(6), 1274–1306. https://doi.org/10.1093/jcr/ucx104

Hutto, C., & Gilbert, E. (2014). Vader: A parsimonious rule-based model for sentiment analysis of social media text. *Proceedings of the International AAAI Conference on Web and Social Media, 8*(1), 216–225. https://doi.org/10.1609/icwsm.v8i1.14550

Janse van Rensburg, C., Coetzee, S. A., & Schmulian, A. (2022). Developing digital creativity through authentic assessment. *Assessment & Evaluation in Higher Education, 47*(6), 857–877. https://doi.org/10.1080/02602938.2021.1968791

Jiao, W., Wang, W., Huang, J., Wang, X., & Tu, Z. (2023). *Is ChatGPT a good translator? A preliminary study*. arXiv Preprint ArXiv:230108745, 1(10).

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences,103*, 102274. https://doi.org/10.1016/j.lindif.2023.102274

Kauffmann, E., Peral, J., Gil, D., Ferrández, A., Sellers, R., & Mora, H. (2020). A framework for big data analytics in commercial social networks: A case study on sentiment analysis and fake review detection for marketing decision-making. *Industrial Marketing Management,90*, 523–537. https://doi.org/10.1016/j.indmarman.2019.08.003

Keengwe, J., & Kang, J. J. (2012). Teaching with technology: Faculty adoption of educational technology. In P. Resta (Ed.), *Proceedings of SITE 2012–Society for Information Technology & Teacher Education International Conference* (pp. 4835–4839). Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/40372/

King, M. R., chatGPT. (2023). A conversation on artificial intelligence, chatbots, and plagiarism in higher education. *Cellular*

and Molecular Bioengineering, 16, 1–2. https://doi.org/10.1007/s12195-022-00754-8

Kulviwat, S., Bruner, I. I., Kumar, G. C., Nasco, A., & Clark, T. (2007). Toward a unified theory of consumer acceptance technology. *Psychology & Marketing,24*(12), 1059–1084.

Leiter, C., Zhang, R., Chen, Y., Belouadi, J., Larionov, D., Fresen, V., & Eger, S. (2023). ChatGPT: A meta-analysis after 2.5 months. *arXiv preprint arXiv:2302.13795*. https://doi.org/10.48550/arXiv.2302.13795

Liu, X., Burns, A. C., & Hou, Y. (2017). An investigation of brand-related user-generated content on Twitter. *Journal of Advertising,46*(2), 236–247. https://doi.org/10.1080/00913367.2017.1297273

Lyu, J. C., Han, E. L., & Luli, G. K. (2021). COVID-19 vaccine–related discussion on Twitter: Topic modeling and sentiment analysis. *Journal of Medical Internet Research,23*(6), e24435.

Malik, A., Khan, M. L., and Hussain, K. (2023). How is ChatGPT transforming academia? Examining its impact on teaching, research, assessment, and learning (April 9, 2023). Available at SSRN: https://doi.org/10.2139/ssrn.4413516

Mamo, Y. Z. (2023). Big data and innovative research methods. *International Journal of Sport Communication,16*(3), 352–360.

Mamo, Y. Z., & Anagnostopoulos, C. (2023). Stakeholders'voice through social media: The case of corporate social responsibility in sport. *International Journal of Sports Marketing and Sponsorship,24*(5), 1002–1020.

McDonald, S. M. (2012). Perception: A concept analysis. *International Journal of Nursing Knowledge,23*(1), 2–9. https://doi.org/10.1111/j.2047-3095.2011.01198.x

McGee, R. W. (2023). Is ChatGPT biased against conservatives? An empirical study. *SSRN Electronic Journal Https*. https://doi.org/10.2139/ssrn.4359405

Metz, A. (2022, December 29). *6 exciting ways to use ChatGPT – from coding to poetry* Techradar. https://www.techradar.com/features/6-exciting-ways-to-use-chatgpt-from-coding-to-poetry

Mhlanga, D. (2023). Open AI in education, the responsible and ethical use of ChatGPT towards lifelong learning. Available at SSRN: https://doi.org/10.2139/ssrn.4354422

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Milmo, D. (2023, February 2). *ChatGPT reaches 100 million users two months after launch*. The Guardian. https://www.theguardian.com/technology/2023/feb/02/chatgpt-100-million-users-open-ai-fastest-growing-app

