Understanding the Workplace Transition Experiences of Undergraduate Queer Engineering Students

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INTRODUCTION:

The transition from school to work is one of the most significant changes in a person's life, impacting their progress in both personal and professional endeavors. We present this work-in-progress paper as a scoping review aimed at identifying what is known about the experiences of Queer engineering students transitioning into the workforce. We searched databases to gather relevant articles within the scope of our research. To conduct this scoping review, we have employed the five-stage framework developed by Arksey & O'Malley (2005), which offers a systematic approach. Our research question aims to focus on exploring the existing literature on the experiences of Queer engineering graduates as they transition to the workforce, specifically within the context of the United States. The five-stage framework comprises the following steps:

1) Identifying the research question
2) Identifying relevant studies
3) Selecting studies based on predefined inclusion and exclusion criteria
4) Charting the data, extracting key findings, identifying recurring themes
5) Collating, summarizing, and reporting the results

The ultimate objective of this paper is to provide a clear and descriptive summary of the existing knowledge related to the research question: "What is the current literature landscape regarding the experiences of Queer engineering students transitioning into the workforce in the United States?"

This paper delves into the tools and framework employed for the study and provides an overview of the current literature landscape. Our ultimate intention is to uncover the prevailing trends within the literature, examine existing theories, and pinpoint potential gaps in the research. The purpose of showcasing this work at the conference is to initiate discussions on established literature concerning queer engineering graduates. We anticipate that future efforts, informed by the insights gained during the conference, will contribute to a thorough and systematic review of the transition experienced of the queer engineering workforce, ultimately fostering the development of a stronger engineering workforce.

Following the iterative approach outlined by Arksey and O'Malley (2005) in scoping review processes, we began by formulating a broad research question. However, this initial inquiry failed to produce results pertinent to our collective investigation. Consequently, we adjusted our research focus, directing our attention to examining (1) the school-to-work transition for engineering students and (2) the school-to-work transition for individuals identifying as queer across various academic disciplines. The term "Queer" is utilized to normalize its usage within this context and to portray an empowered narrative moving forward.

BACKGROUND & LITERATURE REVIEW:

The term "Queer" is widely used as an inclusive and umbrella term to describe individuals who diverge from traditional heterosexual and cisgender identities. It

encompasses a diverse range of sexual orientations and gender identities that challenge societal norms, including but not limited to gay, lesbian, bisexual, transgender, and non-binary identities. In our study, we have chosen to use this term in its broadest sense. However, when discussing this community within the framework of specific research, we will adopt the terminology used by the researchers of those studies. The existing literature on Queer experiences in STEM fields provides unique insights into the distinct challenges and opportunities encountered by people of various gender and sexual orientations. Studies have explored the experiences of LGBTQ+ students in male-dominated fields, such as engineering, shedding light on the challenges they face [1]. Huff et al. [2] offers a comprehensive examination of the development of professional identities among early-career engineers in the United States. Early-career engineers often find themselves on an accelerated path to adulthood shaped by their engineering roles, leading to intricate tensions between their professional identity and personal and social roles [2]. Drs. Lutz, Canney, and Brunhaver's research [3] examines the experiences of early-career engineers and their perceptions of agency within workplace environments, revealing the struggle to exercise autonomy and apply skillsets effectively.

