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PATHWAYS: CREATING A CENTRALIZED PLATFORM FOR THE EXPLORATION OF MAJORS, POST-SECONDARY INSTITUTIONS, AND CAREERS

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Stefany Arevalo Escobar

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The Thesis of Stefany Arevalo Escobar
is approved:

Professor Magy Seif El-Nasr, Chair

Assistant Professor David Lee

Associate Professor Marcella Gomez

Peter Biehl
Vice Provost and Dean of Graduate Studies

Table of Contents

List of Figures

Abstract

PATHWAYS: CREATING A CENTRALIZED PLATFORM FOR THE EXPLORATION OF MAJORS, POST-SECONDARY INSTITUTIONS, AND CAREERS

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As high school and undergraduate students navigate the complex landscape of college and career choices, they often encounter overwhelming amounts of digital information, leading to difficulty in making informed decisions. Deciding on a college and applying can be a daunting multi-step process, that has proven to incite stress and anxiety in high school students. Moreover, obtaining a degree does not guarantee job search preparation and can result in many students working in careers irrelevant to their field of study. To address these problems, this thesis project developed Pathways, an interactive college and career exploration website designed to engage and assist students in their search process. The website provides a space-themed, interactive interface to help users discover potential majors and explore different career paths that align with their interests and goals.

The project team incorporated feedback from stakeholders in the education field and usability testing to develop Pathways. The website was built using modern web development technologies, including React and P5.js. The project also involved creating

and curating a college and career information database and developing a categorization system to match majors with relevant jobs.

The project results indicate that Pathways can potentially improve high school and undergraduate students' college and career exploration experience. Initial user testing showed that users found the website engaging, informative, and helpful in their search process. Ongoing evaluation and refinement of the website will be necessary to ensure its continued effectiveness and usability.

To my family and God,

who provided emotional support.

Acknowledgments

I want to thank my advisor Magy Seif El-Nasr and my committee for providing many insightful questions and suggestions! I am grateful to the advisory committee for the UndocuCareer Development Fund, through which I obtained funding for this project. I also appreciate the feedback provided by Susana Figueroa from Central Valley Cal-SOAP. Finally, thank you to Jazmin Mendoza Paz and Henry Zhou for dedicating many hours to this project as well.

Part I

Introduction

Chapter 1

Background and Motivation

Society has integrated technology into everyday life and provides vast amounts of Internet-based information spanning various fields such as business, healthcare, government, and learning [76]. This great advancement eliminates the time-consuming process of physically conducting research at a library or making phone calls to get answers to your questions. Digital information has become such an intrinsic component of our everyday lives that the United Nations (UN) declared the Internet a fundamental human right in 2011 [35]. How can the Internet be so important that the UN got involved? Well, online knowledge can be a powerful resource that makes life easier and can lead to socioeconomic gain. More specifically, access to educational resources online is a key example of how power can stem from the Internet. The UN explicitly emphasized that the Internet is:

"an important educational tool, as it provides access to a vast and expanding source of knowledge, supplements or transforms traditional forms of schooling, and

makes, through 'open access' initiatives, previously unaffordable scholarly research available [35]."

You can learn new skills by watching a YouTube video or attending school virtually through Zoom, all things that were impossible before the Internet. This knowledge can not only help you be a more educated individual but can serve as leverage to obtain higher education, better-paying jobs, and ultimately improve your quality of life [72, 9]. Education seems to be more accessible thanks to the Internet, and has a significant impact on society. Nonetheless, how much of this is true? Let's investigate this topic further by exploring digital information's effects on students.

In 2012, the Pew Research Center surveyed Advanced Placement and National Writing Project teachers to understand how students' research habits have changed in the digital age. When considering how the Internet and digital resources impact students' research methods, 77% of teachers considered the overall impact to be "mostly positive," but they had many reservations. One recurring theme was that digital technologies "do more to distract students than to help them academically," which teachers hypothesize is due to difficulty judging quality online information, the level of literacy in modern-day students, and increasing distractions [58]. Research exists that supports these claims by proving that large amounts of digital information can be detrimental to an individual's decision-making process if they are not prepared with the information literacy to properly synthesize relevant data into meaningful insights [34, 11, 42]. Additionally, with access to interactive and fast consumable content like search engines and social media, it can be difficult for students to focus on more functional educational

content [56].

These issues not only affect students' academic performance but also allude to an overall lack of knowledge on how to keep a healthy balance in digital use, otherwise known as of cyber wellness. The absence of cyber wellness training can result in a lack of student learning motivation and engagement, which in the long run can prevent them from advancing professionally [74]. In fact, lack of motivation is a significant factor for indecisiveness in student's career exploration and college decision-making behavior [24, 25, 41, 65]. As a consequence, college students often end up working in underpaid careers irrelevant to their major [61, 6].

Just as the United Nations claimed, the Internet has facilitated access to a lot of educational data, but there exists a lack of digital and information literacy to best use this data. Ultimately, this can impede high school and college students from properly using online educational resources to pursue higher education or find prospective careers. As our research focus, we would like to improve student use of college and career information by facilitating the research process and helping students connect their field of study to relevant jobs.

This thesis project addresses these concerns by creating Pathways, an interactive web application designed to centralize college and career data available to high school and college students. Instead of attempting to train all students on digital information literacy, our goal is to adapt to users' existing behavior patterns by making college and career information available on one platform in a format that is easy to understand. We aim to improve student motivation and preparation by simplifying the

digital information landscape through engaging visualizations of college majors, campuses, and relevant careers.

Part II

Literature Review

Chapter 2

Student Decision Process

To create a tool for college and career exploration, we must understand the process students undergo when choosing their prospective field of study. For both educational and vocational development, the period of childhood up until early adulthood is the most prominent phase of growth and experimentation [69, 70]. When exploring the college-choice process, Hossier and Gallagher developed a framework denoting three key phases students go through from grades 7-12:

- Predisposition, Grades 7-9
- Search, Grades 10-12
- Choice, Grades 11-12

The predisposition phase is described as the time when youth develop educational and vocational aspirations, along with core academic skills needed for educational attainment. Once they have determined these initial interests, students transition to

the search phase where they accumulate and process all information necessary to determine their shortlist of prospective colleges. Finally, the choice phase occurs when students apply and enroll at a higher education institution after comparing competing alternatives [49, 55, 27].

Of these phases, search and choice incorporate serious considerations of many sociological and economic factors that might not have been prevalent in the predisposition phase [43, 68]. Student's ultimate choice is highly dependent on the quality of their search process, which can vary greatly based on their access to information, financial aid knowledge, parental involvement, ability to pay, information quality, and socioeconomic status [28, 26]. Out of all these factors, this study attempts to address access to information and information quality, both of which were linked to socioeconomic limitations.

In more recent literature, it is still unclear whether the Internet has helped alleviate these socioeconomic barriers to college access [18]. Initially, the digital divide posed disadvantages in access to the Internet due to the high cost of technology, but now this technology is much more accessible across the nation [73, 15]. Educational and vocational information is available online in the form of Web portals such as XAP, College.gov, and the College Board, but the real problem resides in the overall lack of comfort and experience in using these resources [29, 31]. These familiarity issues stem from deeper behavioral psychology and correlate with Bandura's Self-Efficacy theory regarding an individual's ability to engage in tasks or activities to an extent to which they perceive themselves to be capable [10].

Chapter 3

Career Decision-Making Self-Efficacy

The concept of self-efficacy has been applied to the realm of career exploration and can be considered another key component of the student decision process. Taylor and Betz expanded upon career decision self-efficacy (CDSE), a measure of an individual's confidence in completing career decisions and tasks. They conducted a study focusing on high school and college students' CDSE and concluded that "students who lack confidence in their ability to complete decision-making tasks fail to engage in those tasks and thus remain undecided [71]."

Many soon-to-graduate students lack CDSE and are undergoing a college and career search with little to no preparation. As a result, Gati et al. created a taxonomy of difficulties that have been identified in students such as lack of readiness, lack of information, and inconsistent information [23, 24]. These observations will serve as fundamental insights regarding the challenges faced by our target user group.

3.1 Lack of Readiness

In this taxonomy, lack of readiness is described as a combination of several issues, including lack of motivation, indecisiveness, and dysfunctional myths, hypothesized to develop prior to the start of students' decision process. These are primarily internal constructs wherein dysfunctional myths refer to irrational expectations, such as the belief that "a career choice is a one-time thing and a life-long obligation." Adding this mental pressure to an already complex decision-making process promotes negative feelings of stress, frustration, exhaustion, and more which directly correlates to a lack of motivation and indecisiveness [41, 32].

