Towards Understanding Barriers and Mitigation Strategies of Software Engineers with Non-traditional Educational and Occupational Backgrounds

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ABSTRACT
The traditional path to a software engineering career involves a post-secondary diploma in Software Engineering, Computer Science, or a related field. However, many software engineers take a non-traditional path to their career, starting from other industries or fields of study. This paper proposes a study on barriers faced by software engineers with non-traditional educational and occupational backgrounds, and possible mitigation strategies for those barriers. We propose a two-stage methodology, consisting of an exploratory study, followed by a validation study. The exploratory study will involve a grounded-theory-based qualitative analysis of relevant Reddit data to yield a framework around the barriers and possible mitigation strategies. These findings will then be validated using a survey in the validation study. Making software engineering more accessible to those with non-traditional backgrounds will not only bring about the benefits of functional diversity, but also serves as a method of filling in the labour shortages of the software engineering industry.

CCS CONCEPTS
• Social and professional topics → Computing profession.

KEYWORDS
non-traditional backgrounds, barriers, mitigation strategies, career switch, software engineering career

1 INTRODUCTION
The software engineering (SE) industry has seen significant annual growth in North America over the last decade [7, 27]. Even though the number of Computer Science (CS) and SE degrees has been increasing as well [14, 15], there is still a shortage of software engineers [18, 26]. This surplus in labour demand brought to attention paths into a SE career that are alternatives to the traditional path, i.e., via a university degree in CS or SE related areas [56]. However, there is little understanding on how viable and effective it is for someone with a non-traditional educational and/or occupational background to switch into a SE career. For the purposes of this work, a software engineer has a traditional background if they completed a post-secondary program in SE, CS, or a closely related field, then begin their career as a software engineer. A non-traditional background then applies to software engineers who did not follow this traditional career path, including anyone who switched into SE from another career, who first studied another field before SE, or who taught themselves SE.

As such, this work aims to contribute a first step towards understanding the barriers faced by those with a non-traditional educational and/or educational background trying to switch into a SE career, and explore possible mitigation strategies for these barriers. Having an understanding of the barriers and mitigation strategies serve an essential step in making SE careers more accessible to those with a non-traditional background. This could not only have implications for filling in the current labour shortage, but also contribute to having a more diverse SE community. While not a form of social diversity per se, academic background diversity is a form of functional diversity [23]. While not much research has been done on educational background diversity in CS/SE, prior works in other areas found various benefits. For instance, educational diversity can aid in avoiding the “groupthink” mindset [29]. Lorenzo and Reeves also found educational background diversity having a statistically significant correlation with how innovative enterprises are across eight countries (US, France, Germany, China, Brazil, India, Switzerland, and Austria) [37].

2 RESEARCH QUESTIONS
This paper aims to investigate the following research questions:

RQ1 What are the perceived barriers faced by those with a non-traditional educational and occupational background who are either software engineers, or trying to switch into a SE career? Motivation: Understanding what these barriers are could provide valuable insights into how the SE industry is limited in its accessibility to those with diverse educational and occupational backgrounds currently.

RQ2 What are mitigation strategies that could lower observed barriers to succeed?
Motivation: Barriers are only half the story; a comprehensive understanding also includes exploring the mitigation strategies currently employed by those facing these barriers. Insights into RQ2 could have implications on how well each barrier is mitigated, how current mitigation strategies can be facilitated by various parties, and the possibilities of empowering those with a non-traditional background with new mitigation strategies that are not currently employed.

3 RELEVANT WORK

3.1 Understanding Diversity in CS/SE

Harrison and Klein [23] define diversity as the “distribution of differences among the members of a unit concerning a common attribute.” Much existing diversity research in SE focuses on social attributes like gender, age, and ethnicity, especially as these are protected classes under United States anti-discrimination law [13]. Studies have shown that software engineers face challenges and barriers to developing activities in this field resulting from perceived diversity related to these attributes [46]. Age-related barriers are particularly relevant to software engineers with non-traditional academic backgrounds, who tend to be older at the same career stage as their peers [16]. The perception that younger software engineers are better pervasive throughout the industry and even popular media [4]. This discriminatory discourse tend to create challenges to older software engineers to participate in open-source software (OSS) projects [5, 42].

