Understanding the Computer Science Student Experience Through the Lens of System Ecology

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***Abstract*—This research paper examines the experience of Computer Science students during their period of study in higher education institutions, based on the surrounding ecological system, using Bronfenbrenner's theory of human development as a guiding principle. The objective of the study was to uncover the significant elements of the student experience when the student environment is regarded and categorised as an ecology. We focused on eight distinct student development lifestyle categories that could have an influence on their experience: the student's own awareness of their experience as a concept, their pre-university phase, their transition to the university phase, their university peers and colleagues, their social background outside the university, their hosting department, their extracurricular activities, and their post-university phase, if any. The study involved the participation of 206 computer science students, yielding a suitable population for analysis. The survey contained 42 questions to address the aspects of the eight categories discussed above, with a range of questions for each category. The questions employed a mixed-methods methodology using open-ended and closed questions. For the open-ended questions, we followed a grounded theory coding analysis technique to identify common codes in the student's responses. Word frequencies and figures were also analyzed to gain insights into students' perspectives using sentiment analysis techniques. For the quantitative questions, response rates and summary statistics were calculated. The findings shed light on the pivotal factors that influence the student experience of Computer Science students, offering valuable insights to students, educators, administrators, and decision-makers. The study highlights the significance of environmental factors in shaping student experience in the CS discipline and proposes potential directions for future research in this field. The implications of these findings for the creation of more supportive and effective learning environments for Computer Science students are also discussed.**

I. Introduction

The experience of computer science students is shaped by many factors that span from personal attributes to broader socio-cultural contexts. This study aims to understand the network of influences on student development by employing a qualitative approach to explore student ecology in the field of computer science education. Drawing on the theoretical framework of Bronfenbrenner's Ecological Systems Theory, we seek to understand how various systems interact and influence the student experience, from pre-university preparation to life after graduation. Bronfenbrenner's Ecological System Theory provides an understanding of human development and posits that an individual's development is shaped by the interaction between the individual and their environment, which is conceptualized as a series of nested systems ranging from the immediate microsystem to the broader macrosystem. This theory provides a comprehensive lens through which we can examine the student experience, considering the immediate educational environment and the wider social, cultural, and institutional contexts.

The learning system in a computer science environment provides the student with critical tools in shaping the student's identity; understanding the student's identity will help us understand student behaviour and engagement with the learning environment[11]. Student identity is influenced by the student's immediate environment, which ultimately leads to how the student interacts with the learning system [16]. Peters et al. [15] associate student sense with identity to the chosen discipline with the student experience and the student's interaction with their surroundings. They [15] also argue that students' sense of identity influences how they interact with their peers and educators and, therefore, the student experience. In contrast, a low or negative sense of identity can lead to lower interactions and motivation and could lead to dropout. [17] studied engineering students' identity development, highlighting factors that influence retention, especially for underrepresented students. Other work [13] identified three dimensions of student identity development: accountable domain knowledge (transition to discipline-specific assessments), professional identity (views on discipline-related topics), and socialization (engagement with peers and professional groups).

There are five ecological levels of the student environment; microsystem, mesosystem, exosystem, macrosystem, and chronosystem level. A student's microsystems could be the classroom, student organizations they belong to, their

accommodation, or study halls. The next level of systems with which the student interacts is the mesosystem, a group of microsystems that share similar characteristics with which the students interact. Each group of microsystems comprises a mesosystem. Student life contains many microsystems, some directly related to the student experience, while others are not. For example, working students interact with work and university microsystems, where each set of microsystems (i.e., mesosystem) affects the student experience differently. In this instance, the individual student interacts with work microsystems, categorized as work mesosystems. This set of microsystems shares similar characteristics, but each individual microsystem influences the student experience differently. The interconnectivity of microsystems shapes the student experience. The third ecological level is the exosystem, the social setting in which the student does not have an active role, but it still has a direct or indirect effect on the student's life. For example, local government roles for international students are where international students are not part of the social environment of the local government but are still affected by the requirements of the local government. The fourth ecological level is the macrosystem, where the group members share the same values or beliefs, such as culture or religion. The fifth ecological level is the chronosystem, which includes interconnected environments that evolve. The trajectory of the individual student is considered to be engraved, embedded by the conditions and events that occurred during the historical period in which the student lived [22]. The chronosystem is the learning development of the student living experience, such as specific historical events (e.g., 9/11, COVID), the generations (e.g., millennials), social movements (e.g., civil rights), and popular social/cultural trends such as the Hip Hop culture. Within the student experience of the environment, students go through seven developmental phases [7]: the pre-university phase, the transition phase, university peer and friendship groups, social background outside the university, the degree program, extracurricular activities, and preparation for life after graduation. The journey of each undergraduate student develops during these seven development phases. These microsystem development groups are essential to the experience of all students [7]. Our primary goal in conducting this study is to determine; What does the student ecosystem look like? and What are its drivers and characteristics? To answer the mentioned research questions, the following research objectives are met: To understand the environment of the student experience. and To identify the microsystems that shape the student's experience.

