

Broadening Access to Programming: Exploring Bilingual and Contextualized Approaches for Non-CS Majors and ESL Learners

Qualifications:

Describe any relevant expertise or experience as it relates to this study which prepares this study team member to conduct research with the subject population(s) identified in this submission. Also describe any specialized knowledge of local community attitudes, cultural norms, and the cultural sensitivities necessary to carry out the research, if applicable.

- Ph.D. in Computer Science, specializing in Computer Science Education. Doctoral research focused on conceptual transfer in students learning new programming languages.
- Over 6 years of experience in the field of computer science education.
- Expertise in research methods and identifying gaps in computer science education, particularly in contextualization and bilingual programming.
- Published research on bilingual programming: *"Bilingual Programming: A Study of Student Attitudes and Experiences in the African Context"*, presented at the ACM Koli Calling conference.
- Forthcoming paper on contextualization: *"Computing Education in African Countries: A Literature Review and Contextualized Learning Materials"*, accepted for publication at the ACM ITiCSE conference 2024.
- Extensive experience working within native educational contexts, with a strong understanding of local community attitudes, cultural norms, and necessary cultural sensitivities for conducting research in these settings.

Qualifications

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Ph.D. in Computer Science Education, with research focusing on conceptual transfer in students learning new programming languages, providing a strong foundation for investigating bilingual programming.

Last semester I taught a class of mixed ethnic groups and my research assistants are of mixed ethnic groups

Extensive experience in conducting research on bilingual programming, including a published paper on *"Bilingual Programming: A Study of Student Attitudes and Experiences in the African Context"*, which informs the current study's approach to bilingualism in programming for non-CS majors.

Familiarity with non-CS majors' learning needs, having worked with diverse student populations in various educational settings, making me well-equipped to understand and address their specific challenges in learning programming concepts.

Knowledge of cultural norms and attitudes in the African context, including familiarity with local sensitivities, which will guide the adaptation of bilingual programming and contextualized learning materials to be culturally relevant and effective for non-CS majors.

Experience with contextualization in computer science education, demonstrated by my forthcoming publication on *"Computing Education in African Countries: A Literature Review and Contextualized Learning Materials"* at the ACM ITiCSE conference 2024, which explores the integration of local culture into curriculum design.

Proficiency in research methods and ethical guidelines for conducting studies involving human participants, including experience obtaining IRB approval and ensuring that research aligns with ethical standards.

Strong data analysis and experimental design skills, ensuring rigorous investigation of the effectiveness of bilingual programming and contextualization for non-CS majors.

Commitment to educational equity and inclusivity, with a focus on broadening participation in computer science by developing culturally relevant learning experiences for underrepresented groups.

Please indicate your anticipated start date, making sure that it is not retroactive and allows enough time for review and approval of your protocol submission.

Important Note: The SJSU IRB does not review or approve studies retroactively. You are required to make sure your timeline is reasonable prior to submitting your protocol or submitting requested revisions to your protocol. Refer to our website for information regarding review timeline

7th March 2025

Study Purpose

Provide an explanation of the purpose of the proposed research, written for a general audience. Include a concise statement of your research questions or hypotheses.

Study Purpose

The purpose of this study is to explore the effectiveness of a workshop designed to teach programming to non-CS majors and English as a Second Language (ESL) learners through bilingual and contextualized approaches. The study aims to assess both the understanding of key programming concepts and the attitudes towards programming among non-CS majors. By integrating bilingual programming and culturally relevant examples, the study seeks to determine if these methods can improve comprehension and foster positive attitudes towards computer science.

A primary goal of this research is to broaden participation in computer science, particularly by engaging underserved communities and encouraging them to develop essential programming skills. This study aims to show that making computer science more accessible and relevant to diverse populations can help bridge the gap in tech-related skills, which are increasingly crucial in today's world.

Study Background

Include a brief (1-2 paragraphs) review of any relevant and current scholarly literature that supports the purpose of the research or that led to the formulation of the study. Include citations and include a list of references, if applicable.