3.2 Diversity in Educational and Occupational Backgrounds

Educational background diversity refers to the different sets of knowledge, skills, and abilities that team members acquired in the function of their educational backgrounds. Thus, a team composed of people with diverse educational backgrounds can understand a problem based on various combinations of information, insights, and perspectives [38]. Studies have shown that diverse educational backgrounds may affect work outcomes and team behaviour in several aspects, such as team creativity, team performance, and innovation [21, 30, 40, 43]. However, high educational background levels can lead to an excessive conflict of ideas that is time-consuming due to the need for reconciling knowledge, experiences, and different views [38]. According to Kearney and Gebert, the formation of a team with diverse functional and educational profiles is a way to promote the integration of crossed ideas and to present to the team new perspectives and insights to solve a problem or execute a task [32]. Results of a study conducted by Guo et al. have demonstrated that educational diversity may negatively affect team creativity, especially when tasks are repetitive, defined, and predictable, and personnel team variability is higher [10, 21]. Cases of research have also shown that educational diversity influences, at different levels, team performance in the banking and financial sectors [45].

Functional background diversity refers to differences in the professional background among team members [6, 10, 44]. Research has indicated that functional diversity is associated not only with the promotion of creativity, innovation, performance, and problem-solving ability but allowing a high capacity for incorporating new knowledge from a diverse domain [49, 50]. Although diverse functional backgrounds offer teams various benefits, different views and perspectives might cause disagreements among team members, negatively impacting teams [50]. Also, functional background diversity may be negatively impacted by rising costs associated with the time-consuming consensus process when integrating ideas [49].

3.3 Career Switching

While there does not exist much prior research on career transitions related to the software industry, research by Castro et al. on career transitions by junior academics into Data Science is of particularly relevance [9]. These junior academics faced career barriers within academics, including career uncertainty and the lack of meaning and impact. These barriers, when paired with a failure to meet career expectations, motivated a career switch. The transitioning process is facilitated by what Castro et al. referred to as career catalysts (e.g., “adapting one’s mindset to new industries and roles”). They also captured what junior academics did as part of the transition, which include activities like self-learning. Lastly, they explored how a successful transition into Data Science allowed for an experience of career sustainability [9].

In contrast, this work looks to contribute a more high-level understanding of the barriers faced by, and mitigation strategies used by, those with any non-traditional occupational and/or educational background (i.e., not just junior academics) transitioning into any role related to SE (i.e., not just Data Science).

4 METHODOLOGY

To answer our research questions, we will perform an exploratory study where we qualitatively analyze Reddit posts by our target population, i.e., those who are considering a SE career, as well as those who have already started theirs, with non-traditional educational or occupational backgrounds. This analysis will be based on Hoda’s Socio-Technical Grounded Theory (STGT) [25], and will aim to uncover barriers and possible mitigation strategies. To validate the barriers and mitigation strategies gathered from the qualitative analysis, a survey will be designed and administered to our target population in a validation study. A high-level overview of our methodology is presented in Fig. 1. Below, we discuss the exploratory study and validation study in detail.

Figure 1: A high-level overview of the methodology of this work, which contains an exploratory study, followed by a validation study.
4.1 Exploratory Study

This study uses a qualitative analysis process that is inspired by the STGT, which consists of two stages, the Basic Stage and the Advanced Stage (Fig. 1). STGT, proposed by Hoda, is “an iterative and incremental research method for conducting socio-technical research using traditional and modern research techniques to generate novel, useful, parsimonious, and modifiable theories” [25]. This aligns very well with our study for two reasons. First is the socio-technical nature of our topic, i.e., the barriers faced by those who want to transfer into a SE career have both social and technical aspects. Moreover, STGT is designed with a wide variety of research methodologies in mind, unlike many existing versions of Grounded Theory (GT), which are “predominantly applied as a qualitative method through traditional data collection techniques such as interviews and observation” [25]. One aspect of this is STGT’s allowance for context-specific ontological stands, including non-physical realities like Reddit, a virtual world.