The data collected were analyzed using mixed-method, allowing us to draw on the strengths of both qualitative and quantitative approaches. This comprehensive analysis aims to provide an understanding of the computer science student experience, shedding light on the complex interplay of factors that shape their academic journey and beyond. The findings of this study provide valuable insight that shed light on the computer science student experience and contribute to the enhancement of the computer science student experience.

Related works are discussed in sectionII. We discussed the Methodology design, data collection and the analysis method in section III. In the IV section, we presented the result of the data analysis of each phase. Then we discuss the results in section V, and we then discuss the limitation of our work in section VI. Finally, we present the conclusion and the future work VII.

II. Literature Review

The student experience captures a set of interactions between a student and the components of the learning environment [7]. Some research limits the student experience to the student academic learning experiences[6], [4], [19], while others go far by assuming the "totality of a student's interaction with the institution" [7], [5], [10], [3], in some context the student experience was linked to student engagement, suggests that the student experience is correlated with their engagement; this suggests that student experience goes beyond their academic experience to any academic or non-academic activity within the university [3], [4], [21]. Loh et al. [8] conducted interviews with students and collected repeated terminologies, then formed a categorical classification based on the collected terminologies. They followed two criteria to form these categories; the first criterion depended on the effect of the class with terms such as 'motivation' or 'reasons' or 'incentives'. The second criterion was the reasoning that the students provided. For example, students choose a specific major to get a better job. They selected participants from three fields to better capture the impact of different motivators and blockers among university students as they move in and out of multiple ecological systems. In [8] they find that student motivators are strategies that students use to help them in their studies. Motivators move across multiple ecological systems and directly and indirectly impact the student experience. They also found that blockers inhibit students' persistence in their studies. Blockers also move across multiple ecological systems and directly and indirectly impact the student experience. One of the most common methods used by researchers to understand the student experience was the analysis of student feedback and responses to quality measure surveys. Pradhan and Thakre [18] applied sentiment analysis to analyze student opinions in their responses to survey questions. This research focused on analyzing unstructured feedback submitted by students that contained their opinions about the courses they took. The analysis technique was the motivation in the field, i.e., taking a customer review and social media analysis technique to further understand the student experience through their opinion. In the study conducted by Matus et al. [12], an exploration of the literature was undertaken, examining the concept of the student experience through the lens of customer experience. This perspective places students as consumers of the products and services universities offer.

The computer science student identity is a construct of three components: student recognition, interest, and performance [11]. The three main sub-constructs contributing to developing a student's computing identity are belief in one's performance/competence, the level of interest, and recognition

in computing [11]. Peters et al. [15] claimed that the student identity affects their experience and can affect the student's academic performance. [15], they suggest that student sense of identity is shaped by their interaction with their peers and educators. [17] highlighted the significance of the student identity theory in addressing recruitment and retention concerns. Student's social interactions and memberships to professional discipline organisations help shape the student's sense of identity [13].

Variables of student experiences can differ from one university to another depending on the types of degrees and programs offered by the university, financial support, accommodation, rights and representations, cultural inheritance, diversity, and student activities [19]. Different entities within the academic institution will be interested in different segments of the student experience [19]. Students learn differently in [1], where many preferred to learn from practical sessions, while others stated that they learned from lectures. Higher education institutions welcome the implicit perception of students about many aspects of their student experience and environment; therefore, these institutions are motivated to improve their student experience[19]. The student experience within a course is the student's interaction and perception of the learning content [3]. The student feedback survey is a means of capturing aspects of the student experience. Many aspects can affect the student experience, such as university location, university media presentation, course delivery system, and the university's online presence. The student experience is not limited to what happens inside the learning environment. In an online environment, the student's course experience can be measured by analyzing four aspects: course platform usability, resource availability, course content up to date, and course workload [4]. This study [14] suggests a non-formal learning framework for self-regulation and comes to the conclusion that universities may need to switch learning management systems (LMSs) if a given LMS trivializes students' personal (non-formal) experiences that could encourage a love of using LMS. To improve the learning experience, higher education institutions invest in learning system management software, where LMS plays a role in the phenomenon of the student experience. [14] suggests using LMS for non-formal education with the aim of improving the student experience. We expect course coordinators to strive to improve the quality of the course to meet the satisfaction of the student experience. In [4] student experience responses to the qualitative survey in this study were limited to the course content, raising the need to include other data that could help uncover other aspects of student experience. Other data, such as student interaction and metadata, can be very helpful in assessing the effects of the course improvement process.