Research on LGBTQ+ experiences within STEM fields provides a comprehensive view of the various challenges and opportunities encountered by individuals of different gender and sexual orientations. [1] explored the systemic inequalities faced by LGBTQ+ individuals in STEM professions, revealing issues such as career constraints, harassment, devaluation within their profession, health challenges, and a propensity to consider leaving the STEM field. Their findings underscore the pressing need for research into the mechanisms perpetuating these disparities. [4] underscore the obstacles LGBTQ+ graduates encounter during job searches within chemistry and chemical engineering majors, impacting their post-graduation aspirations. [5] explore LGBTQ+ inclusivity within engineering education, emphasizing the role of open faculty, allies, and curriculum adjustments. Field and Rajewski [6] identified a range of challenges encountered by early-career LGBTQ+ scientists in STEM fields. These challenges include discrimination, career limitations, the necessity of concealing their identities, and elevated poverty rates. These findings underscore the urgent need for creating more inclusive environments in STEM disciplines. Yoder and Mattheis [7] reveal the role of inclusive policies and supportive workplace climates in fostering openness among LGBTQ+ individuals in STEM, [8] emphasize the transformative potential of community support in dismantling barriers and enhancing opportunities. [9] shed light on techniques employed by LGBTQ+ engineering students to navigate and thrive within engineering environments. These studies highlight the challenges faced by LGBTQ+ engineers in the workplace and the process of identity negotiation experienced by engineering students as they transition from student to early career engineers.

The existing literature demonstrates the complex landscape of LGBTQ+ experiences in STEM and the imperative of fostering inclusivity and equity. Research has extensively examined systemic challenges and the STEM culture concerning LGBTQ+ individuals. However, there remains a notable gap in research focused on LGBTQ+ engineering students experiencing the transition from school to the workforce. These existing studies shed light on the negative experiences of queer STEM professionals broadly, emphasizing the need to delve specifically into the transition of queer engineering students into the professional realm. This work serves

as a preliminary exploration of the current literature landscape pertaining to the experiences of queer engineering students during their transition to the workforce in the United States.

METHODOLOGY:

In accordance with Grant and Booth's research [10], a scoping review can be defined as an initial assessment aiming to assess the potential scale and scope of the existing research literature. Its primary goal is to determine the nature and extent of available research evidence, which often includes ongoing research [10]. Scoping reviews are conducted for various purposes, with the most prevalent ones including exploring the extent and depth of the literature, mapping and summarizing the available evidence, guiding future research endeavors, and identifying or addressing knowledge gaps [11]. Hence, we intend to employ a scoping review on the workforce transition of Queer engineering graduates to establish a research agenda specifically within the field of engineering education. We implemented Arksey and O'Malley's [12] five-stage framework to conduct this scoping review as outlined in Fig. 1.

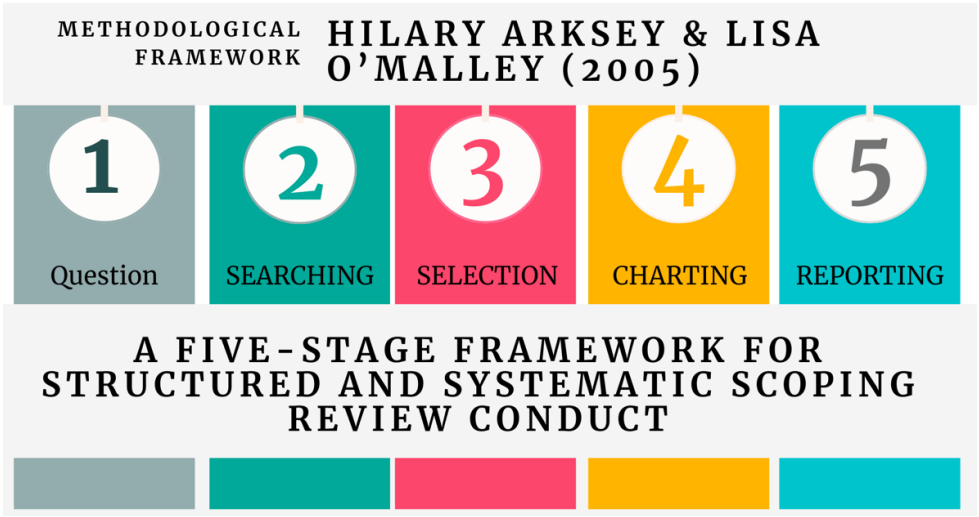

Fig. 1: Five-stage framework by Arksey and O'Malley (2005)