However, it is worth noting that several aspects of this study’s procedures deviate from STGT. First, while STGT takes inspiration from Glaserian, Strauss-Corbinian, and Constructivist versions of GT, [25] does not specify i) if research questions should be defined prior to starting the data collection and analysis phase, and ii) how, if at all, can Inter-Coder Reliability (ICR) statistics be used to verify the reliability of multiple coders’ analysis. This work defined research questions prior to the analysis, closer to Strauss-Corbinian GT, in which “a question should be pre-set as it sets the boundaries around the study area” [12]. Moreover, the questions are structured in terms of barriers and mitigation strategies, which is a structure commonly used in existing SE research on various aspects of diversity (e.g., [4, 8, 19, 31, 48]). This was done to strike “a balance between being sufficiently informed versus overly influenced by existing works”, a Constructivist GT approach [25]. Regarding ICR statistics, we describe below the procedure we plan to use for incorporating Krippendorff’s Alpha [33] to ensure reliability. Another aspect deviating from the grounded theory approach is that this work has pre-determined data sources (i.e., Reddit), instead of allowing for the possibility of theoretically sampling from other unplanned data sources [25]. This decision to determine a fixed data source is made as a balance between manpower and budgetary constraints, and our belief that Reddit serves as a rich data source sufficient for a first step towards answering the research questions.

Ethics Considerations. Since this study involves the analysis of a publicly available archive of Reddit posts hosted by pushshift.io, careful ethics considerations are needed. On this, Gold and Krinke demonstrates the use of Menlo ethics principles within MSR research contexts in [20]. Since obtaining informed consent from Reddit users whose content is analysed in this work is logistically impossible, we will not present any direct quotations from the data. We will anonymize the data by removing usernames and make it privately available for any future researchers interested in replicating or building off of this work. This aligns with Hoda’s suggestion to “obscure identifiable information” when using public data [25].

We describe the details of the procedure we plan to execute below:

4.1.1 Basic Stage. This stage involves a lean literature review, basic data collection and basic data analysis (Fig. 2).

Lean Literature Review. The purpose of performing a lean literature review is to "identify gaps and motivate the need for a
study” [25]. Findings from our lean literature review have been presented in Section 3 above, and revealed that there exists no study or framework that explores our research questions. This motivates our study, especially given the significance of our research questions, as explained in Section 1. To borrow Hoda’s words, the topics explored in this paper are “relatively nascent, with no or few existing theories” [25].

Basic Data Collection. We describe our basic data collection process from Reddit below.

We chose to use Reddit as our data source because it is i) widely used and is one of the top 20 most popular websites in the world [3], and ii) has subreddits, which are forums on Reddit for discussions on specific topics, with posts that are relevant to our research questions. Reddit has seen increasing use by researchers to explore questions related to the social sciences [3] and SE (e.g., [28]). Our dataset was collected from Reddit posts made in the three-year period from 2017 to 2019, using a publicly available archive of Reddit posts hosted by pushshift.io. We wanted to focus on data prior to 2020 to avoid any confounding variables introduced by the global pandemic. On the other hand, to select an appropriate start year, due to the lack of a clear way of studying the trend of the SE world, we instead observed trends in the use of programming languages as reported by Stack Overflow’s annual survey. Particularly, 2017 was when the use of Python increased significantly from 25.9% in 2016 [52] to 32% in 2017 [53] among all survey responses. As such, we chose 2017 as the start year. We restricted the data to a set of seven subreddits, denoted by “/r/”, where posts relevant to our study would be on-topic: /r/learnprogramming, /r/AskProgramming, /r/careerquestions, /r/SoftwareEngineering, /r/careerquestionsEU, /r/ExperiencedDevs, and /r/codingbootcamp. These subreddits were selected since they were the most relevant ones out of the 1000 subreddits with the most subscribers [1]. The resulting dataset contains 312,022 posts in total.