To answer the question 'What affects the student experience and to what degree?', not all students are subjected to a stereotypical pattern of progression and enrolment. Some students are fully engaged with student life, while others feel anxiety and disaffection and are more isolated. Engaged students are eager to interact more actively with their environment, leading to greater learning and development. Alienated student interactions are limited, which negatively reflects on the student experience. The factors of student experience can, of course, vary from one category to another. For example, students taking a data mining course from a data science background will have a different perception of the course than students from a health informatics background. Clustering students based on characteristics that affect their perception of the course will help identify the measurement of student experience [4]. Some microsystems are designed to reach out to students. The students' responses are different; engaged students are more responsive and interactive with the microsystem, which makes the microsystems more peripheral in shaping the student experience. However, alienated students choose not to interact with the system, creating an obstacle for the microsystem in creating a better student experience [7]. Jones [7] concludes that the student's experience is formed by the student's interaction pattern with the microsystems. J. Loh et al.[8] used grounded theory to analyze student responses from their interviews sentence by sentence to transform them into qualitative results. A student's overall positive environment correlates with higher academic achievement [4]. The ambiguity of the definition of student experience makes it difficult to provide a unified framework to measure student experience. In a study in 2021 on the experience of dental students [1], the students had different learning experiences. The opportunities to experience physical experiences gave the student the most confidence. The opportunities presented by the undergraduate curriculum allow students to learn and develop through the consolidation of theory, responses to challenges, and the development of confidence. Recent studies [14] suggest that lecturers use LMS as a repository where the learning process involves knowledge experiences to allow students to retrieve the readings/resources uploaded. Others counter that lecturers only use a small section of an LMS for effective informal learning in the digital age, utilizing discussion boards to encourage students' social interactions. The overall positive environment of students correlates with higher academic achievement [4].

III. Methodology

A. Methodology Design

This study employs a qualitative research design to explore the experiences of computer science students. The design is rooted in Bronfenbrenner's Ecological System Theory[22], which posits that human development is influenced by the different systems of the environment in which the individual interacts. The research design is divided into eight sections, each focusing on a different aspect of the student's ecological system and development life cycle.

We took measures of the environment to understand the development of the computer science student experience through a wide perspective. These measures included the development of the computer science student identity through the phases of student development and its relevance to the student experience. Our approach is to observe the student experience through the student's perspective without using approaches

that might cause bias in the students' responses.

To investigate the students' interaction with the university's ecological environment and their awareness of the surrounding systems, we conducted a computer science student experience survey. A total of 42 questions in the survey were designed to investigate student development through different stages of student life. The Questions design are in III-A. The development process includes obtaining ethical approval from the University's Ethics Committee. The study involved 206 participants, all of whom were computer science students. The participants were selected via classroom advertising. We targeted students enrolled in their second and third years of the degree, ensuring diverse experiences and backgrounds.

Questionnaires Design:

In the pilot study, we designed interview questions to understand the students' interaction with the university's ecological environment and their awareness of the surrounding systems. When designing the interview question, we considered these non-environmental characteristics: How do students' non-environmental characteristics (like previous education, family resources, and social background) help orient student development? The interview contained 11 questions, tackling student's development and interaction with the educational environment. The study was conducted in 2022, and we interviewed 22 students. We followed an inter-rater reliability validation approach to mitigate potential selection basis. Two independent researchers who were not involved in the coding and analysis process received several transcripts of the responses to the interview questions. The pilot study's findings helped us design a more comprehensive Computer Science Student Experience Survey. The survey questions are designed to explore the nature of the computer science student experience. The questions are divided into several sections, each focusing on student development [7] and ecology [22].

The survey questions are designed to provide a comprehensive understanding of the student experience within a university environment, from the pre-university phase to life after graduation. The questions aim to explore the influence of various Microsystems on students' experiences, interactions with peers and colleagues, social background outside the university, experiences within their department, participation in extracurricular activities, and preparations for life after graduation. The first section, "Student Experience Concept" introduces the concept of Microsystems, which are elements within the university environment that students interact with. These can include people, materials, systems, and places within the university. The questions in this section aim to gauge students' understanding of this concept and how they perceive these Microsystems influencing their university experience. The "Pre-University Phase" section focuses on the period before students enrolled in their degree program. The questions aim to understand what influenced their decision to choose their program of study, their perspectives on student life before joining the university, and the factors that affected their decision. The "Transition Phase" section explores the period from when students decided to apply to the university until they had completed at least two semesters. This phase is when students' expectations meet reality, and they adjust to life at the university. The questions in this section aim to understand how their previous learning experiences helped them during this phase, the challenges they faced, and the benefits they believe they gained. The "University Peers and Colleagues" section focuses on students' interactions with their university peers and any professional communities they engage with. The questions aim to understand how these interactions influenced their student experience. The "Social Background Outside the University" section explores the influence of the university environment on students' existing social background and socio-economic status. The questions aim to understand how the university environment has influenced their social background or culture outside the university and how their student experience has influenced their socioeconomic status. The "Department" section focuses on the influence of the school or department that hosts students' degrees on their student experience. The questions aim to understand how the school or department shaped their view of the university environment and how the Microsystems within their school or department influenced their academic performance. The "Extracurricular Activities" section explores students' participation in activities outside of their scheduled curricular activities. The questions aim to understand how these activities influenced their student experience and whether these activities were useful in completing their curricular tasks. Finally, the "Life After Graduation" section focuses on students' preparations for life after graduation. The questions aim to understand how their student experience influenced their career choice and post-graduation plans, the student experience Microsystems that influenced their career decisions, and how they have prepared themselves for life after graduation.

