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Use of Transfer Student Capital in Engineering and STEM Education: A Systematic Literature Review

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1. Introduction

This complete research paper presents a systematic literature review that synthesizes the use of Laanan's theory of transfer student capital in postsecondary vertical college transfers, specifically focusing on use in engineering and Science, Technology, Engineering, and Mathematics (STEM) education [1]. The motivation for this research stems from a need to better understand the theory of transfer student capital, which emerged in 2010 [1]. Since its introduction, literature has used this theory to describe a student's knowledge about higher education influenced by faculty interactions, academic advising and counseling, programs of study, and the ability to navigate university transfer policies and requirements. Yet, to date, no research study has synthesized and provided a comprehensive overview of the use of this theory in empirical research to understand where and how it is being used. A better understanding of theories supporting students' vertical transfer from community college to four-year institutions is becoming increasingly important as 45% of all undergraduates in the United States are enrolled at a two-year or community college institution [2], rising use of community colleges as educational pathway conduits with nearly 49% of all United States baccalaureate graduates have had some previous enrollment in a community college, and increasing opportunities to attend community colleges for free or little tuition cost [3]. Yet, the transfer puzzle is still missing many pieces in understanding "transfer success," such as the lack of a "well-trodden pathway" to a bachelor's degree, students lack of use of articulation agreements, credits lost in the transfer, and the weak relationship between transfer policies and baccalaureate degree completion. Also alarming is the fact that 80% of all community college students indicate a desire to transfer, yet only approximately one-third transfer and earn a bachelor's degree in six years [4]. Explicitly focusing on engineering and STEM at the transfer juncture is essential because it expands opportunities to recruit more diverse students into engineering careers, it explores engineering articulation and transfer barriers, and can inform curriculum and student service needs within engineering transfer programs.

Given that engineering students transfer differently and benefit from more pre-transfer preparation, focus on the engineering transfer process is vital[5]. However, existing research does not provide an adequate understanding of how to increase engineering transfer success. Developing a better understanding of the application of the theory of transfer student capital in engineering transfer will increase understanding of how the theory of transfer student capital can contribute to improved transfer student outcomes in engineering education and provide an overview of the use and critical characteristics of transfer student capital in engineering programs [5]. This review will begin with a brief overview of relevant literature on general transfer patterns, engineering and STEM vertical transfer, and the theory of transfer student capital. Following this, the review will present findings and analysis of a systematic literature review. The study will conclude with a discussion, research recommendations, and implications.

The practical implications of this research, specifically for engineering education and STEM programs, provide a more robust empirical understanding of the application of transfer

student capital to increase the number and success of engineering transfer students. Research implications include recommendations to examine the use of this framework with more pre-transfer students and programs and additional research on how transfer student capital can better impact access and diversity in engineering and STEM education higher education and career pathways. This study provides a distinct, systematic synthesis of transfer student capital in engineering and STEM education. It expands understanding of how to support equitable educational advancement preparing community college transfer students for the workforce of the future and innovative changes needed in traditional educational models.

2. Literature

2.1 Importance of Community Colleges in Engineering and STEM Baccalaureate Pathways

Community colleges are important and overlooked partners in creating baccalaureate pathways to engineering and STEM degrees. The transfer function at community colleges can support social mobility through providing access to a four-year college or university that might otherwise not have been available [1]. Their open-access mission which provides broad access and acceptance of students and broad diversity of student body positions community colleges to serve as a pathway to for women, first generation students, and underserved populations wishing to enter STEM and engineering careers [6]–[8]. The importance of community colleges in STEM and engineering baccalaureate pathways is further illuminated when considering that 18% of students earning a bachelor's degree in science or engineering had previously earned an associate degree and overall, 47% of all science and engineering students reported attending a community college enroute to a bachelor's degree [3]. As demand for STEM and engineering workers is growing, we must think creatively about how to identify and cultivate human capital and talent, creating clearer, more accessible, and more flexible pathways from community colleges to baccalaureate STEM and engineering degrees [9].