Study Background

The growing need for computer science skills in today's job market underscores the importance of making programming education accessible to all learners, especially those from underserved communities. Research highlights the challenges that non-English speakers face when learning programming, as most programming languages and educational resources are dominated by English, which can create barriers for students with limited English proficiency. Studies have shown that bilingual and culturally contextualized programming instruction can help bridge this gap, offering students the opportunity to learn in ways that are more aligned with their linguistic and cultural backgrounds. In particular, incorporating students' native languages into programming curricula or utilizing bilingual instructional materials has been found to improve engagement and learning outcomes for non-native English speakers [22, 27, 35].

However, while bilingual approaches have shown promise, there is still limited research on the impact of these methods in higher education, particularly for non-CS majors. Few studies have focused on the specific challenges faced by students in diverse academic settings or on the effectiveness of bilingual programming in improving both conceptual understanding and attitudes toward computer science. Additionally, there is a need to explore how contextualizing programming education—through examples, metaphors, or language use relevant to the students' cultural context—can further enhance learning experiences. This study aims to address these gaps by investigating how bilingual and contextualized programming instruction can improve both the understanding of programming concepts and the attitudes of non-CS majors, with the broader goal of expanding access to computer science education for underserved populations.

Research Summary

Research design (experimental, descriptive, correlational, etc.).

Research Design:

This study employs an experimental design to investigate the impact of bilingual programming and contextualized programming on the learning and attitudes and engagement of undergraduate non-CS majors at SJSU. The study will involve two groups: a bilingual group

(using programming in both English and their native language) and a control group (using the English-only version programming). The experimental intervention will consist of an engaging programming activity using a programming platform, which will introduce students to fundamental programming concepts progressively. Students' attitudes towards programming will be measured using the Attitudes Towards Computing Scale, administered through pre- and post-surveys. This research aims to explore both the cognitive (understanding of programming concepts) and affective (attitudes and engagement) outcomes of bilingual instruction in programming for non-CS majors, contributing to broader participation in computer science.

Data Collection methods:

Data Collection Methods

For this study, data will be collected using a variety of methods to assess both the cognitive and affective outcomes of bilingual and contextualised programming instruction among undergraduate students at San Jose State University (SJSU). The main data collection tool will be the adapted validated Attitudes Towards Computing Scale, which will specifically focus on programming rather than computing, ensuring it is relevant for this student group. The survey will measure five key sub-constructs: programming confidence, enjoyment, perceived usefulness, motivation, and identity.

Pre-Survey:

A week prior to the bilingual programming workshop, all participating students will complete a pre-survey to gather baseline data on their attitudes towards programming. The survey will include demographic information (research ID, age, gender, prior programming experience) and will be administered via SJSU Google Forms. The survey will take approximately 20 minutes to complete, and consent will be obtained from all participants. To ensure anonymity, each participant will be assigned a unique research ID. This ID will be used to track responses throughout the study while maintaining the participants' privacy.

Post-Survey:

Immediately following the bilingual programming workshop, students will complete a post-survey. This survey will include the same questions from the pre-survey, allowing for direct comparisons of pre- and post-attitudes. In addition, students in the bilingual group will be asked open-ended questions, such as, "Please share any experiences you had coding in both English and native language," to capture qualitative data on the impact of bilingual programming. As with the pre-survey, each student's responses will be linked to their unique research ID, ensuring anonymity.

Data from the Hedy Platform:

Data on student interactions with the Hedy programming platform will be collected to assess programming behavior. The Hedy tool automatically logs student activities, such as the exercises they attempt, the number of lines of code written, and the programming concepts used. These data will be used to compare the engagement levels and programming behaviors of students in the bilingual versus the English-only group. All data collected from the Hedy programming platform will be anonymized and linked to the students' unique research IDs rather than any personally identifiable information.

Together, these data collection methods will provide a comprehensive view of how bilingual programming instruction affects undergraduate students' attitudes towards programming and their engagement with the material at SJSU. By assigning each participant a research ID and not collecting personally identifiable information, we ensure the anonymity of all research participants throughout the study.