B. Data Collection

Data was collected through a comprehensive survey. The survey was divided into eight sections: the student experience concept, the pre-university phase, the transition phase, university peers and colleagues, the social background outside the university, the department, extracurricular activities, and life after graduation. Each section was designed to probe a different aspect of the student's ecological system.

C. Data Analysis

The data were analyzed using mixed methods. The qualitative data from the open-ended questions were analyzed using thematic analysis, which involved coding the data and identifying themes from the students' responses. The quantitative data from the closed-ended questions were analyzed using descriptive statistics to summarise the students' experiences. The survey has 206 responses from computing science major students in their third or second year of the degree. We published the survey in 3 different universities. All the students recruited from selected courses based on the degree design, second and third-year core courses.

D. Validation of the Instrument

To validate the instrument, we followed an inter-rater reliability approach. Independent researchers, not involved in

the initial coding, reviewed several transcripts and produced coding results that matched the final coding, confirming the scheme's validity.

We used the 'kappaSize' package in R to determine the sample size for the second reviewer's analysis [20]. The sample size calculation, using the `Power3Cats` function, included the following parameters:

- Target kappa statistic (`kappa`): 0.61 (moderate agreement)
- Proportions under the null hypothesis (`p0`): (0.33, 0.33, 0.30)
- Proportions under the alternative hypothesis (`pA`): (0.40, 0.30, 0.30)
- Significance level (`alpha`): 0.05
- Desired power (`power`): 0.80

The level of agreement between the three reviewers is 0.87, indicating a strong agreement.

IV. Results: Thematic Analysis

This study explored a complex ecology: the experiences of computer science students that extend beyond the university, guided by Bronfenbrenner's ecological systems theory. Through thematic analysis, we have identified several key themes that illustrate the interaction between the students, the student experience, and their environment. In the following, we discuss the major themes and findings.

A. Academic Integration and Challenges

Pre-university Expectations: Students reported that their expectations of university life were influenced by their previous educational experiences. Responses indicated a range of expectations, with some students feeling well-prepared and others overwhelmed by the academic demands. For instance "My previous learning experience made me more independent and made me realise what was expected of me at University, which included things like how much time and effort I needed to put into subjects." (Participant 44)

Microsystems: The influence of immediate academic environments, environments that the students interacted with most often, such as classrooms and labs was significant. Students highlighted interactions with peers and faculty within these microsystems as crucial to their academic success. See table I for the most frequent microsystem.

Curriculum Difficulty: Students identified that their experience was influenced by their perception of the complexity and workload of the computer science curriculum. Students reported varying levels of difficulty with the computer science curriculum, which impacted their academic performance and engagement. For instance, 41% of respondents noted that the high workload and complex content of programming courses were major hurdles during their initial semesters. "The overwhelming amount of work and assignments in my program of choice compared to easier courses that my friends chose." (Participant 19) "Understanding the concepts " (participant 28) This reflects the microsystem's influence, where academic structures and content directly interact with student development, aligning with Bronfenbrenner's emphasis on the immediate environment's role in developmental processes.

Faculty Support: The benefits of faculty support were frequently mentioned as a crucial factor in students' academic success and adaptation to university life. The surveyed students felt that accessible and supportive faculty were instrumental in their successful navigation of academic challenges. For instance: "the learning and teaching experience at the university has been challenging yet rewarding, as the curriculum is often rigorous and technical, but the faculty and resources available provide opportunities for growth, skill development, and exploration of the vast field of computer science. " (Participant 12) "The computer science microsystems provided a supportive network of peers and faculty members who helped clarify concepts and provided additional guidance, which positively impacted my academic performance." (Participant 77) This finding underscores the importance of interactive microsystems within the educational setting, where positive faculty-student interactions foster not only academic growth but also a better experience.

Learning Environments: The university learning environments were highlighted as significant factors affecting students' ability to learn effectively. Participants mentioned practical sessions, workshops and the learning management system (LMS) as helpful learning environment elements. Students expressed that well-prepared interactive practical session and interactive LMS components enhanced their learning experiences. Participant Quote: "It is very independent and hands-on. We are giving a high-level knowledge then we get to put that into practice through assignments and practicals." (Participant 5), "Practicals and workshops provide hands-on learning that helps students apply theoretical concepts in the real world. " (participant 2). These microsystems directly affect learning dynamics, illustrating Bronfenbrenner's concept of the environment as an active participant in the developmental process and experience.