2.2 STEM and Engineering Vertical Transfer Pathways

Engineering transfer students are privy to a unique set of challenges and barriers. Because engineering degree programs are typically tightly structured, and require specific pre-requisites, not meeting these requirements prior to transfer may hinder persistence in the degree altogether [5]. Additionally, institutional differences in engineering pathways and course sequences can lead to difficulties navigating transfer credits and barriers to integration directly into an engineering major at another institution [10]. Other hindrances for engineering transfer students can be due to communication surrounding the transfer process. A study conducted by Reeping and Knight identified differences in digital communication about the transfer process for engineering majors between the transferring and receiving institution [11]. They also identified potentially negative or confusing language as a common theme which appeared around the transfer process. For first-generation college students, these issues can compound as they work to navigate the hidden curriculum behind transferring [12].

Engineering and STEM students interested in transitioning from one institution from another are able to select one of two pathways. The first pathway is referred to as horizontal transfer or the lateral transfer of a student between four-year institutions. Students engaged in

horizontal transfer often do so for a variety of factors such as geography, social circumstances, and overall fit [13]. The second, more common type of transfer is referred to as vertical transfer. This encompasses transfer between a technical college, community college, or other two-year college institution and a four-year institution. Reasonings behind vertical transfer are similar to those behind horizontal, with the addition of financial and degree advancement benefits.

In engineering students specifically, a study by Smith, Grohs, and Van Aken [14]found that lateral transfers tended to have higher graduation rates than vertical transfers. Vertical transfer students with associate degrees were more likely to graduate than vertical transfer students without an associate degree. Other studies have found that students enrolled in STEM programs may have difficulty enrolling directly with their four-year institution of choice, and instead may elect to enroll in "back-door" bridge programs [15]. These programs are often developed as an agreement between a community college and four-year institution where students are accepted into the community college institution with an agreement that they will transfer to the four-year after their first or second year.

3. Methods

A systematic review of the literature was performed to identify, appraise, and synthesize all appropriate literature on transfer student capital in engineering education and pre-transfer engineering applications. This research review aims to answer the following research questions:

> RQ1: How is the theory of transfer student capital being used, and what are the critical characteristics of use?
> RQ2: How does the theory of transfer student capital impact and contribute to outcomes related to the transfer of engineering and STEM education students and programs?

The systematic literature review was guided by an engineering education framework published by Borrego, Foster, & Froyd [16]. This five-step framework entails basic steps to guide the development of a systematic literature review and has even been previously used in a literature review of similar context to this study [5]. Using this framework, the following steps were followed in this study: (1) conduct a scoping review of all literature to obtain an estimate of the number and accessibility of sources, (2) develop and scope research questions, (3) define inclusion and exclusion criteria for literature, (4) critique and appraise literature selected, and (5) perform synthesis including mapping, critique within studies, and critique across studies. Specifically, within the third and fourth steps which focused on the article search, critique, and appraisal process, the Preferred Reporting Items for Systematic reviews and Meta-Analyses or PRISMA method was used [17] to ensure systematic searching and seamless communication of the search and appraisal process. Figure 1 illustrates the systematic process used to identify relevant literature included in this study.