Type of Subjects

Describe the participant pool or community from which you will enroll participants as specifically as possible (e.g., college students in a

specific class, professionals in a specific field, random pedestrians). If you will be accessing secondary data about individuals or collecting

biospecimens, describe whether you are targeting a specific population as part of the study analysis. If you will have multiple groups of

participants, please answer the protocol application questions for all groups.

We will recruit undergraduate students enrolled in any undergraduate program at the SJSU campus besides computer science related major degrees. Recruitment efforts will include general campus-wide outreach and targeted efforts to engage students affiliated with the Black Leadership and Opportunity Center, the Chicana/Latina Student Success Center, and the Gender Equity Center.

Describe why this is the appropriate population for your study (i.e., is this population the logical choice for answering your research

The selected population is appropriate for this study as it aligns with the research objectives of broadening participation in computer science education through bilingual programming and contextualized programming. These efforts aim to increase interest in computer science among underserved students, particularly those from underrepresented communities. By including non-majors in computer science and individuals from underrepresented groups, the study targets populations most likely to benefit from inclusive and culturally relevant educational

interventions. Access to this population is essential for evaluating how these approaches impact interest, engagement, and perceptions of computer science, ultimately contributing to the development of more equitable and effective educational practices in the field.

State the expected number of participants you wish to enroll in the study as well as what a reasonable sample size would be to answer your research questions. If applicable, explain how the number of participants needed to answer the research question was determined.

We will use 70 students for this study, with 35 students randomly assigned to the control group and 35 to the intervention group. The sample size was determined based on statistical considerations, including the need for adequate statistical power to detect differences between the groups. A sample of 70 students is expected to provide sufficient power to assess the impact of the intervention, while accounting for potential attrition or variability in participant responses.

State any inclusion and/or exclusion criteria, including specific subject demographics (age, race, ethnicity, gender etc.), if applicable. If prospective participants will be screened via tests, interview, etc., prior to entry into the study, explain how, where, when, and by whom the screening will be done. Information on what will be done with the data of those who do not qualify for the study should also be provided in this section. If you will be accessing secondary data about individuals, describe the inclusion/exclusion criteria for record selection, if applicable, or state N/A.

We will recruit undergraduate students from San José State University (SJSU) who meet the following inclusion criteria: participants must be over 18 years old, have no prior programming knowledge, and be non-computer science (CS) majors and non-software and computer engineering majors, English as a Second Language (ESL). Students who meet these criteria will be invited to participate in the study, with informed consent obtained prior to enrollment.

Exclusion criteria will include students who have previous programming experience, are majoring in computer science fields, or are under 18 years old.

Prospective participants will be screened through a brief online survey administered via Google surveys (SJSU), which will assess eligibility based on the inclusion and exclusion criteria. The survey will also collect basic demographic information, including age, major, and prior programming experience.

Students who do not meet the eligibility criteria will be notified and informed that they are not eligible for participation. Their data from the screening survey will be immediately deleted to ensure privacy and confidentiality.

State any inclusion and/or exclusion criteria, including specific subject demographics (age, race, ethnicity, gender etc.), if applicable. If prospective participants will be screened via tests, interview, etc., prior to entry into the study, explain how, where, when, and by whom the screening will be done. Information on what will be done with the data of those who do not qualify for the study should also be provided in this section. If you will be accessing secondary data about individuals, describe the inclusion/exclusion criteria for record selection, if applicable, or state N/A.

If the number of eligible students exceeds the desired sample size of 70 participants, participants will be randomly selected from the pool of eligible students. This random selection process will ensure that the sample is representative and unbiased, providing a fair opportunity for all eligible students to participate in either the control or intervention group.

Recruitment:

Prospective participants will be identified and approached through flyers that will be posted around the SJSU campus, including in common areas such as the student union, libraries, and dormitory bulletin boards. These flyers will provide information about the study, including eligibility criteria, the purpose of the research, and contact information for the research team.

Interested students will be directed to a Google survey where they will be asked to provide basic demographic information, such as age, major, and prior programming experience. The survey will also include eligibility screening questions to determine if they meet the inclusion criteria (over 18 years old, non-CS majors, and no prior programming knowledge, English as a Second Language (ESL)).