B. Social Adaptation and Peer Networks:

Social Challenges During Transition: Transitioning to university life posed social challenges for many students, particularly in forming new friendships and integrating into existing social groups. Representative Quote: "Finding a group where I felt I belonged was harder than I expected. It took almost a semester to start forming meaningful friendships." (Participant 14)

Influence of Extracurricular Activities: Extracurricular activities played a dual role in students' lives, providing both a break from academic pressures and a means to develop social networks. Representative Quote: "Joining the coding club helped me meet peers with similar interests, significantly easing my social integration." (Participant 102)

Peer Support Systems: Being included in study groups, social clubs and professional communities, is perceived as crucial for fostering both academic success and a sense of social belonging among students. The survey participants reported that being part of study groups or student clubs greatly enhanced their sense of community and academic confidence. Students also noted similar perceptions of benefit from interacting with online discipline communities. Participant Quotes: "My computer science colleagues have had a significant academic impact on me by fostering a collaborative learning envi-

ronment. Through group discussions, code reviews, and study sessions, we have been able to exchange knowledge, clarify concepts, and deepen our understanding of complex topics." (Participant 78) "Stack Overflow and github[1] are extremely helpful in guidance for coding and assignments" (participant 6) These interactions within peer groups are perceived to impact student's development. The supportive nature of these groups mirrors the nurturing environment that is essential for student growth [19].

Extracurricular Activities Extracurricular activities are perceived to help students develop interpersonal skills and expand their social networks beyond the academic setting. The majority of the students surveyed felt that their involvement in extracurricular activities such as sports teams, cultural societies, and volunteer organizations played a vital role in enhancing their university experience. Participant Quote: "When I engage in extracurricular activities, it serve [sic] as a form of stress relief and help maintain a healthy balance between academic and personal life. When i [sic] participate in hobbies, sports, or clubs can provide a much-needed break from academic demands, promote mental well-being, and enhance overall satisfaction with the student experience." (Participant 41) "Engaging in extracurricular activities helps to reduce stress, improve my mood, and provide a sense of purpose and fulfilment to me. It also helps to provide a sense of community, making me feel more connected and supported." (Participant 46) These activities represent key components of the student's mesosystem, linking different contexts of a student's life and enhancing their social capital.

C. Students Identity and Career Aspirations (plans post university)

Professional Association with Computer Science: Students come to see themselves as part of the computer science community, emphasizing the influence of curriculum, faculty interactions, and peer engagement. Students surveyed felt that project-based learning and collaborative assignments were crucial in fostering a sense of belonging to the computer science field. Participant Quote: "Yes, I believe I gained enough knowledge to consider myself a professional software developer." (Participant 43), "Yes I do, I have developed skills that is required for software engineer." (participant 108) The student's sense of professional identity and belonging is supported by the interaction of various elements within the university's microsystem influenced by the environment's roles and relationships.

Impact on Career Choices: The student's plans after graduation are influenced by a number of aspects of their experience; microsystems, especially practical workshops and faculty interactions, play a pivotal role in shaping students' career aspirations. Students indicated that internship opportunities, career counselling, and industry guest lectures at the university influenced their career decisions and preparedness. Representative Quote: "... the uni has played a key role by presenting me multiple potential career paths and the courses have helped me chose which ones would be the most suitable for me." (Participant 44) , "I have actively pursued internships and co-op opportunities to gain practical experience and develop a better understanding of the industry I want to enter after graduation." (Participant 78)

These experiences represent a crucial linkage within the mesosystem, where the educational environment connects with professional settings, enhancing students' career perspectives and plans.

D. Cultural and Socio-Economic Influences

Cultural Adaptation and Capital Culture: Students encounter and adapt to new cultural norms within the university, which can lead to changes in their cultural identity. Students reported a cultural adaptation, especially international students, noting the university's inclusive culture as key to their experience. Participant Quote: "The university environment has exposed me to diverse cultures and perspectives, fostering inclusivity and promoting social mobility by breaking down barriers and facilitating interaction between individuals from different socio-economic backgrounds." (Participant 86) "I believe to have become more socially capable and can mentally and emotionally withstand social situations that I could not before." (Participant 19) This theme reflects the university's role as a transformative microsystem where diverse cultural exchanges influence students' identities, in line with the university experience of environmental impact on personal development.