This scoping review framework by Arksey and O'Malley [12] entails Five key steps. Firstly, it involves identifying the research question, which sets the focus for the review. Following this, relevant studies are located and gathered, specifically those pertinent to the research question. Next, a process of study selection takes place, wherein inclusion and exclusion criteria are applied to determine which studies will be incorporated into the review. Subsequently, the data extracted from the selected studies are organized and structured in a chart, facilitating analysis. Finally, the findings will be synthesized, collated, summarized, and reported to offer an overview of the existing evidence regarding the research question. Further details are provided in Table I below, highlighting the Research Agenda Steps for Understanding the Transition of LGBTQIA+ Engineering Students to the Workforce. In the findings section for this paper, we provide detailed information regarding the number of papers that have been carefully selected to undergo a comprehensive review of their abstracts and titles. This process involves a thorough examination to assess the relevance and quality of

each paper for inclusion in the study or analysis.

TABLE I: Research Agenda Steps for Understanding the Transition.

Step	*Description*	*Task as per research plan*
1	Identifying the research question	Focuses on understanding the current literature landscape regarding the experiences of LGBTQIA+ (Queer) engineering students transitioning to the workforce in the United States.
2	Identifying relevant studies: Database (n = 7)	Comprehensive search on specific databases (ERIC, APA PsycINFO, CINAHL, LGBTQ+ Source, Web of Science, IEEE Xplore, and Engineering Village).
3	Selecting studies:	Utilizing Rayyan, a web-based software tool designed to support the systematic review process, the studies were chosen according to predetermined inclusion and exclusion criteria detailed in Table II.
4	Charting the data:	Meticulously examining the data, involving the extraction of essential findings and the identification of recurring themes.
5	Collating, summarizing, and reporting the results:	Collecting, condensing, and presenting a summary of the findings. Reporting the number of papers selected for a full abstract and title review.

Table 2 methodically presents the inclusion and exclusion criteria for our systematic review. Each row specifies a criterion, with a tick "✓" in the 'Inclusion' column signifying that a study is suitable for inclusion in our review process, and a cross "✗" in the 'Exclusion' column denoting that a study does not meet our criteria. This table meticulously details the parameters for selecting studies that align with our research question, "What is the current literature landscape regarding the experiences of Queer engineering students transitioning into the workforce in the United States?" which investigates the transition of queer engineering students from educational settings into the workforce.

TABLE II: Inclusion and Exclusion Criteria for the Review

Criteria	*Included*	*Excluded*
Peer Reviewed Article	✓	✗
Participants Residing Outside the USA	✗	✓
Written in English	✓	✗
Population Including Graduate Students	✗	✓
Meeting Participant Description Criteria	✓	✗
Falling Outside the Specified Timeline	✗	✓
Discussion of Exploring Engineering Workplace Transition	✓	✗

RESEARCH DESIGN:

In our scoping review, we adopted a systematic approach to enhance both the quality and transparency of our work, drawing inspiration from Borrego et al.

[13] definition of a scoping review as a study aimed at determining the necessity of a systematic review on a given topic. We emphasize the significance of conducting scoping reviews as an initial step before embarking on systematic reviews. This preliminary assessment is vital for comprehending the breadth of literature available on a subject, pinpointing key concepts, theories, and evidence sources, and identifying research gaps. The design of our scoping review was intentionally broad, aiming to include a maximum number of articles. This broadness allows for the inclusion of articles from any source and methodology, as defined by Arksey and O'Malley [12] and the Joanna Briggs Institute (JBI) [14]. Our approach aligns with the literature mapping process, enabling us to explore the landscape of literature based on a specific question of interest. As noted by Armstrong et al. [15], the objectives of conducting a review can vary, including exploring the extent of literature, identifying review boundaries and parameters, and pinpointing gaps in a body of literature. Often, the goal of a scoping review is to lay the groundwork for a more rigorous systematic review, a sentiment echoed by the JBI and further elaborated in Peters et al. [14] chapter, which also considers the context of the review's research question.