To find potentially relevant posts within this dataset, we built a simple keyword search engine. The search engine is written in 195 lines of Rust and performs a full-text keyword search over the titles and post bodies of every Reddit post in the dataset. The search is case-insensitive and respects word boundaries, but does not perform any more advanced query processing such as stemming. We compensated for this by explicitly including relevant pluralization and conjugations of our keywords. The source code of the search engine is available at https://github.com/tavianator/pheddit.

Using this search engine, we iteratively refined a set of search queries that gave a large quantity of relevant documents. Starting from an initial set of queries, we worked through the resulting posts to determine whether we deemed them relevant, referring to and revising our inclusion and exclusion criteria as necessary, and whether they contained keywords that might be useful for future search queries. We describe this process in more details in the following paragraphs.

A Reddit post is included for qualitative analysis (i.e., considered relevant) if it meets the inclusion and exclusion criteria. To generate these criteria, we first individually gathered a total set of 52 posts using an initial set of keywords that we thought were relevant to our research questions. These keywords included career, career change, self-taught, switch software engineering, back to school, and community college. The posts were also chosen to aid in the process of designing the inclusion and exclusion criteria, i.e., we had posts that were obviously relevant or irrelevant, and posts that were ambiguous. Then, as a group, we generated the inclusion and exclusion criteria by discussing the relevance of each post (Fig. ??).

In general, our motivation is to cast a reasonably wide net when gathering the various barriers and mitigation strategies; i.e., we do not want to have a narrow scope that artificially excludes the messiness and complexity of the phenomenon studied. As such, other trickier cases (e.g., someone who started their university education in CS and switched to an irrelevant area halfway through) will be accessed on a case-by-case basis based on their contribution towards our process of answering the research questions.

Based on the initial set of posts, we performed a keyword expansion exercise as a group to generate a final set of keywords that reflects relevant concepts to our research questions.

The final set of keywords contains 12 words, including degree, career, programming, school, learn, switch, change, college, university, advice, bootcamp, self-taught. These keywords are used to search the title and body content (i.e., excluding the comments and replies) of all posts in our data pool, resulting in 133,829 possibly relevant posts.

Basic Data Analysis. This step involves an iterative process that includes basic data analysis, basic memoing and theoretical sampling [25].

Basic data analysis will involve two steps, namely open coding and constant comparison. In this study, we will be using NVivo 12, a data analysis software commonly used in qualitative contexts (e.g., [39, 54]), to aid with various steps in our qualitative analyses, including open coding and memoing. During open coding, coders
would be an Alpha of 0.8 or larger [36].

(i.e., the first three authors) will treat each comment or original post as a single unit of coding, a common practice for Reddit-based qualitative coding (e.g., [55]). The exact methods of coding used could include descriptive coding (nouns summarizing the topic of a datum), in vivo coding (codes based on the actual language used in the data), process coding (using “-ing” words exclusively to represent actions suggested by a datum, including observable human actions, mental processes and conceptual ideas) and versus coding (codes with a “A vs B” format) [47]. In terms of types of codes, we expect to have codes on not just barriers and mitigation strategies, but also observed demographic factors of commenters in relevant Reddit posts. E.g., if someone says they are trying a career switch at 40, we will code the age as 40. Importantly, a post will only be coded if it is judged as relevant based on the inclusion and exclusion criteria. To ensure an acceptable level of reliability between the three coders, intercoder-reliability (ICR) will be measured at the initial stage of coding, as shown in Fig. 2.

We plan to use percentage agreement on which posts are considered relevant (i.e., relevant/irrelevant). For relevant posts that are coded, we plan to use Krippendorff’s Alpha [33] given its flexibility in regard to the number of coders, sample size etc. [24], its suitability for our study’s design [17] and its use in existing works that qualitatively analyzed mined Reddit data [34, 51]. Multiple iterations of independent coding, comparisons across coders and refinement of the coding process may be performed if necessary to achieve satisfactory ICR (see [34] for example), which, in our case, would be an Alpha of 0.8 or larger [36].