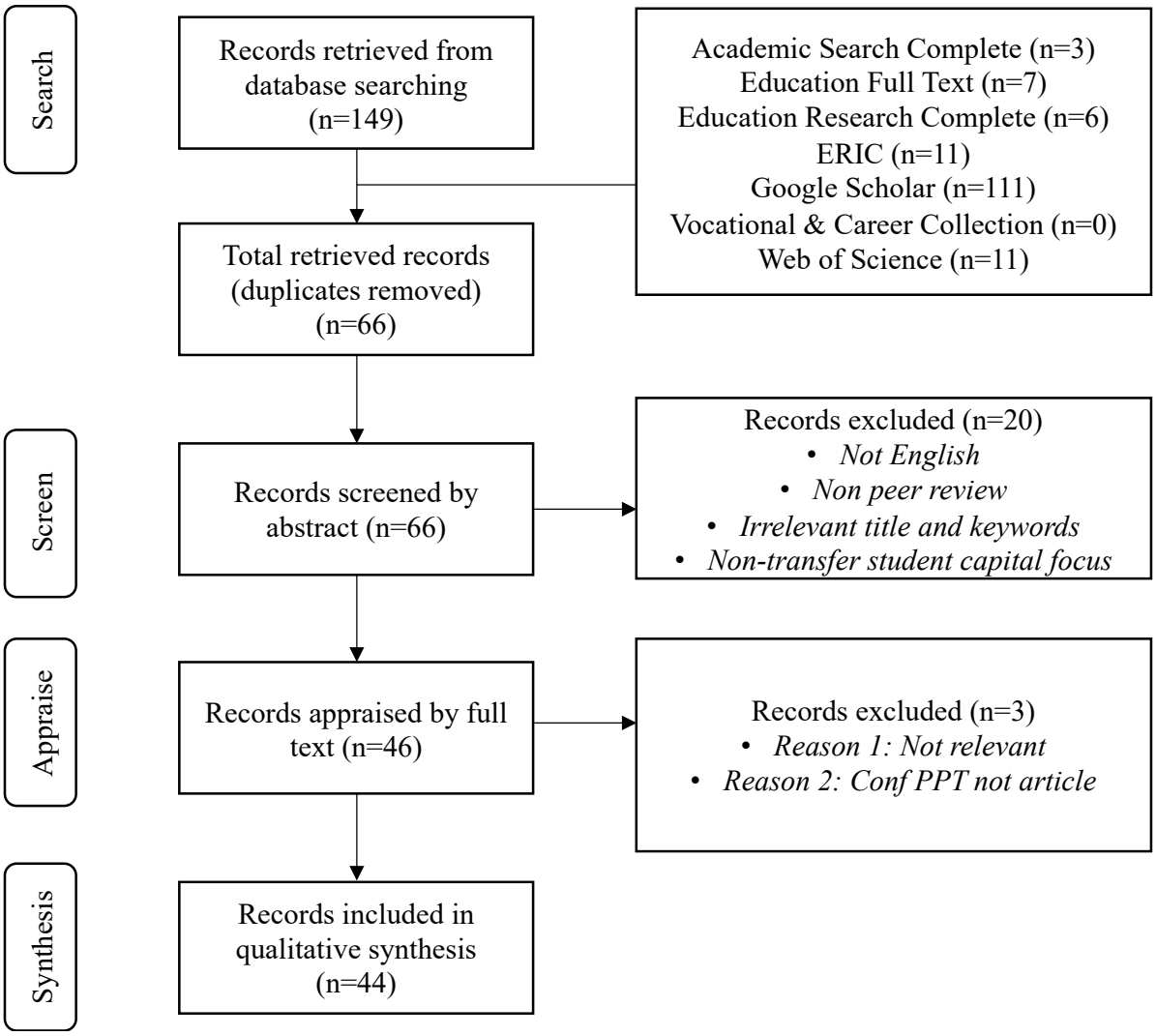

Figure 1. ***PRISMA Flow Diagram of the Systematic Review Process***

A systematic literature search was performed in September-October 2022. An appropriate set of databases were selected to ensure that the higher education, engineering education, and STEM education content was broadly covered: Web of Science, Academic Search Complete, Education Full Text, Education Research Complete, ERIC, Vocational and Career Collection, and Google Scholar. The selected articles from these databases integrate findings from research reviews, empirical studies, and theoretical articles published in both peer reviewed academic journals and academically reputable engineering education and STEM conferences such as the American Society for Engineering Education (ASEE) and IEEE Education Society Conferences. Given the fact that transfer student capital was introduced in 2010, the articles included in the search and this study span from 2010 through October 2022. The initial scoping review resulted in 61 full source texts. It included a topic search of the following terms: "transfer student capital" AND ("engineering education" OR "STEM" OR "engineering"). To expand the literature returned and understanding of the theory being utilized, an additional search was conducted using only the search term "transfer student capital."