3.2 Lack of Information

Once the decision process begins, students may lack information about the steps needed, occupations available, methods of obtaining information, and self-reflection. When analyzing students' ability to use online resources for research, there is demonstrated proficiency in using various digital media but lower levels of information literacy [34]. In a survey about student online research skills, many K-12 teachers rated their students as skilled in the ability to appropriately search for information but lacking in the ability to assess the quality of this information and synthesize it [58]. Although students are skilled in the everyday use of technology, many aren't prepared to use these digital resources for CDSE because they don't know where to find reliable information or understand the steps needed in the process. Moreover, Gati et al. found that students

have very few introspective considerations about their career aspirations, capabilities, and career alternatives, which are key factors in making informed decisions [23].

3.3 Inconsistent Information

Finally, inconsistent information refers to unreliable information, internal conflicts, and external conflicts. Martinez et al. conducted focus groups with high school students in their college search process and found that many considered the amount of information "very overwhelming [41]." Additionally, college outreach efforts that incorporate new digital methods such as emailing and digital marketing have over-saturated the online environment for prospective students and in some instances send anywhere from 2,000 to over 6,000 emails by January of students' senior year [48]. Few students knew how to access reliable information and a majority had difficulty due to the large amount of online sources available.

Chapter 4

College and Career Readiness

Despite understanding the student decision process and its difficulties, these factors can vary based on geographic location and educational standards. So for the scope of this study, we will explore college and career readiness standards in California.

4.1 College Readiness Standards

Conley and Roderick et al. have studied the different skills needed to ensure college readiness in high school students across America, taking a more holistic approach to include qualitative considerations [62, 17]. Four critical areas of expertise include:

- Content knowledge and basic skills
- Core academic skills
- Non-cognitive skills
- College knowledge

The first area refers to subject-specific knowledge and skills that are commonly learned through high school coursework. On the other hand, "core academic skills" include more general educational skills such as the ability to think critically or write [57]. These first two skills are more quantifiable through testing or grading and are considered to be the more common characterizations of college readiness.

"Non-cognitive skills" refer to behaviors and habits that are important for student success, like studying, time management, knowing when to ask for help, and other qualitative skills that are not easily measured. Additionally, "college knowledge" refers to the information and skills needed to successfully complete the college application and financial aid process. These key behaviors and knowledge are often not considered in high school college readiness standards as they can't be easily measured [62].

High schools in California attempt to address these critical college and career readiness areas, but the "College and Career Readiness Anchor Standards" created by the California Department of Education are all subject-specific or based on measurable academic skills [51]. Gao from the Public Policy Institute of California observed how college preparation in the state appears to focus extensively on rigorous coursework, including completion of a-g requirements, AP exams, and STEM courses, yet statistics show overall decreased performance and growing socioeconomic gaps in student attainment. The last two areas of "non-cognitive skills" and "college knowledge" suggested by Conley and Roderick et al. are absent in this system, and potentially incorporating them for a more equitable educational approach could increase student achievement. As recommended by Gao, "future research should also go beyond academic preparation and

examine non-academic factors that may play an important role in preparing students for college [21]."

4.2 Career Technical Education

Career readiness is a growing area in high schools across America and has become part of the available coursework. As mandated by the Perkins Act of 2006, there is a nationwide goal to:

> "develop more fully the academic and career and technical skills of secondary education students and postsecondary education students who elect to enroll in career and technical education (CTE) programs. [44]"

Career and technical education (CTE) programs allow high school students to take courses that provide technical and occupational knowledge in hopes of providing a pathway to higher education and careers [50]. This is a great idea to allow high school students to explore potential career interests before making big decisions upon graduation and can provide financial benefits if they choose to continue the CTE pathway toward a certification or associate's degree. Nevertheless, the success of these CTE programs in California is not as intended. According to Shulock et al., students are not encouraged to pursue CTE programs, and the few who do take the courses do not apply those skills outside of completing assignments in class. [67]. Rather than just exposing students to career pathways, research has suggested increased counseling to help students pick a program of study and obtain technical credentials [66]. This aligns with the gap in "college knowledge" and depicts an overall lack of knowledge about the

long-term process of pursing a career.

Chapter 5

Related Work

5.1 Prior Experience With Students

Apart from investigating college and career exploration literature, this thesis project was greatly informed by my prior experience as a mentor for both high school and undergraduate students.

From late 2020 to mid-2022, I worked with the California Student Opportunity and Access Program (Cal-SOAP) as a remote College Success Coach for high school students in Central California [5]. This role allowed me to guide students with low socioeconomic demographics through the financial aid and college application process, to encourage higher educational attainment. I was also exposed to Career Technical Education (CTE) resources through collaboration with a Cal-SOAP co-worker, the on-staff CTE Professional. Through this experience, I formed a comprehensive understanding of the college and career exploration resources provided in California high schools, which

also brought to my attention various flaws in the system.

One of the primary concerns the Cal-SOAP program faces is the "summer melt" phenomenon regarding the amount of college-bound high school seniors giving up on their college matriculation due to the extensive amount of information and documentation needed [1]. Many students and parents voiced their frustrations about the extensive applications and information they had to keep track of, to the point that the Cal-SOAP program integrated "Summer Melt" programs to provide assistance through Zoom in the summer leading up to college. Nonetheless, very few students showed interest in these resources as they were unfamiliar with the college application process and did not have parental guidance. Moreover, parents who were involved in their child's college matriculation often did not feel comfortable receiving virtual assistance due to their unfamiliarity with online environments. Information overload, lack of engagement, and low digital literacy proved to be prevalent issues for high school students and their families, reinforcing the problems mentioned in the prior literature review.

In addition to high school insights, I experienced the perspectives of undergraduate college students through my time as a Graduate Student Mentor at UC Santa Cruz's Undocumented Student Services during the 2021-22 academic year. As a mentor, I was tasked with helping undocumented undergraduate students navigate their post-graduation options, whether that consisted of career exploration or graduate school. Many soon-to-graduate students I worked with depicted poor career decision self-efficacy (CDSE) as they were still undecided regarding their career aspirations or were unaware of the occupations available for their field of study. Despite having general career goals

such as being a "lawyer" or a "doctor," I noticed students lacked depth of knowledge towards the steps needed to achieve these goals.

I developed and hosted a workshop series called "Close the GAP," where I provided in-depth knowledge regarding career exploration and the graduate application process. This workshop was aimed at preparing students with a range of post-graduate options such as academic and professional degrees or occupation-specific certifications and licenses. In many cases, students stated they "didn't know where to begin" and they appreciated the step-by-step process depicted in this workshop from career exploration through application. For instance, a mentee interested in law was not aware of the higher costs of law school compared to other graduate degrees nor did they realize that they would need to be licensed to practice law in a given state. In meetings subsequent to the workshop, they mentioned being encouraged to research their career aspirations further and shared more concrete career goals as a result. My observations included low CDSE in college students stemming from a lack of readiness to properly conduct in-depth research of career information. However, more interactive and visually engaging methods of career exploration such as workshops demonstrated increased college student motivation and improved CDSE.

5.2 Visualization Tools

Visualization merges computer and data science to create visual representations of datasets with the purpose of helping people complete tasks efficiently [47].

