

Mapping and Impact of Digital Learning Tools Designed to Support Engineering Pre-Transfer Students

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3 Abstract

4 Many websites and digital tools have emerged to support pretransfer students. However, there is
5 little understanding of the perception of availability and accessibility of these digital tools. This
6 gap is even wider for engineering transfer contexts. Since engineering students transfer
7 differently and need more preparation, more needs to be known about engineering pretransfer.
8 This qualitative study of elite interviews, guided by transfer student capital theory, integrates
9 data from interviews with transfer experts and researchers, an analysis of literature, and an
10 Internet search. The three themes emerging from this data highlight (1) the importance of
11 accessible, accurate, and utilizable information; (2) the need for tools and resources developed
12 for transfer students; and (3) the lack of digital resources for engineering transfer contexts. This
13 study provides an expansive list of digital transfer tools and identifies ways to improve upon and
14 expand these existing resources, especially into engineering education contexts.

15 Keywords

16 Digital tools, engineering transfer, transfer student capital, two-year college

17 Introduction

18 Engineering students transfer differently and benefit from more pretransfer preparation, yet
19 existing research does not provide adequate understanding of how to increase engineering
20 transfer success [1]. Engineering transfer students whose curricular pathways are more rigid and
21 sequenced need and rely on information networks and infrastructures to support successful
22 transfer [2]. Although resources and advising differ among institutions, transfer students bear the
23 primary responsibility for identifying and understanding transfer information [3]. Yet,
24 information asymmetries confound transfer pathways and create problems for students including
25 difficulty finding information and fragmentation where information is spread across multiple
26 webpages, individuals, and documents [4]. Digital tools supporting information gathering for
27 transfer students are beginning to emerge from some of the most innovative institutions in higher
28 education; however, no broad list of the digital tools exists in research or otherwise.
29 Development of such a list would help to reduce information asymmetries support reduction of
30 an equity gap for students transferring in engineering [4]. Further, examination of the most
31 recommended and effective digital tools for the ability to go beyond the transfer acceptance of
32 specific courses and technical entrance requirements (where most tools typically stop [5]) to
33 include strategies and tools for improving transfer success, especially in pretransfer stages would
34 create value for transfer students and their network, faculty, staff, and administrators. An added
35 bonus would be identification of the rare resources which address the empirically identified
36 constructs in the transfer student capital theory that have been proven to enhance transfer student
37 success [6]. Thus, the purpose of this study is to identify and gain deeper understanding of the
38 digital tools available for transfer student success and their current utilization in engineering
39 transfer. Lanaan's theory of transfer student capital, which conceptualizes the assets and
40 strengths unique to transfer students as forms of capital, guided this study [7], [8], [9], [10].
41 Because of their unique expertise and knowledge of a vast array of information resources this

42 qualitative study of elite interviews integrates data from leading transfer experts and researchers
43 nationwide, a literature review of digital transfer tools, and an Internet search of transfer digital
44 tools. The following research questions directed this study:

45 RQ1: What are the most recommended, effective, and/or exemplar digital transfer tools
46 which exist to support two-year college pretransfer or, specifically, engineering transfer
47 students?

48 RQ2: To what extent to the recommended digital transfer tools go beyond identification
49 of course articulation and technical entrance requirements to include additional transfer
50 information and support?

51 Findings increase awareness of leading digital transfer tools which can impact transfer student
52 capital and provide insight to support transfer students and reduce information asymmetries. The
53 research and practical implications of this research list and identify current digital transfer tools,
54 identify gaps for needed research and development, and highlight best practices for developing
55 digital learning and information resources for engineering transfer success.

56 **Background and Literature**

57 Transfer Student Friction Points: Transferring from a two to four-year institution presents unique
58 challenges to Science, Technology, Engineering, and Mathematics (STEM) undergraduates. For
59 instance, engineering students are subject to rigid course requirements that are not easily
60 substituted, creating complications throughout the transfer process [1]. In addition, transfer
61 students have the added difficulty of navigating unspoken rules (hidden curricula) for two
62 institutions, the transfer, and the receiving [1], [11]. Issues with communication between
63 institutions further exacerbates these pressures as students may be unclear on which courses will
64 transfer, the financial implications of transferring, and the general process of transfer [12], [13].