Results were analyzed first inductively, allowing the data collected to suggest codes and themes of importance. Multiple rounds of inductive analysis were done to reduce data and identify significant codes and themes are discussed further in the results below. The inductive approach was used in this study due to its power to condense raw data into a summary format and to establish clear links between the analysis, the objectives of the research, and the summary of findings [18]. Analysis began with data familiarization which entailed importing articles into MAXQDA2020 and reading all articles. Coding began with first-round coding which were conducted where big-picture meanings began to form. Next, second-round coding was conducted where subcategories and subcodes were formed to better define and understand the initial or primary codes. After coding rounds, codes were refined through comparing, grouping or regrouping, and collapsing codes. Finally, there was synthesis and interpretation of the codes into overall themes and explanations of the phenomenon. This five-step process of analysis is consistent with inductive content analysis methods [19]. As analysis of the articles progressed, the researchers felt confident that primary codes, themes, and relevant information had been found as data saturation began to occur where articles cited common theorists, theories, researchers, research outcomes, and themes.

4. Results

Forty-four articles were found and included in this study. Over 500 codes were identified throughout the articles analyzed. Table 1 shows the categories and progression of codes leading to overall themes in the analysis. Four primary themes emerged. The first theme is understanding transfer student capital in the engineering and STEM education context. This theme is comprised of research-based definitions, components and constructs comprising the framework, theories and theoretical frameworks that were used to establish and further develop transfer student capital, and the transfer student challenges being addressed by the theory. The next theme is an analysis of the empirical evidence used to establish and develop the theory. This theme explores the type of method used, instrumentation, participants, and research outcomes from the studies. The third theme centers on strategies and implications emerging from the research. This provides practical guidance for practitioners and the area analyzing research gaps provides clear directions for future research. The final theme emphasizes the importance of an asset-based perspective. Many articles highlighted the importance of transfer pathways as an essential means for providing access to baccalaureate engineering degrees. Further, many articles had a strong focus on the capital and assets that students brought to the transfer process. Major findings and themes are explored in more detail below.

Table 1. Codes and Themes

Primary Code	Subcode	Theme
Definitions (18)		Context (164)
Components (19)		
Theories (62)	Original theories (8)	
	Other (54)	
Transfer challenges (65)		
Research use (124)	Lit review or theoretical (2)	Empirical examination (170)
	Mixed (8)	
	Qualitative (51)	
	Quantitative (63)	
Research outcomes (46)		
Strategic focus areas (85)	Engagement (16)	Implications and impact (143)
	Institutional practices (41)	
	Support and advising (28)	
Research gaps (31)		
Engineering specific (27)		
Access (24)		Assets-based perspective (54)
Diversity (30)		

Findings of Key Primary Codes

Definitions and Components

In a recent systemic literature review conducted on engineering transfer students, transfer student capital was the third most used framework throughout research [5]. Throughout the literature most articles defined transfer student capital similarly. The definitions primarily focused on Lanaan, Starobin, and Eggleston's [1] original definition revolving around how students accumulate knowledge and skills to navigate the transfer process. Throughout various articles additional elements were added which included background characteristics and perceptions of the transfer process [20], cumulative higher education experiences [21], and prior academic performance [22]. Lannan et al. [1] also included aspects such as understanding credit transfer agreements between colleges, grade requirements for admission into a desired major, and course prerequisites which were included in multiple definitions. In Laanan & Jain [23], transfer student capital is presented as part of a conceptual model for "studying diverse transfer students and organizational contexts." In addition to the individual elements identified here, several articles also acknowledge the organizational and institutional factor aspects of transfer student capital [21], [24]–[26].