Next, constant comparison, which is “the process of constantly comparing derived codes within the same source and across sources to identify key patterns in the data” [25], will also be performed by the researchers during the analysis to iteratively produce concepts, sub-categories (if suitable) and categories in increasing abstraction levels. We will perform multiple rounds of individual- (for deeper reflections on the data) and group-based (for synthesizing everyone’s reflections) constant comparison in our study, which will be interleaved with other parts of the basic data analysis stage.

Basic memoing is a process where researchers document their thoughts, ideas and reflections on emerging concepts and their connections during qualitative analysis [25]. It will be used by the first three authors who will be participating in the qualitative analysis process. Memos will be referenced when codes are compared and grouped into categories and concepts.

Theoretical sampling is an ongoing sampling process that involves the intentional selection of data sources based on the data’s specific characteristics [25]. For this study, the pool of possibly relevant posts will be randomly divided among us (the first three authors) for individual sampling and coding after all initial disagreements have been discussed and resolved, as described above. Relevant Reddit posts will be theoretically sampled such that they contribute meaningfully towards the qualitative analysis. This means choosing relevant posts from the pool of possibly relevant posts that offer new information instead of those that provide primarily repeated information that have been analyzed from previous posts.

We will move on from the Basic Stage to the Advanced Stage upon the emergence of a few strong categories, as recommended by Hoda [25]. We describe the details of the Advanced Stage next.

4.1 Advanced Stage

4.1.2 Advanced Stage. The Advanced Stage involves targeted literature review, theoretical saturation, and theory development (Fig. 4).

**Targeted Literature Review.** This refers to “an in-depth review of literature targeting relevance to the emerging/emergent categories and hypotheses” [25]. Depending on the findings from the analysis of the Basic Stage, we will periodically perform targeted literature review in order to understand where our findings situate among relevant works.

**Theoretical Saturation.** This refers to when new data collected no longer generate or contribute significantly to the existing findings (e.g., concepts, categories) [25]. Practically, we will define our analysis as having reached theoretical saturation if during independent coding, each of the three first authors come to a point of analyzing three theoretically sampled Reddit posts that no longer contribute significantly to existing findings. Moreover, a following validation study will be used as a form of triangulation to facilitate an understanding of the findings’ trustworthiness [2].

**Theory Development.** STGT provides researchers with a choice of two theory development approaches, *Emergent Mode* or *Structured Mode* [25]. The Emergent mode is preferable when the basic stage reveals categories with emerging relationships, but without a clear theoretical structure. It involves targeted data collection and analysis (where focus is paid almost exclusively to the most significant categories), and theoretical structuring (where researchers could explore how the emerging theory fits with theory genres and templates) [25]. The Structured mode is recommended for use when the Basic Stage yields categories with a relatively clear theoretical structure. It involves structured data collection and analysis (where relationships between key categories are strengthened), and theoretical integration (where categories are full integrated into the overall structure of the framework). What we use will depend on our findings from the Basic Stage. Regardless, the final outcome will be a framework that serves to answer our research questions.

4.2 Validation Study

The validation study will involve the design and administration of a survey that aims to validate findings on barriers and mitigation strategies from the exploratory study (Fig. 5).

**Targeted Audience.** Participants will only be eligible to complete the survey if they are 18 and older, and have extensive experience (a post-secondary degree or diploma or 3+ years of work experience) in a field other than SE, and who...
We plan to ask participants to list possible mitigation strategies that will be used to improve the survey wording and structure. We will also present descriptive statistics about the demographics of the survey participants. No statistical tests will be used because this validation study does not involve any experimental or control conditions but only serves to better understand how widespread barriers and mitigation strategies from the exploratory study are.

Survey Design. The survey will ask participants about their demographics, educational background and occupational background. However, the core part of the survey will be about validating findings from the exploratory study, which include barriers and mitigation strategies. Regarding this, participants will be asked to:

- Rate how relevant each barrier from the exploratory study is in their experience using Likert scales (1 = Not relevant at all and 5 = Extremely relevant)
- List any other barriers they faced and mitigated strategies relevant to them
- List mitigation strategies they used for each barrier from the exploratory study
- Rate how effective each mitigation strategy from the exploratory study is using Likert scales (1 = Not effective at all and 5 = Extremely effective)

We plan to ask participants to list possible mitigation strategy on their own before asking them to rate mitigation strategies found from the exploratory study to understand their perspective better without biasing them with the strategies found in the exploratory study.