65 Supports for Transfer Students: Recent focus in engineering transfer has shifted focus away from
66 barriers and friction points, and onto supports available for these students. Studies on transfer
67 students have identified clear communication and support from both the receiving and transfer
68 institution as critical components to student success [12]. These supports and communication can
69 originate from advising on both sides of the transfer process from advisors who understand
70 transfer-specific needs [5], [14], [15], [16]. Supports may also originate from faculty or staff at
71 either institution, as well as peers or peer mentors [7], [15], [17], [18]. Additional avenues of
72 social or academic support may also be provided through involvement in student learning
73 communities and engineering organizations [5], [7], [18]. Communication for pre and post
74 transfer students also often comes in the form of digital communication. While “traditional”
75 digital supports simply involve institutional websites with transfer information, calls for more
76 comprehensive tools for transfer students have led to the development of new and innovative
77 transfer-specific tools.

78 **Theoretical Framework**

79 The transfer student capital theory identifies components and constructs of various forms of
80 student and higher education knowledge, resources, and information to help make students more
81 successful before, during, and after the transfer process. The theory integrates notions of various

82 known forms of capital which is designed to increase transfer student success [9]. This theory
83 integrates prior research utilizing the various forms of capital including community and cultural
84 wealth, experiential capital, social capital, human capital, and many others as lenses for
85 examining transfer students [5], [8], [19], [20], [21], [22]. One of the most significant strengths
86 of the theory is the use of capital through a cultural and social lens which facilitates an assets-
87 based approach which focuses on identification of factors and assets that contribute to transfer
88 student success. This is significant because much of the prior published transfer student research
89 frames discussions through deficit frameworks which assume that disadvantaged and
90 underrepresented students are lacking in qualities, experiences, and knowledge needed to be
91 successful in the transfer process [22], [23], [24]. The theory of transfer student capital suggests
92 that students with higher transfer student capital are more likely to successfully transfer and
93 experience higher levels of post-transfer success. Constructs of this theory include academic
94 advising experiences, perceptions of the transfer progress, experiences and collaboration with
95 faculty at the two-year institution, learning and study skills, faculty and staff validation, financial
96 knowledge, motivation and self-efficacy, and social support [7], [8], [9], [21]. Understanding
97 these components and how they work together helps to describe how students accumulate
98 knowledge and skills to navigate the transfer process [9].

99 **Methods**

100 To understand the existence, perception, availability, and engineering nuances of transfer support
101 tools and digital transfer support tools, the research team conducted semi-structured “elite
102 interviews” with transfer experts. These experts included executive leaders at national-level
103 higher education organizations and internationally recognized scholars and researchers in the
104 transfer student field. Elite interviews have the advantage of providing researchers with valuable
105 perspectives and unique knowledge from individuals with powerful positions and privileged
106 perspectives [25], [26]. However, gaining access to elites can sometimes be challenging and,
107 given their position, it is sometimes more difficult to gain a full picture when researching more
108 politically sensitive and/or controversial topics [27]. For this reason, utilizing triangulation with
109 multiple data sources can provide greater research validity [28], a fuller picture of the
110 phenomenon being investigated, corroboration for initial findings, and incorporate additional
111 information from what single elite interview sources may provide [29]. Triangulation in this
112 study was achieved through use of multiple methodologies which in addition to the elite
113 interviews included an analysis of peer reviewed published literature and an Internet search. The
114 analysis of literature performed for this study built on a previous systematic literature review on
115 transfer student capital in STEM education which included analysis of 149 articles [6].

116 Participants: The elite interviewees were identified through development of a comprehensive list
117 of leading transfer student organizations and research centers naming executives and top leaders
118 at each organization. Next, researchers in the field were identified. Researchers who had
119 developed or enhanced key transfer theories (i.e. transfer student capital) or instruments, who
120 had received multiple citations were also included in the list. This list was reviewed by several
121 other researchers in the field to ensure its completeness. After expert review, a few new
122 recommendations were added. In total, this list of elite leaders included 12 transfer experts who
123 were invited to participate in interviews. The elite interviewees who participated in these
124 interviews were asked to identify other elite experts to participate in the study. From this
125 snowball sampling approach, 7 additional elite leaders were added to the list. Of this list, 11 elite

126 leaders and researchers participated in this study. Of the participants 1 was male and 10 were
127 female. Titles of participants included Executive Director, President, Research Director,
128 Associate Vice President, Dean, Professor, and Director.