Primary factors and constructs that comprise transfer student capital were first proposed by Laanan and are consistently identified throughout literature. The original four factors included: (a) student background and motivations for transfer, (b) community college experiences which included social campus activities and course learning, (c) transfer capital which includes perceptions of the transfer process advising, learning, and study skills, and (d) four-year university experiences which included experiences with faculty, course learning, and stigma as a transfer student [1]. Some articles simplified these factors describing them as academic counseling, perceptions of the transfer process, experiences with faculty, and

learning/study skills [25], [27], [28]. Building on Laanan's research, Moser [29] added several widely accepted constructs to the transfer student capital theory: staff validation at community college, faculty validation at community college, faculty mentoring at community college, financial knowledge, active coping style, social coping style, motivation and self-efficacy, social support at the four-year university, and formal collaboration with faculty at the community college.

Theoretical Frameworks

The original presentation of transfer student capital was comprised of three theoretical frameworks: Pascarella's [30] model of student learning and development, Becker's [31] theory of human capital, and the notion of transfer student as student retention [32]. Many articles cite these three primary frameworks [22], [33], [34]. However, a variety of research studies integrate new frameworks or use existing frameworks to describe the original frameworks. Several models developed by Tinto and Astin are described as forerunners of transfer student capital. The models that are cited include Tinto's 1993 Student Departure Model [25], [35], Astins 1993 Input-Environment-Outcome (IEO) model [9], [25], [36], frameworks of participation and persistence [37], and theories of social and academic integration [27]. By far, the theories that are most cited in 12 articles with transfer student capital and used to describe how student capital is formed and grown are social and cultural capital frameworks built on Bourdieu's social capital model [38]. This model comprises personal networks that provide individuals with information and opportunities and a model cultural capital which describes accumulated experiences within social contexts [8], [9], [25], [27], [28], [33], [36], [37], [39]–[41]. The next most cited theory appearing with transfer student capital was Yosso's [42] conceptualization of community cultural wealth [6], [25], [37], [43]. Integration of this framework extended transfer student capital to explain development of various types of capital for persisting in education in communities of color and other non-dominate groups [43]. Other frameworks appearing in the literature included Bandura's self-efficacy [27], [33], [37], experiential capital [6], Jain's transfer receptive culture, and critical race theory [43].

Research Use

Of the forty-four articles included in the analysis, 17 were articles about transfer student capital across all types of transfer students, 9 focused specifically on STEM transfer students, and 18 focused on engineering transfer students. Throughout the articles, many reported strong use of quantitative survey methods in prior research exploring transfer students, however, the mix of methodology in this study was nearly even. The methodology used in articles included in this study included 19 quantitative articles, 15 qualitative articles, 3 literature reviews and theoretical or conceptual articles. Overall, a variety of instrumentation methods were used. A commonly used survey was the Laanan-transfer students' questionnaire (L-TSQ) [1], [7], [34], [41], the Moser or modified Laanan-transfer students' questionnaire (ML-TSQ) [29], [34], [44], Engineering Transfer Student Survey [40], researcher constructed surveys [7], [24], [35], [37], [45], focus group protocols [46], and interview protocols [20], [45], [47].

Characteristics of the research articles may be divided into four broad categories: student experiences, perceptions, and self-efficacy; institutional factors; diverse student perspectives and

voices; and instrument and framework development. Details on the number of articles and subtopics are provided in Table 2. It is important to note that several of the articles are reported in multiple categories. This was done to provide the most accurate perspective of article characteristics and topics.

Table 2. Characteristics and subtopics of articles

Category	Number of Articles	Subtopics
Student experiences, perceptions, and self-efficacy	22	Self-efficacy, transfer processes perceptions, pre- and post-transfer experiences, transfer identity, academic and social adjustments
Institutional factors	15	Institutional support, climate, articulation agreements, pathways, campus resources, key personnel, academic factors, social support, advising, transfer information
Diverse student perspectives and voices	11	Nontraditional aged students, female students, first generation college student, Latinx and Hispanic students, students of color, Black students
Instrument and framework development	3	Identification of constructs, instrument development and validation, framework development

Strategic Focus Areas

Transfer student capital was cited as developing from many different types of sources. Students may develop transfer student capital through peers, family, student and institutional culture, high school teachers and staff, community college faculty and staff, and four-year institution faculty, staff, and advisors [27], [33], [48]. Interestingly, in one study, a latent class analysis found that race and ethnicity were not significant factors in determining transfer student capital [35]. There were also many articles which mentioned "internal" ways that students could develop transfer student capital which included setting appropriate transfer expectations [27], managing transfer intentions [34], and through other "self-initiated" strategies [39]. To build on these sources three primary strategic focus areas supporting developing greater transfer student capital emerged from the data, support and advising, institutional practices, and engagement. The strategies which emerged are taken primarily from the research outcomes and implications in the articles.