Montclair State University describes a scoping review as a type of literature review, yet it is distinguished by its structured, transparent, and systematic methodology. Unlike a traditional literature review, authors are required to report every step of the process, presenting findings not narratively but in a tabulated and aggregated format. This methodological rigor helps eliminate bias, as the steps and research design are meticulously laid out from the onset. Arksey and O'Malley (2005) characterize the scoping review process as iterative rather than linear, advocating for the search to be revisited and refined in a potentially circular manner. This includes engaging subject experts throughout the process, for instance, the crafting of search terms benefited from the expertise of a librarian, with 2 other graduate students playing pivotal roles in executing searches across various databases, thereby bringing to light nuances and necessary corrections.

The inclusion of a complete search strategy for one major database (ERIC), as recommended by McGowan et al. [16] in their evidence-based guideline for Peer Review of Electronic Search Strategies (PRESS), was a critical component of our methodology. This guideline highlights the critical role of conducting the primary search with a librarian's expertise and subjecting it to peer review by another librarian, a practice that highlights the thoroughness and meticulousness of our scoping review.

Data Collection

We conducted our initial search in the ERIC database hosted by EBSCO, EBSCOhost is an online research platform offering high-quality databases and search functionalities. ERIC sponsored by the Institute of Education Sciences (IES) of the U.S. Department of Education, is a digital library offering a wealth of educational research and information resources. We organized our search terms into four distinct concept lines. A concept line, as we define it, is a search criterion that carries a similar definition or meaning as the suggested keyword. For example, one of our concept lines pertained to our target population, which is queer. For this concept line, we listed all potential keywords used to search journal articles. We've outlined our concept lines and keywords in the fig. below,

customized specifically for one database. These concept lines' terminologies, along with nuances in words and Boolean operators, were adjusted based on the database we searched.

Undergraduate Searches for literature pertaining university/college students, including recent graduates.	university student" OR "college student" OR "undergraduate student" OR "former student" OR student*
Engineering Focuses on articles related to the engineering field or profession.	Engineering OR Engineer* OR Engineers
Transition Targets studies discussing the transition from educational institutions to the professional workforce.	"school to work" OR "school to career" OR "school-to-work" OR "school to Industry" OR "education to work" OR "college to work" OR "university to work" OR "school to workforce" OR "school to workplace" OR "study to work"
Population Encompasses a broad range of terms associated with the queer and LGBTQ+ community.	queer OR lgbtq OR gay OR lgbt OR lesbian OR homosexual OR transgender OR glbtq OR lgb OR glb OR trans OR transgender OR "sexual minority" OR "gender diversity" OR genderqueer OR "gender fluid"

Fig 2: Presenting the concept line operationalized in our study.

In our meetings, it was suggested that we use a single concept line search and then combine them for the comprehensive search. These concept lines include the first, focusing on undergraduate students in our study; the second, engineering, representing the industry sector; the third, school-to-work, the context of our study; and the fourth, our target population, the queer community, encompassing individuals who identify as part of the LGBTQ+ spectrum. As we defined our research question, "What is the current literature landscape regarding the experiences of Queer engineering students transitioning to the workforce in the United States?" We combined all four concept lines in an AND loop to compile the articles in exploring the question. our search was crafted to include the following areas: The "Queer" aspect focuses on literature related to the LGBTQ+ community within engineering; "Engineering" scrutinizes studies on engineering education and industry practices, especially concerning LGBTQ+ individuals. "School-to-Work Transition" delves into the shift from engineering academic settings to professional employment, "United States" and "Undergraduate" components of our research focus on studies specific to the American context, aiming to provide insights into the experiences of Queer engineering students who are either currently enrolled in undergraduate programs or have completed their engineering degrees in the United States. We structured our agenda to encompass studies focusing on the transition from school to technical engineering roles for undergraduate students. For instance, the study excludes cases such as graduate students or those engaged in non-traditional engineering roles or part-time work.