129 Procedure: Consistent with elite interview methodology, prior to developing interview protocols
130 and conducting interviews, elite leaders and elite leader organizations and backgrounds were
131 researched [25], [27]. Interviews were semi-structured and the protocols contained questions
132 grouped into three general categories designed to (1) gain additional background information and
133 understanding of the elite interviewees expertise and their organization, (2) information on assets
134 and barriers facing engineering transfer students, and (3) transfer tools and digital transfer tools.
135 For the purpose of this study the research team focused primarily on findings from the third
136 category. Thirty-minute interviews were conducted and transcribed via Zoom. Following
137 interviews, the transcripts were cleaned which also provided the researchers with additional data
138 familiarization. After transcripts were cleaned, they were imported into MAXQDA2020 for
139 analysis and gender-neutral pseudonyms were assigned. Next, the literature articles were
140 analyzed in MAXQDA2020 where any information regarding transfer tools and digital transfer
141 tools was coded. Finally, to ensure that any other popular, well-known, or other public tools were
142 included in the study, an Internet search was conducted. Given the size and scope of a search for
143 online tools, a systematic search was not possible, however, targeted searches on transfer tools
144 were done.

145 Analysis and Data Mixing: General inductive analysis of the elite interviews provided the
146 primary data for this research study. Initial inductive codes identified included recommendations
147 for technology, interactive tools, non-interactive online resources and websites, model or best
148 practice, student support, and suggested resources and contact. Codes were then grouped into
149 primary themes. From the data set containing the literature, codes pertaining to transfer tools
150 were identified as digital resources, institutional information sharing, institutional engagement,
151 institutional tools increasing transfer student capital, and student support and advising building
152 transfer student capital. Following coding of both the interview and article data sets, lexical and
153 extended lexical searches were conducted to ensure all pertinent information had been identified.
154 Further, all resources and tools identified in the interviews and literature were researched on the
155 Internet to further explore the tools. Finally, implementation of multi-method triangulation
156 allowed the research team to analyze the convergence and divergence of findings between the
157 data sets. Using a procedural triangulation approach, the three data sources were individually
158 analyzed, then combined and compared for similarities and differences, next specific questions
159 or gaps found in one data source were systematically searched in the other data sources for clues
160 and additional information, and finally the integrated information was utilized to establish a final
161 set of themes emerging from the data [30].

162 **Findings**

163 Elite Interviews: The findings from the elite interviews were grouped into two primary areas:
164 interactive digital tools, and noninteractive tools. It was generally agreed by the participants that
165 the use of technology to support vertical transfer students was beneficial and could give them
166 access to more information and resources. However, one interviewee, Peyton, a director for a
167 national organization, noted that while technology is an asset, caution must be used to ensure it
168 does not become a barrier to populations of students:

169 “In [this] moment, in time, where there is where technology is exploding, there's
170 so many different technological solutions that can be applied to this. I think the
171 challenge is applying it and implementing it in the right way... it can also be ... a
172 barrier... for students... But I think, when done and used and implemented
173 correctly, I think there is a huge possibility for technology to be helpful.”

174 *Interactive Digital Tools* - For this study, interactive digital tools are digital tools that adapt to
175 and/or provide personalized information to students based on the information that they input.
176 Many of the tools discussed were degree planning and degree audit tools. Most of these types of
177 tools are local solutions, homegrown by institutions and systems. Peyton, a national organization
178 director, identified a digital degree planner, part of a guided pathway, created by the California
179 State University System ([https://www.calstate.edu/csu-system/why-the-csu-matters/graduation-](https://www.calstate.edu/csu-system/why-the-csu-matters/graduation-initiative-2025/closing-the-equity-gap/Pages/access-to-a-digital-degree-planner.aspx)
180 [initiative-2025/closing-the-equity-gap/Pages/access-to-a-digital-degree-planner.aspx](https://www.calstate.edu/csu-system/why-the-csu-matters/graduation-initiative-2025/closing-the-equity-gap/Pages/access-to-a-digital-degree-planner.aspx)). The
181 website describes this tool as “a personalized, app-based tool that prepopulates degree
182 requirements and course-taking options offering students real-time, semester-by-semester
183 planning for registration and degree completion”[31]. Two other participants (one a scholar and
184 one a national organization director), identified a similar tool developed by the Virginia
185 Community College System called the Transfer Virginia Portal
186 (<https://www.transfervirginia.org/>). This portal contains a wealth of transfer information for the
187 60 colleges and universities participating in statewide transfer pathways. This portal contains
188 web resources in several categories: About Transfer VA, Transfer Steps, and Transfer Tools
189 (<https://www.transfervirginia.org/degrees/transfer>) an interactive portion which allows students
190 to identify equivalent courses at transfer receiving institutions. This area also allows students to
191 check credits and explore careers through a connection to O*NET.