Socio-economic status: Student's experience is perceived to impact their socioeconomic mobility and opens up new job prospects. Students reported improved job prospects and economic status as a direct result of their university education. Participant Quote: "computer science degree as a student has the potential to improve socio-economic status by providing access to well-paying jobs, and opportunities" (Participant 12) "Interacting with peers studying in the same field and experienced professionals enhances my student experience by providing valuable insights. These interactions enable me to develop a focused and efficient approach towards achieving my goals in the field. By engaging with like-minded individuals and learning from their experiences, I am better equipped to navigate the path I wish to pursue in my future career." (Participant 41)

E. Transition Experiences:

Expectations meets reality: Students enter university with predefined expectations that often clash with reality, affecting their adjustment process. Students indicated a disparity between their expectations of university workload and social life and their actual experiences. Participant Quote: "One of the main challenges was adapting to the higher academic expectations and workload" (Participant 77) " For my first it was a struggle because of lecture, workshops and tutorials I was bit lost because place I have to be on time is so different then high school so it was learn year for me to grow [sic]" (participant 16) This theme highlights the microsystem's influence on student adaptation during the transition phase where personal development is shaped by the interaction

[1]Stack Overflow and github are online platforms that host large multi-participant discussions relevant to Computer Scientists and programmers.

between expectations and real-world experiences.

Adjustment Challenges: The initial semesters at university often come with adjustment challenges, including academic pressure and homesickness. The first-year students reported difficulties in adapting to the university's academic demands and social environment. Participant Quote: "Being independent was challenging which caused me to learn to learn on my own using online resources and textbooks. This encouraged me to be more independent and learn things outside of University." (Participant 5) "The overwhelming amount of work and assignments in my program of choice compared to easier courses that my friends chose." (Participant 20) These challenges are critical elements of the microsystem that impact students' ability to adapt and succeed, underscoring the need for supportive educational practices.

Transition growth: Students reported several beneficial gains during their transition phase: social skills, academic skills, and technical skills. "I learnt independence (learnt how to fill in gaps in knowledge), time management (knowing how to manage and complete many different assignments at the same time) and social skills (knowing what to ask lectures and tutors). " (Participant 6)

F. Well-being and Personal Development:

CS student's well-being : The academic pressures and social dynamics at university can impact students' student's well-being. Students reported experiencing stress or anxiety related to their studies at least once during their academic careers. Participant Quote: "we support each other, especially in group project and other aspects" (Participant 24) This theme highlights the university's critical role as a microsystem that can either exacerbate or enhance the student personal development.

Personal Growth: University life is perceived to offer numerous opportunities for personal development, including developing resilience, time management, and independence. Students felt they had grown especially in personal independence and time management skills since starting university. Participant Quote: "Personally, my computer science colleagues have become a source of inspiration and motivation. Witnessing their dedication, passion, and achievements in the field has encouraged me to push myself further and strive for excellence in my studies." (Participant 80) These aspects of personal growth are fostered by the interactions within the university's microsystems, such as academic demands and extracurricular activities, illustrating the dynamic interplay of factors that contribute to student development.

G. Results: Quantitative Analysis

In line with the thematic analysis findings, students find the tools and services available within the study environment influence their perspective of the university environment4. (22.11%) of the participants felt that their social skills were enhanced, suggesting effective community-building initiatives within the department. (63.3%) of the participants felt that the department was exposed to different cultures, illustrating the university's role in promoting cultural diversity and inclusion. 119 students (63.3%)of the participants, felt that their exposure to different cultures was the most prominent impact, highlighting the university's role in promoting cultural diversity5. (20.74%) reported a change in their cultural group affiliation, pointing to substantial shifts in social identity during their university years. The factors influencing students' choice of academic program varied widely, reflecting a range of personal and external influences 2, and the most significant factor in 3. The largest group, comprising 79 students (35.59%), stated that they chose their program without external influence, emphasizing a strong sense of agency in their academic decisions. This influences the student's ability to adapt and form a CS student identity. The media also played a significant role, with 47 students acknowledging its influence on their choice of study.

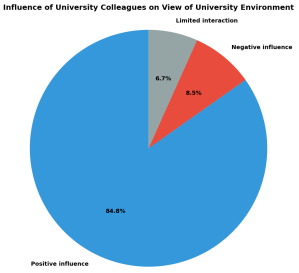

Fig. 1: Students Peers Influence

TABLE I: Microsystem Count

Microsystem	Count
Lecture	108
Workshop	104
Practical sessions	99
Other students	92
Library	78
Zoom	74
MyUni	41
Central Hub	34
Math Help Center	29
Ask Adelaide	25

Peer interactions and technological tools like LMS significantly shaped the students' educational experiences. Figure 7 indicates students' perception of the university LMS.

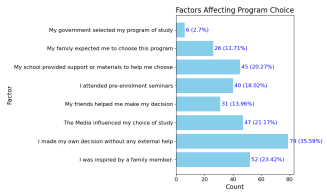

Fig. 2: Factors Affecting Program Choice

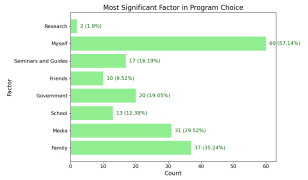

Fig. 3: The most significant factors in choosing the program

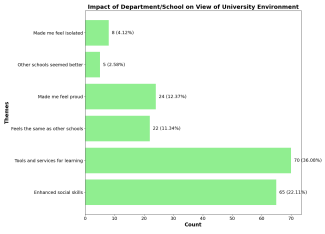

Fig. 4: Impact of Department/School on Students View of the University

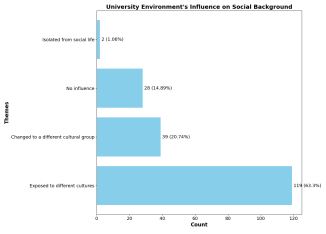

Fig. 5: University Environment's Influence on Students Social Background

H. Sentiment Analysis

We performed sentiment analysis to measure the student's responses to the open-ended question. The TextBlob python library was used for this task [9]. The overall sentiment was