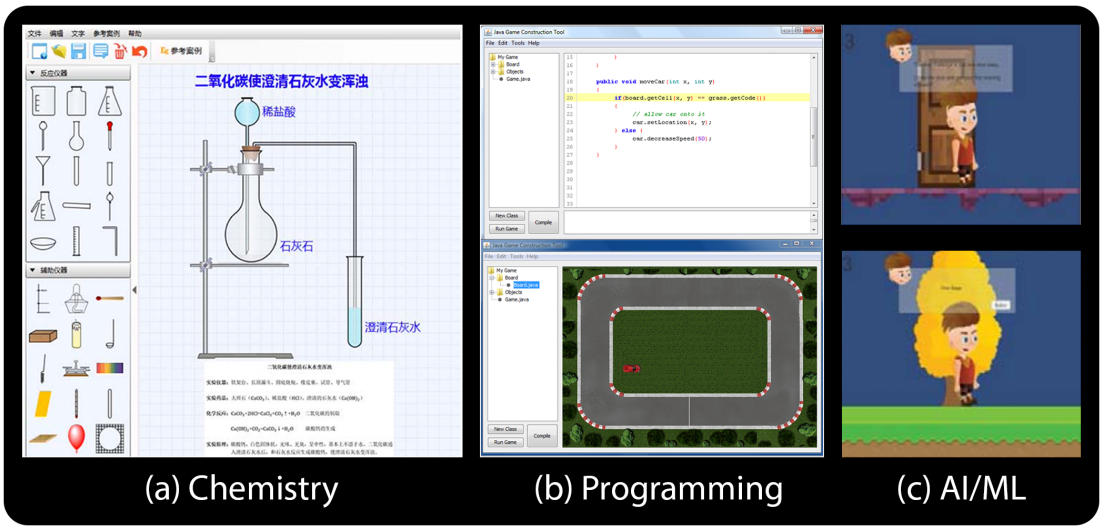

Figure 5.1: Example of educational visualization tools. (a) Platform for learning chemistry, (b) Game-based visualization tool for programming, (c) Platformer-inspired visualization tool for AI/ML

Eppler and Burkhard state that visualization is useful for cases where "little is known on the data and if the goals are not clear," as imagery can provide a new perspective for understanding. In fact, research on visual imagery and psychology suggests that visual recall is superior to verbal recall [20]. Moreover, a study on the benefits of static and dynamic visualizations resulted in a better understanding of content due to the offload of working memory, which encourages learners to engage in more valuable processing activities [33]. These characteristics of visualization make it an ideal tool to reformat college and career data, as it targets the lack of motivation and information literacy in students.

Modern forms of visualization include interactive aspects and have been proven to evoke greater enthusiasm and depth of learning, within the field of education. A study conducted on junior high school students in China implemented an interactive

platform for chemistry experiments and compared the student's results to those of a control group who learned through traditional learning methods [77]. Testing concluded in improved learning from students who used the interactive platform as they held a deeper understanding of complex topics. Additionally, visualization is a versatile tool that can integrate other interactive features such as game-based approaches to promote education. Game-based visualizations have been used to improve engagement and recall when teaching programming, Excel, AI, ML, and more [36, 38, 60]. As such, we would like to incorporate these interactive visualization features in the design of Pathways.

Part III

Method

Based on the literature review, the goals of the Pathways web application are to improve overall student motivation in the college and career exploration process through easy access to quality information. To do so, a variety of steps were needed to obtain the necessary data and develop the working web application.

Chapter 6

Data Collection and Integrity

This project was scoped to college data from the University of California (UC) and California State University (CSU) systems with a total of 32 campuses. Institutional data such as name, geographic coordinates, city, tuition, and website were sourced from the Urban Institute Education Data Explorer database comprising various U.S. Department of Education datasets. More specific information regarding the majors offered at each campus was not available on this database nor through any existing API. To obtain this information, it was necessary to data scrape directly from the UC CSU systemwide websites [14, 3] to aggregate over 2,000 majors offered and their corresponding campus.

Regarding career databases, the Occupational Information Network (O*NET) is a comprehensive tool sponsored by the U.S. Department of Labor that proved to have easy-to-read information and readily available developer tools to access career data [2]. The source reliability and easy-to-read data format made this platform ideal for the

target student user group. Over 300 occupations were collected to provide students with job descriptions and common tasks regarding the given position. As O*NET is still conducting research to populate its database, a sorting algorithm was used to filter out any incomplete occupations in our dataset.

Chapter 7

Database Organization

When organizing the Pathways database, the primary goal was to form connections between college majors and their related occupations. During the data collection process, there were inconsistent categorization systems used to organize both college and career data which made it difficult to clearly denote the interrelatedness between the two. To address this issue, it was necessary to create our own categorization system that connects the two kinds of data.

The lack of insights from an information science professional and subject matter experts proved to be a limitation in the database organization process. Nonetheless, information science literature suggests thematic methods of knowledge mapping as valid tools that anyone working with data can apply to improve information access and navigation [39, 19, 78]. Despite its predominant application to qualitative research, thematic analysis has proven to serve as a dynamic approach for understanding complex data with great potential in ontological knowledge management scenarios [53]. As such, thematic

analysis became the chosen method to organize the college and career database and required an iterative process to condense a conceptual knowledge map into a concrete categorical system. Three researchers analyzed the data in several rounds and agreed upon a two-layered categorization system based on the common themes and sub-themes. Ten major categories were created to span various prominent fields of study, and over 30 minor categories exist within these overarching themes. This system allows users to formulate more granular college and career goals by finding more specific interests.

In a secondary analysis phase, the research team created keywords based on the various majors available and assigned them across the 30 minor categories in our system. For example, the "Environmental Science" minor category was assigned keywords such as climate, environmental, fire, hydro, forest, and soil. These keywords matched the names of college majors that were relevant to this minor category and would allow us to algorithmically filter this data based on the selected minor category in the final Pathways platform. The process of assigning careers to minor categories was a bit more complex as many occupations have inter-sectional properties allowing overlapping fields of study. This aspect of careers made it difficult to algorithmically filter the occupations based on keywords, but due to the smaller amount of careers, it was possible for the researchers to manually assign them to relevant minor categories they agreed upon.

Once in place, this categorization system created a way to present students with majors and occupations that fall under the same minor category, thus allowing us to bridge the gap between academia and industry.

Chapter 8

Design

To inform the design of this web application, we conducted a competitive analysis of existing online platforms designed for this similar purpose and user group. Direct competitors [Figure 8.1] consisted of the College Board's BigFuture platform and CaliforniaColleges.edu, which are two comprehensive resources for college and career information created for high school students. Both websites provide expansive data regarding colleges, financial aid, majors, and occupations, primarily in a text-based format.

BigFuture is a child platform of the well-known College Board organization that overlooks SAT and AP testing, among other college resources. Through the SAT and AP testing databases, the BigFuture platform has access to extensive college data, financial aid resources, and a large user base. It provides free access to many services on the site, although other more useful features, such as their Career Quiz and bookmarking features, are only available upon account creation. On the other hand,