192 Three participants (two scholars and deans and one a senior executive of a regional
193 organization), identified a resource developed by South Carolina called the South Carolina
194 Transfer and Articulation Center or SCTRAC (<https://www.sctrac.org/>). This portal contains
195 similar information to that of the Transfer Virginia Portal. This portal contained links to all
196 participating institutions (29), a search for articulation agreements (PDF documents of university
197 website screenshots), a database to search for courses that may transfer to particular institutions,
198 a link with information and four guided steps on planning a transfer. Additional tools allowed
199 students to search for exam equivalencies, college profiles and programs, and a transfer event
200 calendar (which contained no events).

201 Another participant, Parker, a senior executive of a national research organization, further
202 discussed the websites that many institutions have created or subscribe to similar the portals and
203 database systems which show course equivalencies. She explained however that these systems
204 became problematic because, “Sometimes you have to go hunt for it, which means that that's
205 where the advising piece comes in at both ends [two- and four-year institutions]. Somebody
206 needs to tell you to go hunt for it ...[and] if you dig hard enough on the institutional website, you
207 can find [it].” Interestingly, Sawyer, a participant representing a large top tier engineering
208 institution, “dreamed” of having an interactive tool but said instead students are left using a
209 “template of self-evaluation” which is paired with an explanation video.

210 Two directors of national organizations also identified additional portals and tools that were
211 under development. One discussed a request for proposals that was sent out in Florida to

212 education technology companies for building a transfer articulation application. The other
213 identified a project in Texas currently underway which was funded by the Gates Foundation to
214 fully map their degree plan through the four-year university electronically dynamic degree map.
215 Similarly, one of the participants mentioned that the State of Ohio is developing a centralized
216 system to serve as a one-stop-shop for all transfer students in the state.

217 There were several tools that participants discussed that were developed for use by students
218 anywhere in the United States. The first tool, identified by two participants (one dean and one
219 university director), is Curricular Analytics (<https://curricularanalytics.org/>), a free nationally
220 available resource, provides tools and data analyses which helps students to visualize curricula
221 and degree plans and analyze the impact on their student progress. This tool allows students to
222 input curriculum or a degree plan in CSV file format and then provides an interactive
223 visualization, generates an analysis of the complexity of the degree and potential bottlenecks,
224 and provides 2-to-4 year articulation pathways. This tool allows students to simulate student
225 progress under various scenarios so that they may create the best degree plans and pathways.
226 Another tool, Edvisorly (<https://edvisorly.com>), a nationally available application for transfer
227 students, was identified by Peyton. Originally started in California, Edvisorly is an interactive
228 application which helps identify transfer opportunities, connect and build relationships with
229 admissions teams, plan courses for successful transfer, and supports a more seamless application
230 which can go to multiple universities. Universities partner with Edvisorly to increase national
231 awareness of the institution, access transfer applicants, engage directly with prospects, and
232 simplify student understanding of credit transfer through the use of the Edvisorly tools.

233 Finally, additional national level tools included cost credit calculators and financial estimators
234 (<https://studentaid.gov/aid-estimator/>) and related college financial and cost information
235 (<https://www.usa.gov/estimate-college-cost>). In reference to the use of these calculators for
236 transfer students, Avery, a director for a national organization, stated that the "...cost credit
237 calculators that are required by the Federal Government are for first-time full-time students.
238 They are not for transfer. They're not geared towards transfer students, and they are also not
239 geared towards part time enrollment." Avery went on to say that some individual institutions
240 have adjusted their federally required calculators to make them more transfer friendly tools but
241 when it is not required by the federal government then it becomes inconsistent between
242 institutions and lacks longevity of implementation. One organization identified and highlighted
243 institutions were that had built credit calculators that supported transfer students. These
244 institutions included Florida International University (<https://transfer.fiu.edu/transfer-101/ted/>),
245 George Mason University (<https://admissions.gmu.edu/transfer/transferCreditSearch.asp>), Old
246 Dominion University (<https://transfer2.odu.edu/equivalency/>), and Wilmington University
247 (<https://www.wilmu.edu/transfer/collegetransfer.aspx>).