Mohammad, S. M., & Turney, P. D. (2013). Crowdsourcing a word–emotion association lexicon. *Computational Intelligence,29*(3), 436–465. https://doi.org/10.1111/j.1467-8640.2012.00460.x

O'Connor, C., & Joffe, H. (2020). Intercoder reliability in qualitative research: Debates and practical guidelines. *International Journal of Qualitative Methods,19*, 160940691989922. https://doi.org/10.1177/1609406919899220

O'Hallarn, B., Shapiro, S. L., Hambrick, M. E., Wittkower, D. E., Ridinger, L., & Morehead, C. A. (2018). Sport, Twitter hashtags, and the public sphere: A qualitative test of the phenomenon through a Curt Schilling case study. *Journal of Sport Management, 32*(4), 389–400.

Rae, J. (2022). Connecting for creativity in higher education. *Innovative Higher Education,48*, 127–143. https://doi.org/10.1007/s10755-022-09609-6

Rahman, M. M., & Watanobe, Y. (2023). ChatGPT for education and research: Opportunities, threats, and strategies. *Applied Sciences,13*(9), 5783. https://doi.org/10.3390/app13095783

Rawlusyk, P. E. (2018). Assessment in higher education and student learning. *Journal of Instructional Pedagogies, 21*, 1–34.

Reed, L. (2022). *ChatGPT for automated testing: From conversation to code*. Sauce Labs: Cross Browser Testing, Selenium Testing & Mobile Testing. (2023, December 29). https://saucelabs.com/resources/blog/chatgpt-automated-testing-conversation-to-code

Reuters Tech News | Today's latest technology news | reuters. (2023, December 29). https://www.reuters.com/technology/ropertechnologies-raises-2023-profit-forecast-increased-software-adoption-2023-07-21/

Ribeiro, F. N., Araújo, M., Gonçalves, P., André Gonçalves, M., & Benevenuto, F. (2016). Sentibench-a benchmark comparison of state-of-the-practice sentiment analysis methods. *EPJ Data Science,5*, 1–29.

Rodríguez-Ruiz, J., Mata-Sánchez, J. I., Monroy, R., Loyola-Gonzalez, O., & López-Cuevas, A. (2020). A one-class classification approach for bot detection on Twitter. *Computers & Security,91*, 101715.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.

Rudolph, J., Tan, S., & Tan, S. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education? *Journal of Applied Learning & Teaching,6*(1), 7–15. https://doi.org/10.37074/jalt.2023.6.1.9

Saldana, J. (2015). *The coding manual for qualitative researchers* (3rd ed.). Sage.

Shaw, J., Rudzicz, F., Jamieson, T., & Goldfarb, A. (2019). Artificial intelligence and the implementation challenge. *Journal of Medical Internet Research,21*(7), e13659. https://doi.org/10.2196/13659

Shivaprasad, T. K., & Shetty, J. (2017). Sentiment analysis of product reviews: A review. *2017 International conference on inventive communication and computational technologies (ICICCT)* (pp. 298–301). IEEE. https://doi.org/10.1109/ICICCT.2017.7975207

Strauss, A., & Corbin, J. (1995). Grounded theory methodology: An overview. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 273–285). Sage.

Sullivan, M., Kelly, A., & McLaughlan, P. (2023). ChatGPT in higher education: Considerations for academic integrity and student learning. *Journal of Applied Learning & Teaching,6*(1), 31–40. https://doi.org/10.37074/jalt.2023.6.1.17

Taecharungroj, V. (2023). What can ChatGPT do? Analyzing early reactions to the innovative AI chatbot on Twitter. *Big Data and Cognitive Computing,7*(1), 35. https://doi.org/10.3390/bdcc7010035

Tlili, A., Shehata, B., Adarkwah, M. A., Bozkurt, A., Hickey, D. T., Huang, R., & Agyemang, B. (2023). What if the devil is my guardian angel: ChatGPT as a case study of using chatbots in education. *Smart Learning Environments,10*, 15. https://doi.org/10.1186/s40561-023-00237x

Tung, L. (2023). *ChatGPT can write code. Now researchers say it's good at fixing bugs, too* ZDNET. https://www.zdnet.com/article/chatgpt-can-write-code-now-researchers-say-its-good-at-fixing-bugs-too/. Accessed 29 Dec 2023.