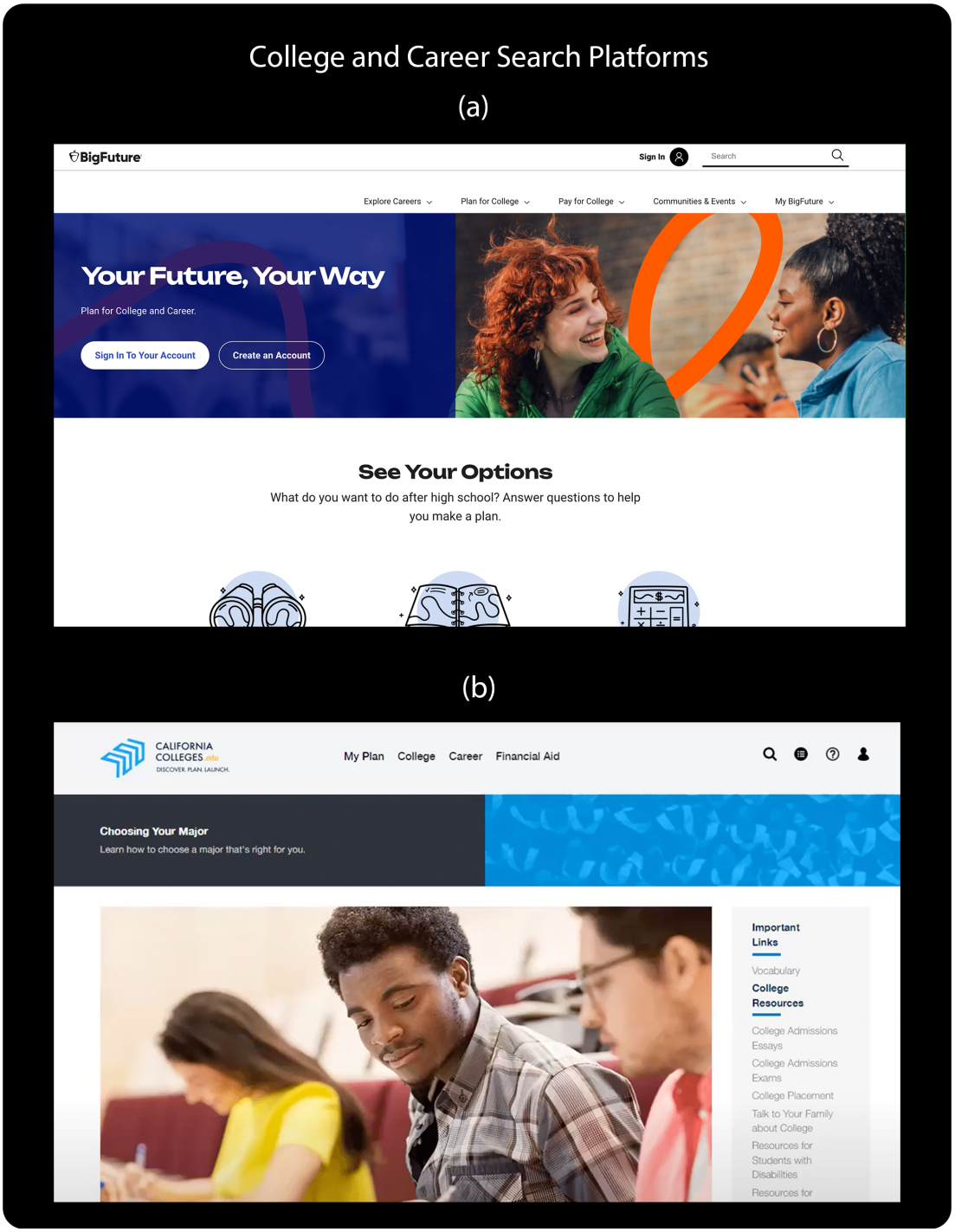

Figure 8.1: Online college and career search platforms that serve as direct competitors to Pathways (a) The College Board's BigFuture, (b) CaliforniaColleges.edu

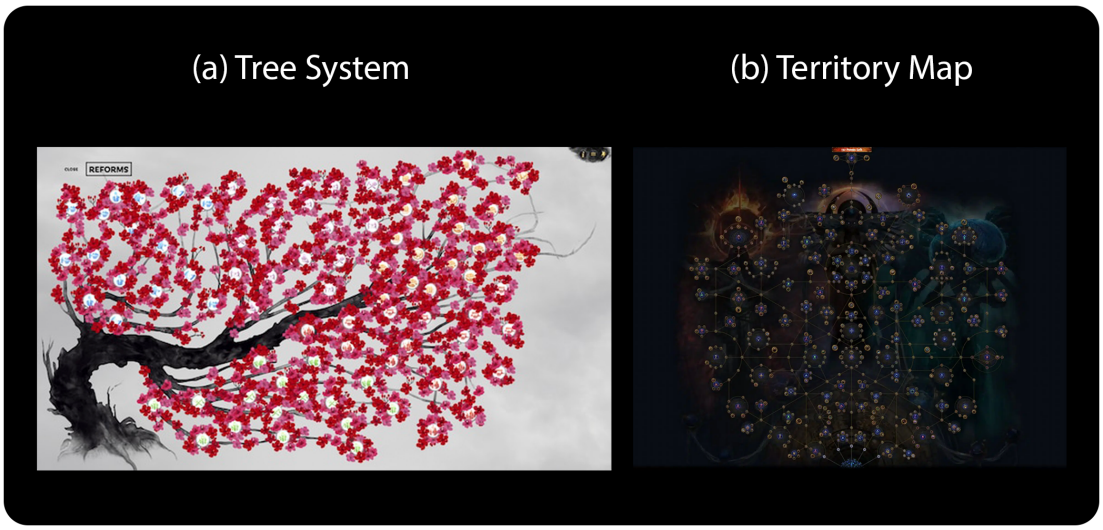

Figure 8.2: Game interfaces used as design inspiration (a) Tree system from Total War: Three Kingdoms, (b) Skill map from Path of Exile

CaliforniaColleges.edu is a college and career planning platform developed by the State of California. This site provides extensive information about colleges, careers, and financial aid, focusing on creating an explicit plan to achieve educational and vocational goals. Access to this site is marketed as free, but in fact, it is only available to students, educators, and parents whose school district is a partner or holds a paid license as it integrates students' current transcripts to track progress.

These platforms have the advantage of encompassing over 3,000 colleges across the United States, and both platforms have access to student data such as AP/SAT scores and transcripts that can be used to personalize their experience further. Financial aid information appears to be an important aspect of these platforms, and we would also like to integrate financial features in the form of tuition and housing costs. Despite these advantages, there are areas for improvement found in both sites that Pathways

can address.

The user interface of both sites relies heavily on scrolling lists and large amounts of text, which has been proven to be an issue in student motivation and comprehension [23]. Moreover, student reviews of BigFuture have low ratings and mention frustrations regarding the site's "sluggish loading time" and "very buggy" login features [4]. These pain points can be addressed by incorporating animated visualization features to encourage engagement and learning. Latency will be considered in the development phase to ensure a smooth experience so that the platform interactivity will be limited for optimal navigation.

Based on this analysis, we began to brainstorm designs for an interactive dashboard to display our categorization system. Game maps and dashboards served as a design inspiration where we considered depicting the categorization system as a tree or territory [Figure 8.2]. After several iterations, we decided to represent the categorization system as major planets in space with minor orbiting planets. This design process included low-fidelity sketches and a high-fidelity Figma prototype [Figure 8.3]. Feedback on initial designs was obtained from other graduate students in the Computational Media and Human-Computer Interaction departments. High-fidelity prototypes were critiqued by educational stakeholders in the Santa Cruz area through participation in the Digital Apps for Youth Education and Career Exploration Project Fair at UC Santa Cruz. Moreover, I met with the California Student Opportunity and Access Program (Cal-SOAP) Program Director for further insights from an educator in the Central California area.

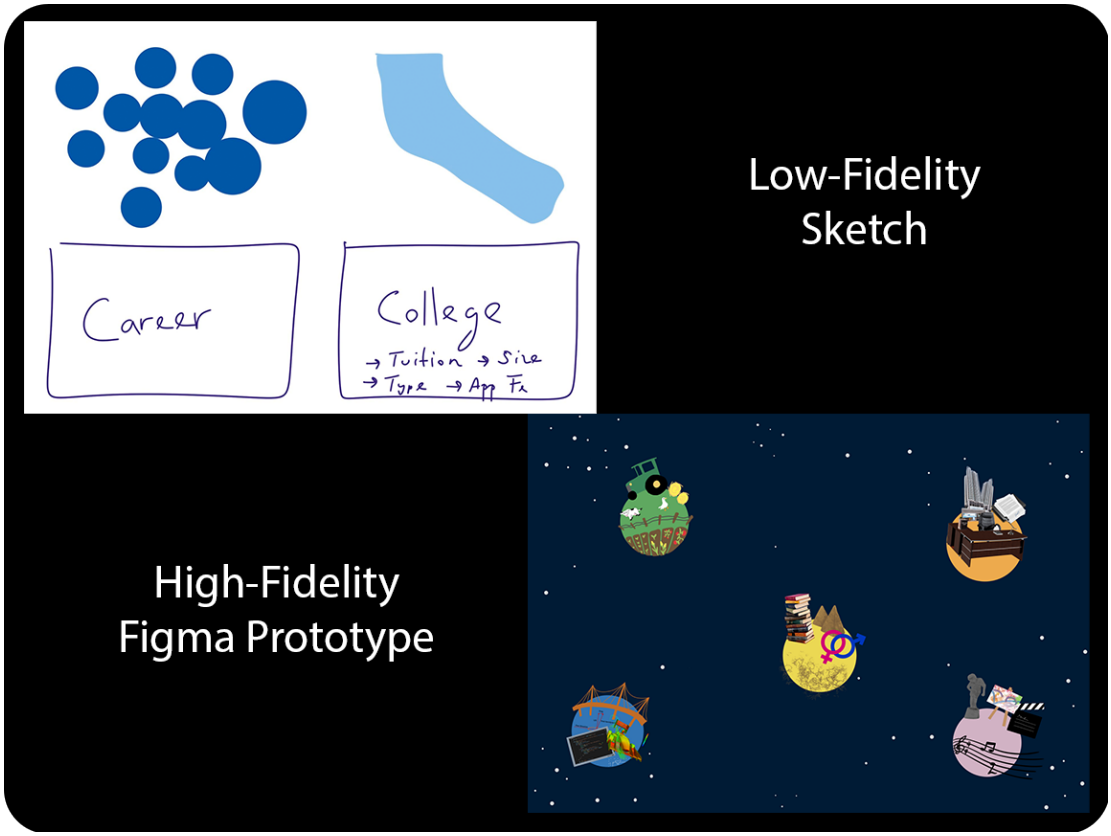

Figure 8.3: The low-fidelity sketch used for the initial interface design is shown at the top left, and the high-fidelity Figma prototype is shown on the bottom right.