248 *Non-interactive Technology and Tools-* The most referenced technology resources classified as
249 non-interactive (technology, tools, and resources that do not change and adapt to provide
250 personalized information and data for users) were websites. Quinn, a senior executive for a
251 national organization, stated:

252 "...we know that our transfer students get the majority of their information about
253 destination institutions from the web. Second is friends and family. So, it's really
254 important that institutions have taken a specific look at how their websites are

255 attracting, and adding value for transfer students, and there's a lot of complexities
256 around that.”

257 Bailey, another senior executive for a national organization, felt that reducing complexities on
258 the websites is important to ensure that students can and will find pertinent information
259 identifying the “three click rule” stating, “If I can't find it in 3 clicks ... then it's not overly
260 student friendly.” However, beyond the ease of finding information, the quality of information,
261 especially where multiple institutions are involved, was a concern. Beck, a scholar in the field,
262 shared that, “We've collected data on where do advisors say students should get their information
263 ...? And oftentimes what they suggest is the four-year institution's website is the best, most
264 accurate source.” Beck further went on to explain, “Oftentimes the community college websites
265 are lagging in kind of the information being updated.”

266 Finally, Peyton, a director for a national organization, discussed institutions which have had
267 success in using text message platforms engage with and nudge potential transfer students. These
268 higher-ed texting platforms are providing accurate information literally to students’ fingertips
269 which may include answering admissions questions or advisor check-ins, send important
270 application reminders and scholarship information, encourage social media participation, and
271 send other important event and reminder information.

272 Analysis of Published Peer-Reviewed Literature: Like the elite interview findings, the literature
273 confirmed their discussions about how students find information citing transfer equivalency
274 guides, websites, and “people” sources of information as the most frequently used information
275 sources [12]. A few articles discussed the importance of the use of statewide virtual transfer
276 credit systems [5], [32]. For example, one institution specific transfer equivalency online
277 platforms and applications developed for statewide use and provided TRANSIT at Iowa State
278 University (<https://transit.iastate.edu>) as an example [32]. Another study advocated for the
279 importance of institutions to provide accurate information and domestically develop systems,
280 which could include a mixture of vendor supplied products, with information about course
281 enrollment, transferability, and other transfer specific information [33]. Next, a national level
282 interactive tool, Transferology (<https://www.transferology.com>), was identified in the literature.
283 Transferology is a nationwide network designed to help students identify transferability of course
284 credits, exams, and prior experiences such as military learning [13].

285 Specific to websites, however, it appears that institutions have unintentionally disadvantaged
286 transfer students. One study suggested that two-year college students overwhelmingly prefer
287 online research of transfer-related information but that many institutions frequently publish
288 curriculum guides and information for native students without providing transfer equivalencies
289 thus making the information more difficult for transfer students to locate than first-time students
290 [34]. Another study specifically examining websites found many information asymmetries (gaps
291 in information) in institutional website engineering transfer information. Concerns revolved
292 around the ability of students to navigate the complex structure of the websites to find pertinent
293 information, lack of up-to-date information, broken links, use of complex language around
294 policies or processes, and sites which contain no information specific to transfer [13].

295 Other tools included online documents that were used by both students and institutional agents
296 which included, “advising resources and handouts used by pretransfer advisors, websites and

297 online resources maintained by the state higher education office, and websites maintained by
298 university transfer offices and transfer student” [5] (p. 39). There was also a stated need for more
299 online transfer resources including interaction with supportive institutional personnel [5], [15],
300 [35]. Also, several studies identified resources that were published online by the state systems
301 but found those resources to often be out of date or not specific to majors such as engineering
302 whose programs of study are more complex [5], [35].