Student support and advising was a significant code in the research. Advising written about in these articles was typically performed or suggested to be performed by a traditional student advisor. The impact of advising on transfer student capital was reported to be significant [1], [24]. The recommendations for advising centered around amping up general advising dedicated transfer advisors engaging in pre-transfer advising and more pro-active advising [25], [27]. Further, advisors needed additional training to better understand the unique needs and course loads of transfer students [24], [36]. Finally, examining how to overcome transfer student stigma at the four-year college or university was identified as an advising aid to support development of transfer student capital [46].

Student support was discussed throughout the articles in many formats including increasing methods of student engagement, events, resources and tools, and faculty engagement.

Student support was reinforced through faculty engagement, interactions, and assistance that were described as caring, validating for the students, demonstrating appreciation for diversity, going the extra mile in and outside of class to assist with learning [8], [24], [25], [27], [37]. Other student support was evidenced in the form of transfer fairs [25], campus visits, career center access, computer support, daycare, writing tutors, academic success workshops, and post-transfer information sessions [24]. It was also noted that often transfer support comes most in the pre-transfer phase but that student support should be provided across three points: pre-transfer, pre-enrollment, and first term post-transfer [6]. Similarly related to student support is engagement. Ways to improve student engagement to increase transfer student capital included engaging with peers, role models, and peer mentors [6], [46]; developing student learning communities focused on the transfer process and engaging peer networks [24], [27]; joining student and professional engineering organizations [8], [48]; and assisting with research projects [8].

Finally, institutional practices, institutional coordination, and information sharing from institutions were highlighted as strategic ways to improve transfer student capital. One of the most often mentioned institutional practices to support transfer students was orientation (face-to-face and online) and transfer days or preview days to provide students with necessary information and orient them to the culture of the institution [24], [28], [33], [34], [46] . There were also several articles that discussed creating a more transfer receptive culture [6], [23], [43]. Strategies to do this included creating a first-year transfer student success course [35], addressing transfer student stigma with faculty [46], and introducing pre-transfer students to successful post-transfer students [33]. Institutional coordination between the community college and the four-year college or university was also highlighted as an important factor in building transfer student capital.

5. Discussion and Implications

Throughout the analysis of the literature included in this study, four primary themes emerged: context, empirical examination, implications and impact, and an assets-based perspective. Examination and discussion of these themes aids in answering the research questions of this study. In this discussion section, the themes are discussed as well as their alignment with previously published literature on transfer students. Also presented in this section are limitations of the study and implications for practice and research.

5.1 Discussion

Use and Critical Characteristics of Transfer Student

Merriam-Webster's dictionary defines context as "the parts of a discourse that surround a word or passage and can throw light on its meaning" and "the interrelated conditions in which something exists or occurs"[49]. This theme of context provides a lens for discourse on the use of transfer student capital in STEM and engineering education settings. This notion is further supported by the primary codes which comprise this theme and provide an understanding of how transfer student capital is defined throughout STEM and engineering education related research, the primary components or factors which are used to describe and support the theory, the

accompanying theoretical frameworks which not only provide the theoretical providence of the theory but also other synergistic theories which provide support, and the challenges that accompany transfer students and transfer student capital. The definitions themselves align with the original conceptions of Laanan's theory [1] however, throughout the literature the additional discourse of use in STEM and engineering education provides more concrete perspectives on how this theory is defined, constructed, and supported within this specific educational context. This understanding of context lays the groundwork for viewing the use of transfer student capital across research applications, examining the implications and impact of the theory on STEM and engineering education, and acknowledging the ability of the theory to address and bring awareness to issues of access and diversity in the field.