positive. The highest positive sentiment is associated with the question about the learning and teaching experience at the university, with an average sentiment of 0.2372. The sentiment polarity score ranges from -1 to 1. -1: very negative to 1 very positive [2].

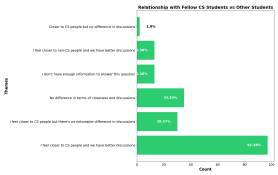

Fig. 6: Relationship with Fellow CS Students

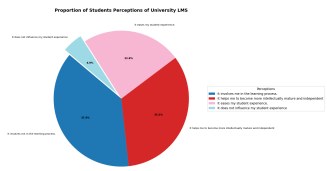

Fig. 7: Students Perceptions of University LMS

V. Discussion

The results of the thematic analysis highlight the significant role of different elements within the student experience environment in shaping the computer science student experience. These insights demonstrate the utility of using Bronfenbrenner's ecological systems theory and [7] in an educational environment to understand the CS student experience. These themes emphasize the need for universities to consider these systems when designing support structures for students, and for the students themselves to outlook these elements that can enhance their experience.

This work aims to set the grounds for a new perspective of the student experience that can benefit the research community by opening many paths of future work possibilities. The student experience has never been considered an ecological environment before, but this view will lead to a better understanding of the student experience and generate many possibilities to enhance the student experience. The survey results identified the students' developmental phases and microsystems that we drew from the Brenfenberner theory of human development. The findings can help the researchers and students identify enhancement elements on their own.

Our research findings highlight the critical role of both academic and non-academic interactions in forming the student experience. This dual focus is supported by previous studies that emphasize the importance of the totality of a student's interaction with the institution [7], [5], [10], [3]. Moreover, consistent with Loh et al. [8], our findings suggest that both motivators and blockers within these interactions influence student persistence and engagement, which can traverse multiple ecological systems, affecting their academic trajectory and professional identity.

The influence of learning management systems (LMS) on student experiences, as found in the most frequent microsystem that the students interact with, resonates with the findings of [14], where the adaptation of LMS to enhance non-formal learning experiences proved crucial. This perspective is critical as it cements the LMS as a main influencer within the student experience, thereby enhancing the overall student experience. Student perceptions and experience should be considered carefully when enhancing or changing LMS elements. Similar to [18] findings, our study utilized the student's qualitative responses to their courses, department and the university environment. This approach allows us to understand students' perceptions and highlight key insights into this environment that are affecting their perception of the university.

Our findings highlight the roles of student identity, well-being, and sense of belonging in shaping their experiences. Previous studies, such as [16], [17], have also noted the student identity influence on engagement and retention. We included the student's recognition and interest in shaping the computer science students' experience. The findings suggest that students and universities should consider elements within the student's environment factors that shape the CS student experience. Enhancing any of these elements can improve the overall student experience. Additionally, recognizing the impact of these elements on learning outcomes can guide the development of targeted interventions to support students' academic and personal development.

VI. Limitations and Challenges

The research team aimed to recruit student volunteers from specific core courses offered at three universities to complete the surveys. Student bias, inconsistency, and inaccuracy are possible challenges. The study is limited to computer science majors and did not compare or contrast the CS student's experience with that of students of different disciplines. This might result in a limited understanding of the challenges students of other disciplines face compared to CS students. Due to the complexity of the student's experience with environmental elements, future research should consider longitudinal designs and mixed-methods approaches to address these limitations and provide a more dynamic understanding of how student experiences evolve over time.

VII. Conclusion

This work aimed to understand the computer science student experience based on the student environment and identify the ecosystem influence on their student's experience. The analysis revealed a diversity of students' experience perspectives in the themes in section IV. We discovered significant themes, including 'Academic Challenges and Integration,' 'Social Integration and Peer Networks', 'Professional Identity and Career Aspirations,' and the overarching influence of cultural and socio-economic factors. These themes highlighted the complex interplay between students and their educational environment, demonstrating how both academic and non-academic elements contribute to shaping their experiences and outcomes. The findings can help students understand and increase their awareness of the surrounding environment and inform the educational institute to make informative decisions when designing or enhancing new programs. The university and department microsystems have a greater influence on the students beyond the university level. These microsystems influenced students' carers and future. Universities can help students maximize their potential by encouraging them to interact more with these microsystems. This study contributes to our understanding of how to foster an environment conducive to both academic achievement and personal development. This is particularly relevant in computer science education,

where rapid technological advancements and industry demands necessitate adaptable and well-rounded educational strategies. Students can gain a better understanding of their environment and how to enhance their experience. Educational institutions can use these insights to implement more effective engagement strategies to enhance the student experience. By considering the wide range of factors that influence student experience, researchers and policymakers can better support the development of students who are not only academically proficient but also well-prepared to meet the challenges of the industry. As educational landscapes continue to evolve, ongoing research and adaptation will be key to ensuring that student experiences are enriching, supportive, and effective.