DISCUSSION

Upon connecting all our concept lines, we obtained 22 results from ERIC,

employing a strategy that integrated Concept Lines 1, 3, and 4. These lines relate to university students, the school-to-work transition, and LGBTQ+ individuals, providing literature on queer university or college students and their experiences transitioning from school to work. However, combining concept lines 1, 2, and 3 yielded 100 research findings focusing on the school-to-work transition for undergraduate engineering students. To ensure comprehensiveness, we have created a figure detailing how the search concept was utilized, with a Venn diagram also depicted in Fig. 3. The first bubble represents research articles covering the school-to-work transition of engineering students. Meanwhile, the other bubble highlights studies focusing on the school-to-work experiences of queer individuals in any field of study, both focusing on undergraduate populations and the intersection that illustrates our research agenda, that explores our research question.

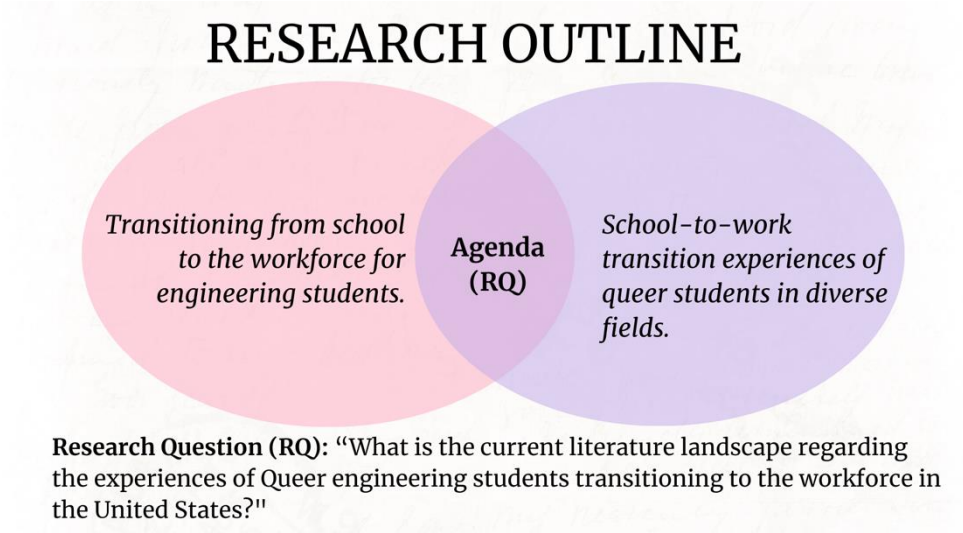

Fig. 3: Defining the research question in the scope of existing literature.

Despite this, combining all search parameters to directly address our research question did not yield any papers specifically covering the experiences of queer engineering students in their school-to-work transition. We approached this scoping review as an iterative process, analyzing the yielded results each time we conducted a search and refining our search by modifying keywords. In doing so, we also identified discrepancies in some data imports. While conducting our review, we retrieved a total of 274 articles from 7 databases (ERIC n=100, APA PsycINFO n=55, CINAHL n=1, LGBTQ+ Source n=0, Web of Science n=50, IEEE Xplore n=15, and Engineering Village n=53). Upon screening, we assessed 209 articles and identified 67 duplicates flagged by Ryyan, these duplicates were subsequently excluded following manual review. We excluded 32 articles based on title review and conducted abstract reviews on 177 articles. From these, we excluded 122 articles that did not meet our inclusion criteria, primarily focusing on the school-to-work transition of engineering students in USA.

We have now selected 55 articles for retrieval to conduct a full-text analysis on them. We have highlighted all these data following PRISMA 2020 guidelines in Fig. 4. This overall process led us to the conclusion that there is a gap in research highlighting the school-to-work transition for queer engineering students. Therefore, future research should prioritize highlighting these experiences and working towards making engineering programs more inclusive and diverse.