These iterations resulted in the space-themed dashboard in Figure 8.4 with interactive planet animations that trigger when clicked. Users are meant to explore these planets and select any categories of interest. Once they have made a selection, that category is stored at the bottom left corner of the page and will be used to filter relevant content on subsequent pages. Users are then prompted at the top right corner to choose whether they would like to navigate to a detail page regarding college majors or careers [Figure 8.4 b and c]. These pages are meant to be informative, but we limited the amount of text to concise details that are easy to read. We provide users with a list of relevant majors or careers and more visually intriguing features, such as a map interface to depict available campuses in a format that helps conceptualize the location [Figure 8.4 b].

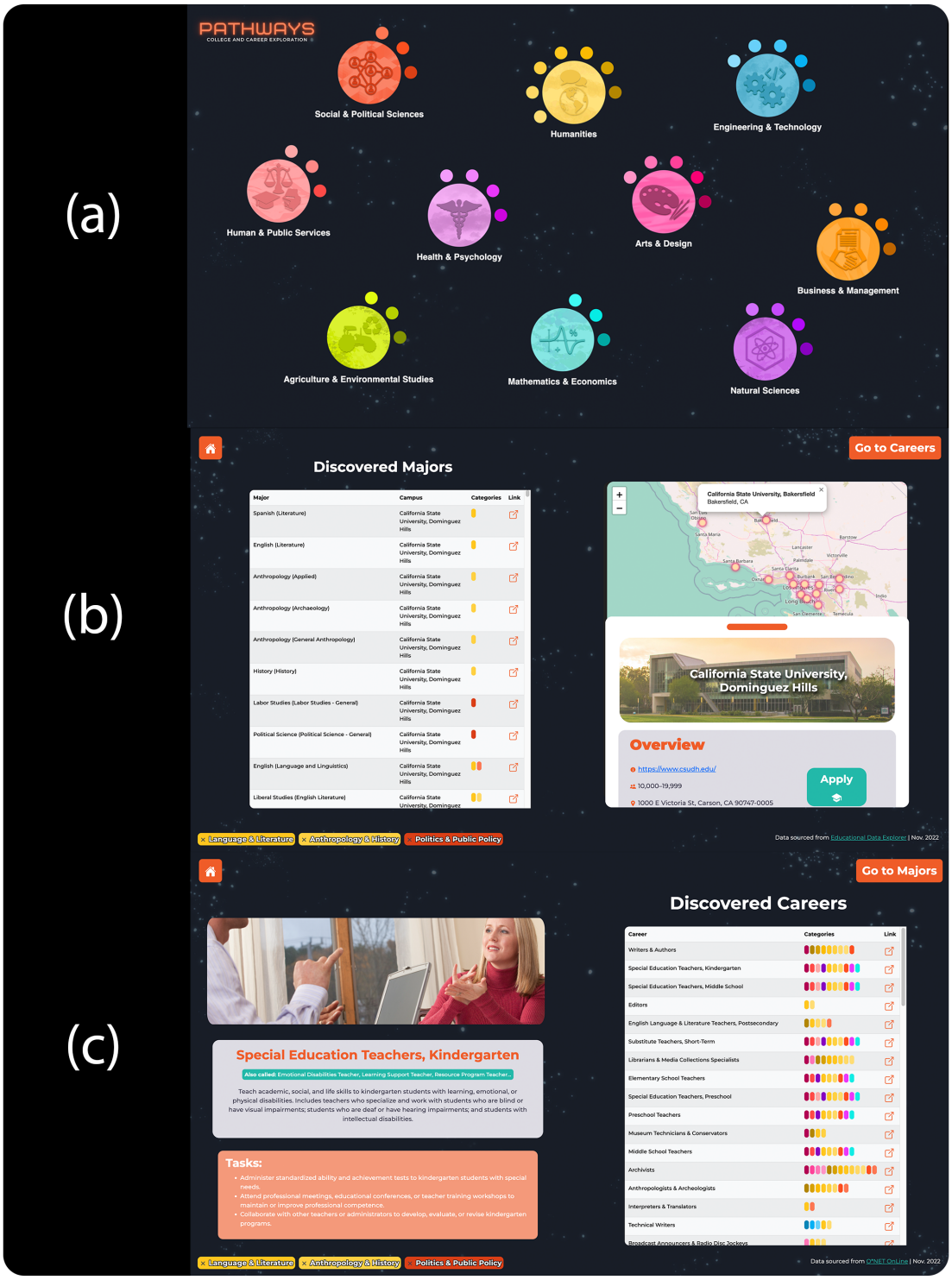

Figure 8.4: The three primary interfaces of the deployed Pathways platform (a) Dashboard, (b) Majors Detail Page, (c) Careers Detail Page

Chapter 9

Development

The Pathways platform was created using the React front-end framework to allow for a single-page application with optimized page renders. This format does not require a server and results in faster loading times, as data is only rendered once. It was important to use a framework requiring less Internet bandwidth because not all high school students can access a reliable Internet connection. Moreover, the component-based structure of React would accelerate development time due to the re-usability of these components.

To incorporate interactive information visualizations, we integrated p5.js, an open-source JavaScript library for creative coding with features to easily create 2D animations. This library allowed us to develop our space-themed dashboard of planets with orbiting sub-planets that animate upon interaction.

Part IV

Study Protocol

We opted to conduct a comparative study between users' experiences using a traditional college and career search method like BigFuture and Pathways. This study was conducted through Zoom, and we obtained participant consent to record their given session and proceeded to anonymize participant data during analysis. Study recordings included participant screen-sharing and interview audio that was transcribed using Zoom's built-in Otter.ai transcription service. The target demographic consisted of college students 18 years and older in the state of California who completed high school within the state. High school students were not included due to IRB restrictions. However, we hoped to obtain insights unique to college students regarding college and career search (CCS) tools they found helpful in their matriculation process and the factors that most impacted their decision process. We also hypothesize the career aspirations of college students are more concrete at their educational level and look to explore their career decision self-efficacy at this stage.

Usability evaluation methods include techniques such as interviews, questionnaires, think-aloud testing, time per-task metrics, task success, and more [45]. A pilot study with three participants was conducted to finalize the user study protocol, and we decided upon an hour-long session with three phases: a pre-survey, a usability study, and a post-survey. As recommended for comparative studies, we aimed to recruit 8-25 participants to ensure statistically significant results [40, 75].

15 participants were recruited via email and posters, shared with college students through academic advisors and professors. Through screening, participants from various majors were chosen with ages ranging from 18 to 40, including students from

community colleges, CSU, and UC campuses.

Chapter 10

Pre-Survey

After consent was obtained, the pre-survey was administered at the beginning of each participant's session. This conversational interaction facilitated the inclusion of follow-up questions to obtain qualitative insights. Questions were formulated to investigate participants' academic and career aspirations and find what college and career search (CCS) tools they used when transitioning from high school.

This data helped us determine what CCS resources participants used to make their college and career choices. Moreover, follow-up questions regarding what CCS tools they use now as current college students show what resources maintained relevancy past their high school phase in terms of career development. These insights uncover whether students continue exploring career aspirations after college admission.

Chapter 11

Usability Study

To help gauge an understanding of how our web application fares against other college and career search (CCS) tools, we conducted a comparative usability study where participants are allocated ten minutes per website to use BigFuture and Pathways to explore colleges and careers. BigFuture is one of the largest sites available in the United States that provides college and career data sourced from databases similar to those used in Pathways. This website is heavily reliant on text-based data, so through this comparison, we wish to see how the interactive interface of Pathways changes users' experience.

To avoid biases, the order in which these platforms were presented alternated across participants (e.g. some used BigFuture first, while others started with Pathways). In both circumstances, participants had task-based interactions where they were asked to reflect on their high school decision process and use the platform to find college and career information that aligns with their current aspirations. Within the ten-minute

time limit, they can search until they believe they have found all the necessary details. During the search process, participants are encouraged to "think-aloud" to explain the thought process behind their search method [16].

Chapter 12

Post-Survey

After each ten-minute usability session, participants were asked to complete the System Usability Scale (SUS) post-test usability assessment for the given platform. The SUS assessment is a 5-point Likert-scale questionnaire often used in user experience research as a quick way to measure a system's usability [13]. We calculated the average SUS score of BigFuture and Pathways for comparison. The 10 questions presented in the survey are the following:

1. I think that I would like to use this system frequently.
2. I found the system unnecessarily complex.
3. I thought the system was easy to use.
4. I think that I would need the support of a technical person to be able to use this system.
5. I found the various functions in this system were well integrated.