Pilot study. Following STGT’s recommendation for a preparation and piloting phase, we will conduct a pilot study by running three participants through the survey using a think-out-loud methodology (see [22, 35, 41] for similar survey pilot methodologies), and at least two researchers will be present for each participant when they fill in the survey. Feedback from these participants will be used to improve the survey wording and structure.

Data collection. We will make the improved survey available to participants and collect responses from around 50 participants, as estimated from our budget for this work. We plan to recruit participants by advertising on relevant subreddits (e.g., /r/learnprogramming, /r/careerquestionsEU) and through snowball sampling via personal connections. Each participant will receive a remuneration of CAD$ 10 for completing the survey.

5 THREATS TO VALIDITY
The first threat to validity is the subjectivity involved in the Reddit query building process. For instance, there might be important keywords that are missing from our Reddit search query, especially since it is not possible to objectively measure the completeness and quality of the keywords. To address this, we snowballed the group of keywords by starting with a set of keywords that we thought were relevant to our research questions and expanded it as we became more familiar with the dataset. Moreover, the survey in the validation study contributes towards a more comprehensive understanding by validating any findings and contributing new findings that might have been missing from the exploratory study. Another threat to our work’s external validity is in terms of its geographic generalizability. We expect most of the users whose comments are posts in our dataset to be from the United States (US), since the US accounted for 48.93% of all traffic to Reddit in the six months leading up to June 2021 [11]. We also expect participants for our validation study to be mostly located in the North America. As such, we do not claim to have findings that are generalizable across all continents, but to mostly be valid in the context of North America. Besides, findings from this work only serve as a first step exploration of the research questions, since they predominantly reflect barriers and mitigation strategies reported in the selected subreddits. While Reddit is a rich source of data, future works by larger research teams with more budget can better apply grounded theory’s theoretical sampling by preparing to branch into other unexpected data sources to explore other possible aspects of the research questions [25].

6 POTENTIAL IMPLICATIONS
We hope that findings from this work can not only lead to a better understanding of the i) barriers and ii) mitigation strategies faced by those with non-traditional educational or occupational background in a career related to SE, but also iii) serve as a basis off of which discussions and research of possible solutions could be held. Particularly relevant to EMSE is this work’s implications for future work on possible SE processes and tools that can be designed based on the mitigation strategies observed.
7 SUMMARY
This work aims to analyze barriers and mitigation strategies of software engineers with non-traditional educational and occupational backgrounds, an important aspect of SE that remains unexplored currently. The analysis is carried out in two steps. The first, an exploratory study, will involve the analysis of relevant Reddit data using a grounded-theory-based approach towards emerging themes and patterns around barriers and mitigation strategies. The second step is a validation study that will validate findings from the exploratory study via a survey that will be filled out by software engineers with non-traditional educational and occupational backgrounds.