Use of this theory is widely represented across multiple research methodologies which include quantitative, qualitative, and mixed methods. Theory-method fit is widely acknowledged as an important aspect of research design [50]. The fact that this theory has been successfully utilized across a variety of methodologies gives it a strong research foundation and flexibly to applied to many research contexts. Additionally, the characteristics of the use of theory in research spans from individual level research on student experiences, perceptions, self-efficacy, and perspectives to organizational level research on institutional factors. This is unique and provides even greater flexibility for the use of this framework; especially considering that many theoretical frameworks are primarily designed to focus either on individual or organizational level research. Finally, in current literature it is a highly relevant and up to date framework. In fact, 31 of the 44 articles or 70% of the articles in this study were published five or less years ago. Its fresh perspective gives researchers the ability to look beyond traditional theories, factors, and variables found in transfer student research to offer new insights and perspectives.

Impact of Transfer Student Capital on STEM and Engineering Education

One of the most important impacts of this theory is on its ability to shift the perspective of how transfer students are viewed in research and practice. Transfer student capital is a strong and widely accepted theoretical framework. Its roots in a variety of different types of capital situates it as a tool to "shift the lens" from a deficit-based perspective where transfer students are missing things or are insufficient in some areas to a strength-based, asset approach where the abilities, skills, talents, and advantages of transfer students become a primary focus [6]. This is important because non-traditional transfer students who tend to more broadly diverse than traditional students in terms of demographics, age, socio-economic status, working status, first generation student status, and familial responsibilities, do not typically fit a one size fits all policy mold [24], [33]. Wang [51] highlighted community college transfer students as a heterogeneous group and that administrators and faculty at four-year universities should consider students' gender and other demographic differences in implementation of policies and strategies [24]. Understanding how to increase and build transfer student capital supports a variety of different types of transfer pathways that are not only an important way to increase diversity in engineering programs of study but equally as important in helping students successfully persist through the pathway to a degree and into the workforce [1], [8], [52].

The types of capital, resources, and supports needed for success in STEM and engineering education are unique [5], [10], [11]. The importance of institutional practices, particularly focusing on using transfer student capital as a conduit for institutional coordination, new institutional practices, and pathways can have a significant effect on increasing access to,

diversity of, and success in STEM and engineering vertical transfers [27], [34], [37], [44], [46]. Additionally, focus on the specific components and factors of transfer student capital theory reveals specific tactics and strategies which are specifically designed to enact several forms of capital to help students succeed in STEM and engineering education [6]. Finally, the impact of transfer student capital on STEM and engineering education is further emphasized through increased attention to the importance of (a) providing unique student support and advising tailored specifically to the STEM and engineering transfer context [1], [6], [24], [25], [27], [36], [46] and (b) deep engagement of students, faculty, and staff across both the two- and four-year institution [6], [8], [24], [25], [27], [37], [48].

5.2 Limitations

There are several limitations within this research study. First, any publications that are not indexed in primary search platforms may have been omitted. This limitation was addressed through the use of multiple platforms to search for articles. In total, seven widely accepted and utilized indexed database platforms were used. Next, the research in this study extended to include articles that were not specifically focused on engineering but more broadly included transfer student capital with transfer students across disciplines and in the broader STEM contexts. Inclusion of these articles provided a broader understanding for transfer students across engineering and related fields because there is a larger volume of published literature on STEM transfer students [52], [53]. Additionally, inclusion of these articles was beneficial because of the large overlap of engineering and STEM and the additional knowledge that the general articles were able to provide in an area of scant but emerging engineering education research.