303 Another category of virtual and online resources discussed in the literature included use of
304 virtual transfer fairs [36] and virtual orientations and transfer-related events designed to provide
305 access to students with family and work obligations that would limit in-person attendance [17].
306 These virtual events provided students with curriculum plans, pre-transfer advising packets,
307 connections for pretransfer advising and development of other social supports and helped to
308 boost transfer student capital and self-efficacy for transfer and academic success. Another virtual
309 tool described in one article is the use of ePortfolios, facilitated by the CourseNetworking
310 (<https://www.thecn.com/>) platform, as a tool to identify work demonstrating core competencies
311 and proficiencies, and opportunities to reflect on previous associate level course learning and
312 self-assess their level of prerequisite knowledge required for future post-transfer courses [37].

313 Internet Search: National level websites and portals, similar to those identified by the elite
314 interviewees, can be found throughout the Internet. One example is CollegeSource
315 (<https://collegesource.com/>) which provides a one-stop-shop of tools and access to higher
316 education institutions (over 2,000) for transfer students. These tools include TES, the Transfer
317 Evaluation System, Transferology (a tool identified in the literature above [13]), uAchieve (an
318 academic planning system), and HigherEd Policy Central (a tool for researching and comparing
319 institutional policies). Another example, CollegeTransfer.net (<https://www.collegetransfer.net/>) is
320 an online system developed by Academy One using ArticulateED which delivers state and
321 systemwide cloud-based solutions designed to reduce academic and economic impact of
322 transferability. This system provides transfer profiles, course equivalences, transfer agreements,
323 and information on programs, courses, and exams. The SCTRAC portal discussed above is built
324 using this system. Finally, Common App (<https://www.commonapp.org/apply/transfer-students>)
325 with its ability to support multiple college applications was identified as an online resource to
326 support transfer students. General college search tools also appeared in the search for transfer
327 tools. An example is the CollegeExpress (<https://www.collegexpress.com/college/search/>)
328 college search tool. Another example is a college ranking website, College Consensus
329 (<https://www.collegeconsensus.com/resources/finding-a-school/tools-for-transferring/>). The
330 Internet search also revealed another state-level portal, in this example California’s official
331 course transfer and articulation system, ASSIST (<https://assist.org/>). A final tool that was
332 highlighted by an Institute of Higher Ed article as an innovative technology to improve transfer
333 success is Arizona State University’s MyPath2ASU
334 (<https://admission.asu.edu/apply/transfer/MyPath2ASU>) [38].

335 Other national organizations provided information on websites. Some websites were primarily
336 student focused such as the Coalition for College
337 (<https://www.coalitionforcollegeaccess.org/transfer-student-resources>). And some such as The
338 Aspen Institute’s College Excellence Program provided information and resources for both
339 students and institutions (<https://highered.aspeninstitute.org/community-college-transfer/>). Or

340 one designed for researchers and institutions such as TacklingTransfer
341 (<https://tacklingtransfer.org/research-tools/>).

342 **Discussion and Conclusion**

343 This study reveals a myriad of digital support tools developed to support transfer students. The
344 combination of these data sources revealed three basic themes: (1) the importance of accessible,
345 accurate, and utilizable information; (2) tools and resources must be developed specifically for
346 transfer students; and (3) the lack of digital resources tailored to engineering transfer contexts.
347 The first and third themes help to answer the first research question about recommended and
348 effective digital transfer tools two-year college pretransfer students including engineering
349 transfer students. The second theme aligns with the second research question examining the
350 extent to which the resources and supports to go beyond articulation and technical entrance
351 requirements.

352 Discussion

353 *Accessible, Accurate, and Utilizable Information* - The primary and consistent theme of this data
354 revolved around a transfer student's ability to find and understand relevant and up-to-date
355 information [33]. The wide range of digital resources and tools identified in this study indicates
356 that there is a lot of information however except for a few exemplars, it appears to be somewhat
357 spread out, fragmented, and hard to find. Additionally, many interview responses and studies
358 indicated that information available to transfer students was hard to find, lacking, out-of-date, or
359 inaccurate with one study even identifying it as asymmetry of information [13]. A significant
360 component of this theme is utilizable information. For the information to be utilizable, support
361 for understanding and applying that information is indispensable. Bailey, a senior executive of a
362 national organization, stated that if "...we just assume that transfer students were successful
363 before, and they will be again ... that just seems like kind of setting people up for failure rather
364 than success from the get go." Students need support in the form of digital tools but they alone
365 are not sufficient. Information should be accompanied by guidance and access to professors and
366 advisors to enable more positive experiences and long-term planning [34]. Many students have
367 reported that they are not sure how to "transfer online", thus an advisor to answer questions,
368 create transfer pathways, and ensure greater credit transferability is essential [35]. This support is
369 also key to helping students understand the difference between transferability and applicability.
370 Providing support to help students translate and understand terminology, policy, and processes is
371 as important if not more important than simply providing the information.