REFERENCES
[1] [n.d.]. Subreddit Stats. https://subredditstats.com/list/most-subscribers
[2] Khuldoun M. Alhabsat and Carole-Lynne Le Naveuc. 2015. Data Saturation: The Mysterious Step in Grounded Theory Methodology. The Qualitative Report 23, 1 (Oct. 2015), 245–261.
[3] Ashley Amaya, Ruben Bach, Florian Keusch, and Franke Kreuter. 2021. New data sources in social science research: things to know before working with reddit data. Social sciences computer review 39, 5 (2021), 943–960.
[4] Sebastian Baltes, George Park, and Alexander Serebrenik. 2020. Is the New the 60? How Popular Media Portrays the Employability of Older Software Developers. IEEE Software 37, 6 (2020), 26–31. https://doi.org/10.1109/MS.2020.3001478
[5] Sebastian Baltes, George Park, and Alexander Serebrenik. 2020. Is the New the 60? How popular media portrays the employability of older software developers. IEEE Software 37, 6 (2020), 26–31.
[6] J. S Bunderson and K. M Sutcliffe. 2002. Comparing Alternative Conceptualizations of Functional Diversity in Management Teams: Process and Performance Effects. Academy of Management Journal 45, 5 (2002), 875–893.
[7] Statistics Canada. [n.d.]. Strong growth in operating revenue, software development and computer service industries, 2019. https://www150.statcan.gc.ca/n1/daily-quotidien/2010430-dq10430-eng.html
[8] Edna Dias Canedo, Fabiana Mendes, Anderson Cerqueira, Marcio Okimoto, Gustavo Pinto, and Rodrigo Bonifacio. 2021. Breaking one barrier at a time: how women developers cope in a men-dominated industry. In Brazilian Symposium on Software Engineering. 378–387.
[9] Mayra Ruiz Castro, Beatrice Van der Heijden, and Emma L. Henderson. 2020. Catalysts in career transitions: Academic researchers transitioning into sustainable careers in data science. Journal of Vocational Behavior 122 (Oct. 2020), 103479. https://doi.org/10.1016/j.jvb.2020.103479.
[10] J. Chen, Wei Yang Lim, B. Tan, and Hong Ling. 2018. The Role of Functional Diversity, Collective Team Identification, and Task Cohesion in Influencing Innovation Speed. Evidence From Software Development Teams. J. Glob. Inf. Manage. 25, 4 (2018), 163–192.
[11] J. Clement. [n.d.]. Distribution of Reddit.com traffic 2021, by country. https://www.statista.com/statistics/325144/reddit-global-active-user-distribution/
[12] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[13] Statistics Canada. [n.d.]. Distribution of Reddit.com traffic 2021, by country. https://www150.statcan.gc.ca/n1/daily-quotidien/2010430-dq10430-eng.html
[14] Kun Luan, Chu-Ding Ling, and Xiao-Yun Xie. 2016. The nonlinear effects of separation, variety, or disparity in organizations. IEEE, 346–356. 12th Working Conference on Mining Software Repositories.
[15] J. Clement. [n.d.]. Distribution of Reddit.com traffic 2021, by country. https://www.statista.com/statistics/325144/reddit-global-active-user-distribution/
[16] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[17] Katherine W Phillips, Elizabeth A Mannix, Margaret A Neale, and Deborah H. Gruenfeld. 2004. Diverse groups and information sharing: The effects of diversity in employees’ ethnic and educational backgrounds Facilitates Firm-Level Innovativeness: WORKFORCE COMPOSITION AND INNOVATION. The ANNALS of the American Academy of Political and Social Science 407, 1 (1972), 179–190. https://doi.org/10.1177/00027162730070115
[18] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[19] Krippeff. 2011. Computing Krippendorff’s alpha-reliability. https://repository.upenn.edu/asc_papers/43
[20] Ashley Amaya, Ruben Bach, Florian Keusch, and Franke Kreuter. 2021. New data sources in social science research: things to know before working with reddit data. Social sciences computer review 39, 5 (2021), 943–960.
[21] Klaus Krippendorff. 2011. Computing Krippendorff’s alpha-reliability. https://repository.upenn.edu/asc_papers/43
[22] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[23] William W. Ouchi. 2002. Comparing Alternative Conceptualizations of Functional Diversity in Management Teams: Process and Performance Effects. Academy of Management Journal 45, 5 (2002), 875–893.
[24] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[25] Katherine W Phillips, Elizabeth A Mannix, Margaret A Neale, and Deborah H. Gruenfeld. 2004. Diverse groups and information sharing: The effects of diversity in employees’ ethnic and educational backgrounds Facilitates Firm-Level Innovativeness: WORKFORCE COMPOSITION AND INNOVATION. The ANNALS of the American Academy of Political and Social Science 407, 1 (1972), 179–190. https://doi.org/10.1177/00027162730070115
[26] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[27] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[28] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[29] Katherine W Phillips, Elizabeth A Mannix, Margaret A Neale, and Deborah H. Gruenfeld. 2004. Diverse groups and information sharing: The effects of diversity in employees’ ethnic and educational backgrounds Facilitates Firm-Level Innovativeness: WORKFORCE COMPOSITION AND INNOVATION. The ANNALS of the American Academy of Political and Social Science 407, 1 (1972), 179–190. https://doi.org/10.1177/00027162730070115
[30] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[31] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[32] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[33] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[34] Eric Kearney and Diether Gebert. 2009. Managing Diversity and Enhancing Team Outcomes: The Promise of Transformational Leadership. Journal of applied psychology 94, 1 (2009), 77–89.
[35] Zainab Masood, Rashina Hoda, and Kelly Blincoe. 2020. How agile teams make a career change to the software industry?. In 2021 IEEE/ACM 12th Working Conference on Mining Software Repositories. IEEE, 346–356.
[44] Andreas W Richter, Giles Hirst, Daan van Knippenberg, and Markus Baer. 2012. Creative Self-Efficacy and Individual Creativity in Team Contexts: Cross-Level Interactions With Team Informational Resources. *Journal of Applied Psychology* 97, 6 (2012), 1282–1290. https://doi.org/10.1037/a0029359