6. I thought there was too much inconsistency in this system.

7. I would imagine that most people would learn to use this system very quickly.

8. I found the system very cumbersome to use.

9. I felt very confident using the system.

10. I needed to learn a lot of things before I could get going with this system.

Part V

Results

Chapter 13

Data Analysis

To analyze interview data, two researchers conducted an iterative thematic analysis to find insights, as it is ideal for the qualitative data collected[46].

We developed themes using the Dedoose Qualitative Coding Tool and revised our themes in three rounds. For the first round, we enabled the Dedoose blind coding filter that hides other contributors' work to avoid biases in our initial codes. No pre-existing themes were used in this round, and we inductively coded the interview notes and transcripts to formulate individual sets of themes [12]. Researchers reviewed initial themes to combine similarities and discuss differences. The subsequent rounds of coding applied the combined themes, and we measured inter-rater reliability (IRR) using Cohen's Kappa [7]. The pooled Cohen's Kappa resulted in an IRR of 0.87, indicating significant agreement.

In terms of quantitative data, we analyzed the difference in SUS scores between the two sites. This includes comparing the overall average and exploring specific

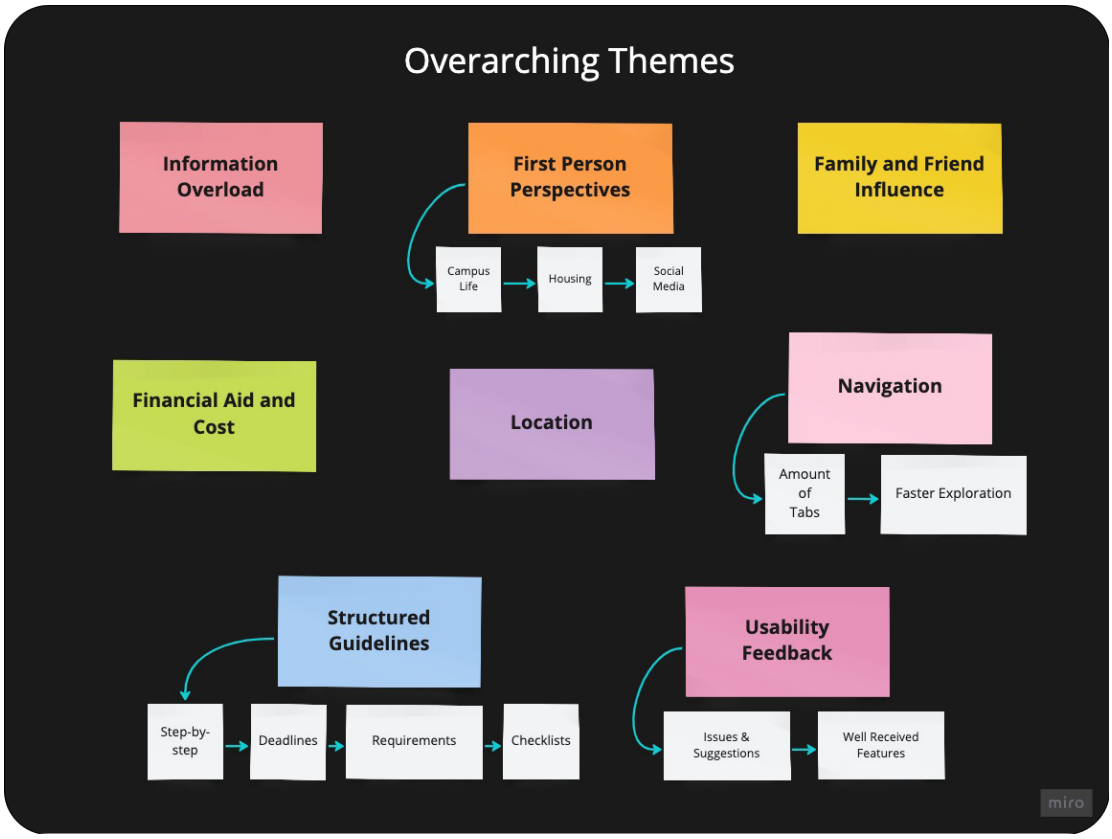

Figure 13.1: Resulting themes from thematic analysis of usability study notes and transcripts.

questions addressing system attributes such as ease-of-use and learnability [37].

Chapter 14

Qualitative Data

Initial thematic analysis resulted in 39 combined codes, but we reduced our final set of themes based on the number of relevant excerpts found in the data. As shown in Figure 13.1, eight themes were identified of which four themes directly relate to important factors for the students' decision process while the other four address the platforms' user experience and interface. All direct quotes in our findings are anonymous and will be attributed in the format P1-P15. Quotes will be labeled accordingly for any reference to BigFuture or Pathways, and contextual details such as the researcher's questions are included when necessary.

14.1 Factors Influencing Student Decision Process

14.1.1 First-Person Perspectives

In addition to basic information about colleges and careers, participants valued more insightful details informed by primary sources such as current students or career mentors. We found two sub-themes regarding the kind of information they hoped to gain from these first-person perspectives and the methods they used to find this information. Experiential content about an individual's college or career struck interest in 9 out of 15 participants.

14.1.1.1 Campus Life and Experience

Reviews from individuals who were once in their position held significant value for students to determine if the environment was safe and the community fit their own values.

> "I enjoy that they have campus life. I think that's a really big thing sometimes because I feel like a lot of the times, especially when you're in high school...when you go directly to a 4-year university since it's the first time being on your own, it really matters exactly the community and the culture of the school." - P10, [BigFuture]

> "Just talking to like my supervisors and stuff at different clubs and different jobs that I've had, and seeing like what they did. So kind of like getting advice from other people that work and I saw what I wanted to do" - P14

14.1.1.2 Social Media

Various participants mentioned looking for this experiential information during their decision process as high school students. However, these insights are often not readily available, and participants mentioned resorting to social media platforms such as Reddit, Instagram, and YouTube.

> "It was kind of hard to find people's personal experiences at this school. I had to look at Reddit and stuff and like read. It's kind of a dark place, but also I didn't have many friends here[at UCSC]." - P5

> "Actually, I used Instagram like when I got accepted into UCSC. Part of the thing that really drew me to the campus was when I went on Instagram...I like kind of just did a whole deep social media dive, and I think there was a UCSC Reddit." - P7

> Q: What resources did you use to decide on your current college? "I looked at like Youtubers. They would talk about college. And yeah, give advice and stuff." - P2

14.1.2 Family and Friend Influence

Other than online tools and resources, participants obtained guidance from parents, siblings, and friends in their decision-making process. 10 out of 15 participants relied on family or friend advice to decide on a college or to complete the necessary paperwork for matriculation.

> "I relied on my sister's since I am the youngest out of 5. They all attended Fresno State, so I never really thought of applying anywhere else." - P15

> "I had a lot of help from my friends, who kind of like, told me about the deadlines and like what to do on the websites for college because it's kind of confusing." - P8

> "I also have an older brother who, you know, graduated from Berkeley. So I got a lot of his help on the UC application...he was able to literally walk me through the application." - P9

14.1.3 Financial Aid and Cost

Affordability was one of the most important deciding factors for students' college search. Moreover, the process of obtaining financial aid was confusing for many students.

> "I feel like for a lot of students what will either prevent you from going to school or discourages you from going to school is like the cost." - P6

> "In terms of like financial aid, that really was more hard for me to figure out. Kids from my school didn't even apply for financial aid because they didn't even know what existed or where it was or what it was." - P7

14.1.4 Location

Campus location proved to be another deciding factor in students' college search and was influenced by family matters and cost. 11 out of 15 participants either mentioned location being important or preferred searching for colleges near their home-town. The distance filter in BigFuture was used by many participants and they enjoyed the campus map interface on Pathways.

"I'm from Southern California. So I kinda wanted to get away from home just because home life wasn't the best." - P5

"Living, far away from family, in my case it doesn't really matter. I was only searching for in-state because I knew that out-of-state would cost more money." - P8

"All of the colleges that are near me, I like that. I didn't know there were that many colleges." - P3

14.2 User Experience and Interface Feedback

14.2.1 Information Overload

10 out of 15 participants considered the BigFuture website to be overwhelming. Moreover, several participants described the career data presented on Pathways as text-heavy and would like to see more visual representations. Despite being potentially useful information, its amount and format reduce its functionality and result in information overload [11]. These quotes depict the importance of formatting information to best fit the need of users, from shortening textual content to designing interfaces that limit the amount of information shown at one time.