372 *Tools and Resources Developed Specifically for Transfer Students* - The theme of the need for
373 tools and resources to be developed specifically for transfer students was most evident in the
374 interview data. While they identified several digital resources that were uniquely designed for
375 transfer students, they also pointed out that many tools were not useful for transfer students.
376 Transfer students tend to be more broadly diverse than traditional first-time students in their
377 demographics, age, socio-economic status, working status, first generation status, and many tend
378 to be parents or other family caretakers [15], [17]. This means that transfer students need unique
379 resources, policies, and strategies [39]. Unfortunately however, transfer students are trying to
380 translate resources, policies, and materials that are designed for traditional, first-time students
381 which is a disadvantage [34]. This issue suggests disparities in access and equity for

382 nontraditional and transfer students. More information developed from an assets-based
383 perspective that is specific to transfer students needs to be created and made accessible.

384 *Lack of Digital Resources for Engineering Transfer Students* - Throughout the expert interviews,
385 although asked for specific engineering context, none of the experts identified digital resources
386 or tools that were specific to engineering transfer students. Most of the tools however do include
387 the ability to look up or request information on an engineering degree program. However, given
388 that we know that engineering pathways are more complex, specific, have more pre-requisite
389 requirements, and differ based on engineering discipline the lack of digital tools specifically
390 designed for engineering transfer students is surprising [1]. When conducting the Internet search
391 focused specifically on engineering transfer resources, the results that were returned were all
392 websites that were specific to a single institution that included general institution information
393 such as transfer guides, course equivalency guides, and general transfer requirements.

394 Limitations: This study is not without limitations. The number of interviewees (11) may be seen
395 as a limitation however, elite interview methodologies use smaller groups of participants [25],
396 [26], [27], [29]. In addition, the research team reached saturation of data where in later
397 interviews, new data began to be redundant of data already collected [40], [41]. Also, as
398 previously noted the use of elite interviews can sometimes leave gaps in understanding therefore
399 triangulation utilizing multiple data sources served to strengthen the validity and provide richer
400 descriptions of the phenomenon under review in this study [28]. Next, the analysis of the
401 literature included in the review focused on transfer student capital in engineering and STEM
402 contexts. While general transfer digital tools and resources might have been omitted, this
403 provided a specific perspective for engineering transfer students, specifically addressing part of
404 the first research question of this study. Finally, given the scope and breadth of this research
405 study, a systematic search of all transfer resources on the Internet was not possible. Given that
406 search engine algorithms are dynamic and change often, identical search strings and queries will
407 produce differing results at different times [42]. Thus, the research team opted to conduct simple
408 searches and continued to search until saturation was reached.

409 Implications for Engineering Education Practice and Research: This research study identified
410 many high-quality digital transfer tools and resources. Engineering education practitioners
411 should evaluate the resources that are relevant for their students and create an accessible location
412 for the relevant, curated resources. Additionally, proper supports and connections to personnel
413 should be included to help transfer students successfully utilize the information. Institutions
414 should also inventory curricular information and resources to determine where transfer specific
415 versions should be developed. This will better support accessibility and equity for all students
416 while not specifically disadvantaging the more diverse transfer student population. Additionally,
417 attention should be made to highlighting the engineering specific requirements and nuances.

418 There are many new areas to explore in engineering education research related to digital transfer
419 tools. Future research should explore the student use and perceptions of digital transfer tools.
420 Research should also focus on utilizing existing resources (to prevent duplication) while tailoring
421 digital transfer tools to the unique and specific context of engineering transfer. Also, new tools
422 should focus on innovative ways to digitally build transfer student capital. It is also crucial that
423 as research and new tools are evolving that a focus on an assets-based approach is maintained.

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