REFERENCES

[1] Hannah L. Crowe and Stephen M. Woolley. Dental students' experience of conscious sedation: A qualitative review of student reflections. European Journal of Dental Education, 26:197–205, 2022.

[2] Tom De Smedt and Walter Daelemans. Pattern for python. The Journal of Machine Learning Research, 13(1):2063–2067, 2012.

[3] Jennifer Gilbert, Susan Morton, and Jennifer Rowley. E-Learning: The student experience. British Journal of Educational Technology, 38(4):560–573, 2007.

[4] Heather B., Clara H. Lee, Noelle E. Wyman Roth, Kun Li, Mine Çetinkaya-Rundel, and Dorian A. Canelas. Understanding the massive open online course (MOOC) student experience: An examination of attitudes, motivations, and barriers. Computers and Education, 110:35–50, 2017.

[5] Khe Foon Hew, Xiang Hu, Chen Qiao, and Ying Tang. What predicts student satisfaction with MOOCs: A gradient boosting trees supervised machine learning and sentiment analysis approach. Computers and Education, 145(July 2019):103724, 2020.

[6] Alan Jaap, Avril Dewar, Colin Duncan, Karen Fairhurst, David Hope, and David Kluth. Effect of remote online exam delivery on student experience and performance in applied knowledge tests. BMC Medical Education, 21(1):1–7, 2021.

[7] Rob Jones. The student experience of undergraduate students: towards a conceptual framework. Journal of Further and Higher Education, 42(8):1040–1054, 2018.

[8] Jennifer M.I. Loh, Ken Robinson, and Katrina Muller-Townsend. Exploring the motivators and blockers in second year undergraduate students: an ecological system approach. Australian Educational Researcher, 1(0123456789), 2020.

[9] Steven Loria et al. textblob documentation. Release 0.15, 2(8):269, 2018.

[10] Karsten O. Lundqvist, Tharindu Liyanagunawardena, and Louise Starkey. Evaluation of student feedback within a MOOC using sentiment analysis and target groups. International Review of Research in Open and Distance Learning, 21(3):140–156, 2020.

[11] Jonathan Mahadeo, Zahra Hazari, and Geoff Potvin. Developing a computing identity framework: Understanding computer science and information technology career choice. ACM Transactions on Computing Education, 20(1):7–714, 2020.

[12] Nicolás Matus, Cristian Rusu, and Sandra Cano. Student eXperience: A systematic literature review. Applied Sciences (Switzerland), 11(20), 2021.

[13] Robert McCartney and Kate Sanders. School/work. ACM.

[14] Cedric Bheki Mpungose and Simon Bheki Khoza. Postgraduate students' experiences on the use of moodle and canvas learning management system. Technology, Knowledge and Learning, 27, 2022.

[15] Anne-Kathrin Peters, Anders Berglund, Anna Eckerdal, and Arnold Pears. First year computer science and it students' experience of participation in the discipline. IEEE.

[16] Anne Kathrin Peters and Arnold Pears. Engagement in computer science and it - What! A matter of identity? Proceedings - 2013 Learning and Teaching in Computing and Engineering, LaTiCE 2013, pages 114–121, 2013.

[17] Olga Pierrakos, Thi Kay Beam, Jamie Constantz, Aditya Johri, and Robin Anderson. On the development of a professional identity: engineering persisters vs engineering switchers. IEEE.

[18] Ajitkumar Pradhan and Vipul Thakre. Analysing Student'S Textual Feedback Using Sentiment Analysis. International Journal of Advance Engineering and Research Development, 4(01):335–338, 2017.

[19] Kristen A. Renn and Karen D. Arnold. Reconceptualizing research on college student peer culture. Journal of Higher Education, 74(3):261–291, 2003.

[20] Michael A Rotondi and Maintainer Michael A Rotondi. Package 'kappasize'. URL http://cran. rproject. org/web/packages/kappaSize/kappaSize. pdf, 2013.

[21] Saida Ulfa, Rex Bringula, Citra Kurniawan, and Muhibuddin Fadhli. Student Feedback on Online Learning by Using Sentiment Analysis: A Literature Review. 2020 6th International Conference on Education and Technology (ICET), 1(1):53–58, 2020.

[22] Bronfenbrenner Urie. The ecology of cognitive development: Research models and fugitive findings. Routledge, 1993.