Finally, as so much has changed in the world of higher education because of COVID-19, analysis for a specific COVID effect is important. COVID-19 related changes may impact research findings, implications, and recommendations for educational settings which were affected by new teaching methodologies, student expectations, and workforce demand. 15 articles included in this study were published in 2021 or later and only five of those articles mention COVID-19. Of those articles, many acknowledge the challenges of virtual education but few attribute specific changes to transfer challenges, strategies, and outcomes to COVID-19 [22], [33], [54]–[56].

There were two delimitations that were used to limit the number of articles included in this study. These delimitations included articles that were published in English and were peer reviewed. It is acknowledged that there could have been relevant articles that were excluded from this study based on these delimitations. However, these were intentional limitations to produce articles which were of greater scholarly quality and were readily available for analysis by the researchers.

5.3 Implications for Practice

Numerous implications for practice are provided throughout the strategic focus areas in the literature. The summary in the findings section will provide many practical strategies and tools. Strategies revolved around three primary areas including ways to increase engagement for faculty, staff, and students; institutional practices designed to improve transfer student success;

and a deep dive into the myriad of ways to provide additional student support and stronger transfer student advising.

In addition, the articles comprising this study presented a wealth of knowledge through a variety of research methods and fields of study. Analysis of the research outcomes, implications for practice, and implications for research provide important insight and future direction for practitioners and researchers alike. Since students typically use online searches and resources as a primary source of information to help them apply for credit, new and better systems providing detailed and accurate information need to be made available to them [44], [51], [57]. While important in providing transfer information to students, resources need to go beyond static websites and web handouts maintained by advisors and state higher education offices to help students navigate the transfer process [27]. Some of the prototypes of online, technology based cross-institutional credit transfer systems [44] and online platforms like TRANSIT that show expected credit transfer [57] are showing promise. The recommendations for online support extend to academic advising, orientations, providing other online resources to support the transfer process [24], [34]. To better addresses information asymmetries and provide customized transfer tools and resources to students that are designed to increase transfer student capital, more attention needs to be placed on developing and using state-of-the-art digital platforms and resources.

5.4 Implications for Research

Access needs greater attention across higher education literature. Many of the articles 16 of the 44 articles (over one-third) discuss the importance of the community college open access mission and lower cost as means for democratizing higher education and broadening participation in STEM and engineering. However, once these important points are made, the research moves on and doesn't circle back to the importance of access and the strength of transfer student capital in the ability to address significant barriers to accessibility of higher education. More research closing the loop and focusing on using transfer pathways and increasing transfer student capital to increase access is needed.

Next, only one article explored the importance of disaggregating the data by subgroup and examining effects on individual students [35]. Again, given the great diversity of transfer students and the inability of a one-size-fits-all approach to address the needs of this student population [24], [33] this is a significant gap in the research. Additional research needs to be conducted on subpopulations of transfer students so that the emerging research findings and implications are relevant and tailored to uniqueness of the transfer student population.

Finally, across the qualitative articles the primary methods used were standard case studies, interviews, and focus groups. Given the ongoing changes in technological context and society overall, these traditional approaches may be improved through examination of new qualitative research methodologies. Innovative and advanced qualitative methods may be borrowed from emerging research in other fields and include crowdsourcing, netnography, sentiment analysis, hybrid textual analysis, combining observation and introspection, digital ethnography, or experiential testimonial research [58]. These and many other less traditional

qualitative methodologies could reveal new and deeper understanding of transfer student experiences and identify new practices for building and sustaining transfer student capital.

6. Conclusion

Transfer student capital is a powerful framework. Its introduction in 2010 gives it a strong foundation of work to build upon while still engaging research that is new, current, and up to date. Research has shown it as an effective framework to use in both pre- and post-transfer explorations. This framework gives the ability to examine specific factors of transfer student success that go beyond "transfer shock" [1]. It is a framework that has clearly identifiable and distinguishable components that specifically address challenges in STEM and engineering education contexts. Specifically in the STEM engineering education context, it is a powerful framework because of its ability to provide a new language and lens through which to view transfer students through a variety of accumulated capital in an assets-based perspective. It also has the ability to illuminate new more accessible and diverse pathways into STEM and engineering baccalaureate education and fields of practice.

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