[45] Muhammad Rizwan, Mula Nazar Khan, Babar Nadeem, and Q Abbas. 2016. The impact of workforce diversity towards employee performance: Evidence from banking sector of Pakistan. *American Journal of Marketing Research* 2, 2 (2016), 53–60.

[46] Gema Rodríguez-Pérez, Reza Nadri, and Meiyappan Nagappan. 2021. Perceived diversity in software engineering: a systematic literature review. *Empirical software engineering: an international journal* 26, 5 (2021), 102–102.

[47] Johnny Saldaña. 2014. Coding and analysis strategies. In *The Oxford handbook of qualitative research*.

[48] Sumit Sharma, Pawandeep Kaur, and Upinder Kaur. 2015. Communication understandability enhancement in GSD. In *2015 International Conference on Futuristic Trends on Computational Analysis and Knowledge Management (ABLAZE)*. IEEE, 28–33.

[49] Starlene M Simons and Kimberly N Rowland. 2011. Diversity and its impact on organizational performance: The influence of diversity constructions on expectations and outcomes. *Journal of technology management & innovation* 6, 3 (2011), 171–183. http://dx.doi.org/10.4067/S0718-27242011000300013

[50] Anit Somech. 2006. The Effects of Leadership Style and Team Process on Performance and Innovation in Functionally Heterogeneous Teams. *Journal of management* 32, 1 (2006), 132–157.

[51] L Sparrow, Madeleine Antonellos, Martin Gibbs, and Michael Arnold. 2020. From ‘Silly’ to ‘Scumbag’: Reddit Discussion of a Case of Groping in a Virtual Reality Game. In *Proceedings of the 2020 DiGRA International Conference: Play Everywhere, The Digital Games Research Association*.

[52] StackOverflow. [n.d.]. Stack Overflow Developer Survey Results 2016. https://insights.stackoverflow.com/survey/2016#technology

[53] Stackoverflow. [n.d.]. Stack Overflow Developer Survey Results 2017. https://insights.stackoverflow.com/survey/2017#technology

[54] Anastasia Tkalich, Nils Brede Moe, and Rasmus Ulfsnes. 2021. Making Internal Software Startups Work: How to Innovate Like a Venture Builder?. In *International Conference on Software Business*. Springer, 152–167.

[55] Marc Estevé Del Valle and Rik Smit. 2021. Moonwalking together: Tracing Red- ditors’ digital memory work on Michael Jackson. *Convergence: The International Journal of Research into New Media Technologies* 27, 6 (March 2021), 1811–1832. https://doi.org/10.1177/13548565211003878

[56] Graham Wilson. 2017. Building a new mythology: The coding boot-camp phenomenon. *ACM Inroads* 8, 4 (2017), 66–71.