"I liked that it's short too. When I see too much writing, I get overwhelmed, and I ignore it" - P15, [Pathways]

"If I'm like, actually a high school student, I would just not bother reading all that, because it's like boring." - P8, [BigFuture]

Q: Why do you think you would use Pathways frequently?

"I think just because it wasn't like an overload of information at first...it didn't dump a lot of things right away, and you could choose on what things you wanted to expand on versus the other one." - P11, [Pathways]

"It just shows you from the beginning, what was it, like 100+ careers that you could look into. So that's why I'm saying that maybe it would be a little bit cognitive overload where it's like holy crap like this is so many." - P10, [Pathways]

14.2.2 Structured Guidelines

13 out of 15 participants displayed a preference for concise step-by-step details about the college application process, financial aid, and career attainment. Structured guidelines such as deadlines, checklists, and requirements were more helpful than informative articles or descriptions as this format allows them to keep track of their progress.

"I think I would just appreciate something a lot more straightforward...it doesn't even have to be customized, I think just getting like a ballpark of where I might land like on the financial aid scale." - P6

"I think that's a nice touch where they say, like, these are the next steps after you do the application...similar to just holding the person's hand and being like this is what's coming up." - P10, [BigFuture]

"Just different, like, you know, here's a list of things that you should be considering when like trying to choose your college or just some kind of guidance like that. Just so I feel like I'm doing it." - P14

14.2.3 Navigation

BigFuture is formatted as a multi-page application, while Pathways is a single-page application, leading to different user flows that impact overall navigation. Two sub-themes were found when investigating the way participants navigated the two platforms.

14.2.3.1 Excessive Tabs

When navigating to a new page, the BigFuture platform opens a new tab in your browser. Numerous participants disliked the amount of tabs generated when using this platform and had difficulty keeping track of their progression.

> "So maybe that's something that is probably annoying from the BigFuture one is the fact that it opens up a ton of tabs. I have like 10 tabs...I would rather it just be like one or 2." - P10, [BigFuture]

> "I realized that when I clicked on things like it would lead me to another tab. So it opened up various tabs, and I don't really like doing that." - P4, [BigFuture]

14.2.3.2 Increased Exploration

On the other hand, participants viewed more colleges and careers within the time limit when using Pathways and demonstrated an increasingly exploratory nature. Despite sharing their college and career aspirations, participants were more open to exploring colleges and careers that strayed from their primary interests.

> "I realized that you could apply multiple majors to look at careers. So I just

wanted to see if I clicked education plus sociology, what kind of jobs would pop up." - P5, [Pathways]

"I checked what I already wanted, and I just wanted to see what other combinations could lead." - P12, [Pathways]

14.2.4 Usability Feedback

Participants provided both negative and positive feedback regarding Pathway's usability. We have split this feedback into two sub-themes.

14.2.4.1 Interface Problems

The ability to select more than one category was not intuitive, and many participants were confused about how to deselect categories. Upon making a selection, participants were expecting a detail page listing relevant colleges and careers. They did not immediately realize that they must first select whether they wanted to navigate to colleges or careers first. These buttons would appear in the upper right corner upon the selection of categories to give users the choice of content to explore first, but its placement did not capture the users' attention.

Several features were not immediately intuitive to participants, perhaps due to the novelty of the interface, such as the interactive map showing college campuses and the inter-sectional categories shown in the tables. Various participants suggested we create a tutorial to inform new users of these overlooked features.

> "The pop-up kind of sneaks up on you if you're not looking for it, for these two up on the right." - P3, [Pathways]

> "I think it was just kind of hard to figure out. Like when you click on a major, and then, you could also add another major. I didn't know that you could, and the little tab at the bottom of the screen it's a little hard to see." - P5, [Pathways]

14.2.4.2 Well-Received Features

There were many positive comments regarding the visual appeal of Pathways. 14 out of 15 participants enjoyed the space-themed design and considered it to be a fun, eye-catching platform. Despite being unfamiliar with interactive interfaces, participants appreciated the animation elements and were surprised by the ease of use.

In terms of information, the categorization system was helpful to many, and they valued seeing the connection between majors and occupations. Moreover, participants were surprised by the inter-sectional categories and found it to be a very helpful insight.

> "Well, I did like Pathways, like, the layout, and I think it's very fun and cute. I think that helps engage in while you're looking for more information on universities, majors, and anything else." - P4, [Pathways]

> "I really liked it, not only because it was color-coded, but I like how there's multiple options, categories that it's under. It kinda gives you more options, and I like seeing how they collide or overlap." - P5, [Pathways]

Chapter 15

Quantitative Data

To interpret SUS scores, we used the Sauro-Lewis curved grading scale [Figure 15.1] and calculated the average SUS score for each platform. Based on industry standards, a SUS score of 80 is evidence of an above-average user experience, and this value served as our target score. Questionnaire responses for each platform were collected in separate Google Sheet documents with integrated equations to calculate each participant's individual scores, the average score per platform [Figure 15.2], and the average agreement per SUS question [Figure 15.3].

As seen in Figure 15.2, BigFuture's average SUS score is 61.17 resulting in a D grade for system usability. Based on the Sauro-Lewis scale, this is an "OK" score considered to be "marginally acceptable" and falls well below the industry standard for user experience [64]. There was an even division in participant scores with opposing values, half gave excellent scores, and the other half gave very poor scores. When considering specific questionnaire items [Figure 15.3], most participants demonstrated

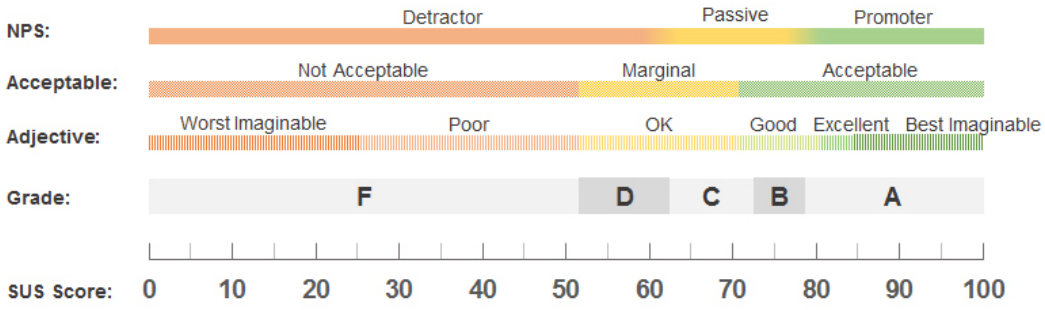

Figure 15.1: The Sauro-Lewis curved grading scale was based on data from 241 industrial usability studies and is the basis of our SUS scores. [64]

ease of use and confidence using the system, potentially due to their familiarity with interfaces like BigFuture. The most evident issue was the unnecessary complexity of the system, which made it inconvenient to use. This issue correlates to the qualitative themes of *information overload* and *excessive tabs*, both of which caused frustration in participants and could be leading factors for BigFuture's low SUS score.

On the other hand, Pathways has an average SUS score of 86.67 reaching an A grade for system usability [Figure 15.2]. This score surpasses the above-average user experience standard and is considered "Excellent" by the Sauro-Lewis scale [64]. As opposed to BigFuture's scores, participants had much more uniform scores with the lowest values staying within the "marginally acceptable" range. Most questionnaire items had ideal results for ease of use, consistency, learnability, and confidence [Figure 15.3]. However, a few users found the platform unnecessarily complex, a result that we attribute to the novelty of the Pathways interactive interface. Qualitative usability feedback addressed participant confusion regarding new features such as the selection

of categories, inter-sectional categories, and the campus map which evidently can make the platform seem complex to new users unfamiliar with these features.