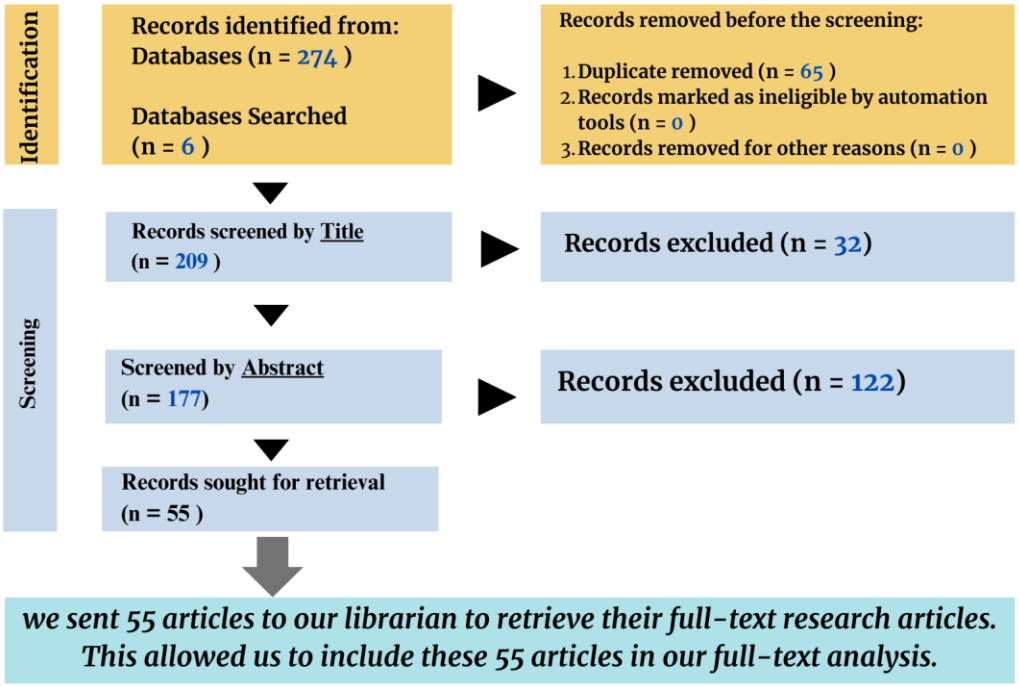

Fig 4: Flow chart following The PRISMA 2020 statement.

FUTURE WORK

The transition from school to work represents a pivotal phase in an individual's life journey. It is during this transition that students confront the hurdles of securing employment and assimilating into professional settings. For LGBTQ+ engineering students, this period is also significant as they establish their identities both as queer individuals within the engineering field and as engineering professionals. Understanding the experiences of queer engineering students during this transition is imperative for fostering inclusive and supportive environments that facilitate their success. Following the rhetorical process, we intend to analyze these articles through a qualitative lens to explore the school-to-work transition within the engineering context. Several studies have explored the experiences of LGBTQ+ students in male-dominated fields, such as engineering, shedding light on the challenges they face [17]. Despite the current landscape exploring the experiences of LGBTQ+ students, there is still a significant gap in the literature when it comes to specifically addressing the experiences of queer engineering students during their transition from school to work. This gap hinders the development of targeted support programs and resources that can cater to the unique needs of this demographic. To address this disparity, [1] suggested that future studies should aim to further explore LGBTQ+ inequality within STEM fields. Our approach to narrowing this gap involves collecting qualitative data via interviews and surveys from queer engineering students, specifically targeting the systemic disparities encountered during the transition from school to work through asset-based lenses. This would provide valuable insights into the specific challenges they face during their transition and the strategies they employ to navigate them. Additionally, exploring the role of support networks, both within educational institutions and professional settings, would be beneficial in understanding the factors that contribute to the success of queer engineering students during their transition to the workforce [18]. By

addressing these research gaps, we can work towards creating a more inclusive and supportive environment for queer engineering students, ultimately enabling them to thrive in their chosen fields [19].

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