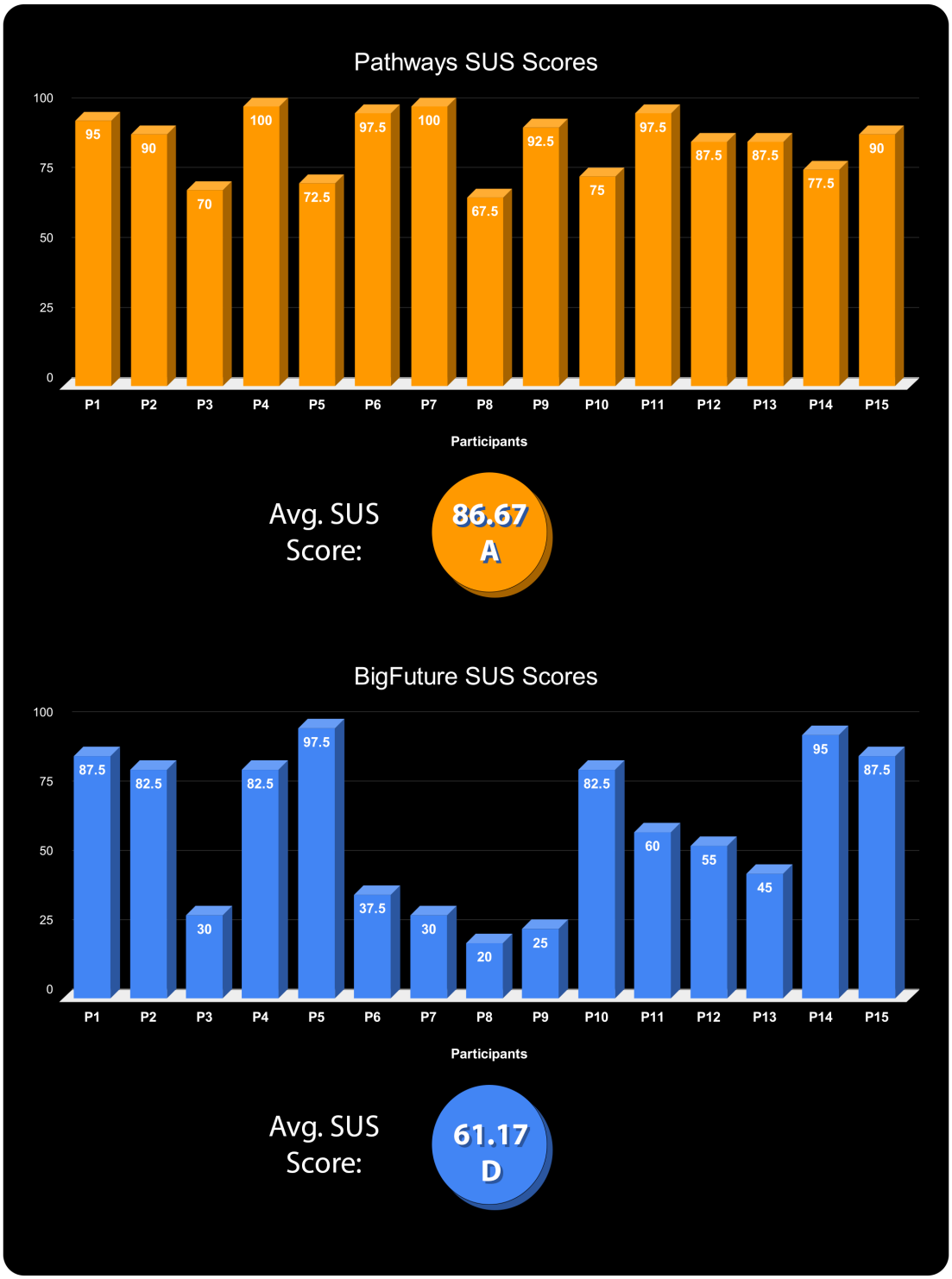

Figure 15.2: SUS scores of all participants per platform. Pathways is shown in orange and BigFuture in blue.

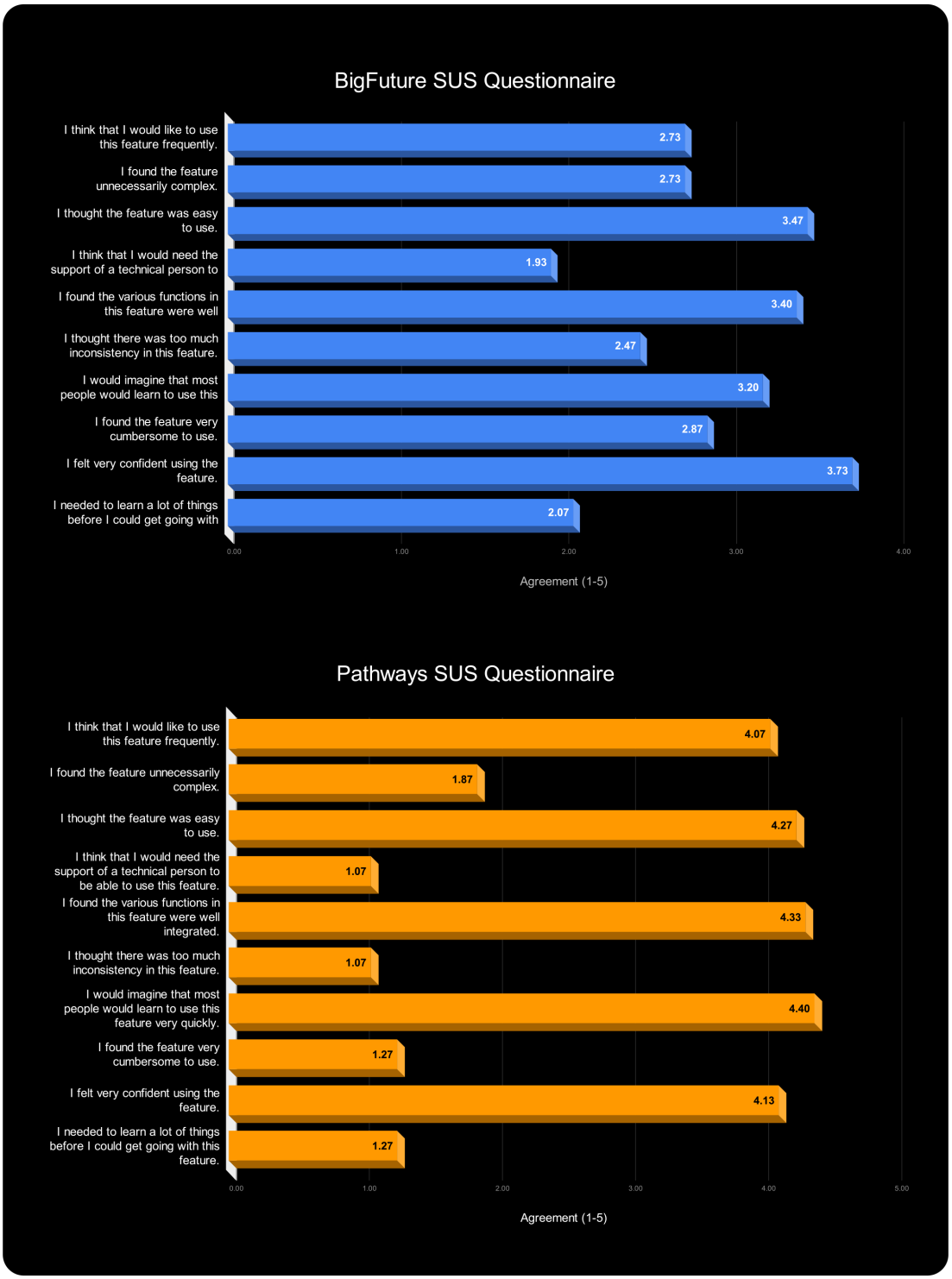

Figure 15.3: Average participant agreement with SUS questionnaire. Pathways is shown in orange and BigFuture in blue.

Chapter 16

Conclusion

16.1 Discussion and Future Work

A large majority of our qualitative results focused on the academic aspect of college and career exploration and expanded upon the contributing factors to students' college decision process. These insights are valuable for curating information most relevant to students' needs and avoiding information overload. However, we were not able to obtain as many career-related insights from participants despite hypothesizing clearer career aspirations in college students. Many participants were still undecided about their prospective careers and in some cases only mentioned contributing factors such as job salary or conversations with peers. Future studies should conduct an in-depth analysis of the factors that determine students' career-decision self-efficacy and explore methods of providing support through interactive online methods.

Nonetheless, our usability results show great potential for Pathways in facili-

tating students' college and career exploration. Participants showed enthusiasm for the interactive format of the platform, which was not present with traditional informative formats shown on BigFuture. Despite being a novel interface, most participants were able to learn how to use it within the allotted time frame and showed appreciation for the inter-sectionality between varying college majors and careers. Continued design iterations and dataset expansion are necessary in order to truly become a comprehensive resource, but I hope other existing college and career platforms consider taking a similar approach to improve students' experience.

Online educational resources have not existed long enough to comprehensively determine their impact on student education. Moreover, the most prominent educational resources still maintain very traditional interfaces. Considering that many students have now grown up around the Internet, isn't it time for us to update and catch up to their way of thinking?

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