The recruitment process will be managed by the principal investigator and research team members. Students who complete the survey will be informed that they will be contacted after the recruitment period ends to notify them whether or not they were selected to participate in the study.

Recruitment Materials:

Screening Survey - Training Intervention .pdf 04/10/2023 (Recruitment Materials)

Email Script - Training Intervention.pdf 04/10/2023 (Recruitment Materials)

Email Script - Youth Survey.pdf 04/10/2023 (Recruitment Materials)

Flyer - Training Intervention.pdf 04/10/2023 (Recruitment Materials)

Flyer - Youth Survey.pdf 04/10/2023 (Recruitment Materials)

Web Content - Training Intervention.pdf 04/10/2023 (Recruitment Materials)

Web Content - Youth Survey.pdf 04/10/2023 (Recruitment Materials)

Study Sign-up Form - Summer Youth Space Camp.pdf 04/10/2023 (Recruitment Materials)

Please note that if you plan on obtaining signed consent remotely, you will need to use a third party application like Docusign via your SJSU single sign-on account. Email is not a method for getting signed consent unless you plan on having participants scan a signed version of the consent document.

Prospective participants who meet the eligibility criteria and are selected to participate in the study will receive an invitation email with a link to the consent form via Docusign. The link to the consent form will be distributed two weeks prior to the start of the workshop. Participants will be informed that they will be randomly assigned to either the control or the intervention group.

Participants will have the option to review and sign the consent form via Docusign at any time during this two-week period. Alternatively, they may choose to return the signed consent form in person at the first study orientation session, which will provide an additional opportunity for participants to ask any questions they may have. This process ensures that participants understand the study details and are fully informed before giving their consent.

List procedures in which the participants will take part in a chronological manner. Include only those procedures that involve the participants (e.g., interventions/interactions, data collection procedures). Do not include procedures that the researcher will be doing separately (e.g., literature review, transcribing recordings, data analysis).

Participants will complete a survey on their attitudes toward programming before attending the workshop.

On the day of the workshop, participants will attend a one-hour orientation session to familiarize themselves with the workshop objectives and procedures.

Coding Activity: Participants will engage in a two-hour coding activity.

- One group will receive bilingual and context-based programming instruction.
- The other group will receive instruction in English-only programming.
- Both groups will be taught by separate trainers assigned to their respective instructional approach.

In the final hour of the workshop, participants will complete a survey to provide feedback on their experiences and attitudes toward programming.

If applicable, describe the content of and procedures for any intervention that will be applied with participants. Please also delineate the nature of the intervention - behavioral, educational, or physical.

The intervention in this study is **educational** and involves bilingual and contextualised programming activities designed to engage students through the Hedy platform. The intervention incorporates bilingual programming (English and native language) for one group and English-only programming for the other group. Below are the key components of the intervention:

1. **Introduction to the Hedy Platform:** Participants are introduced to the Hedy platform, provided login credentials, and taught fundamental programming concepts. Facilitators explain the importance of the activity and provide initial examples.
2. **Progressive Learning Levels:** Participants work through progressively challenging levels on the Hedy platform, beginning with basic input-output statements (Level 1) and advancing to more complex concepts, such as variables and conditional statements (up to Level 5).
3. **Use-Modify-Create Framework:** Students are encouraged to interact with Hedy's examples by modifying and creating programs, fostering active engagement and learning.
4. **Individualized Assistance:** Facilitators and teachers offer personalized guidance to help students progress and troubleshoot challenges.
5. **Feedback:** The Hedy platform provides real-time feedback on students' work, which is supplemented by guidance from facilitators.

Explain who will conduct the procedures and where and when they will take place. Please provide specific names if you listed multiple team members in the study personnel section. If you will be using an online or third party vendor or application to disseminate your data instruments to participants, please provide the name of the online or third party vendor/application.

The activities will occur in **DH450 on the SJSU premises**, a classroom allocated by the Computer Science Department. The activity will take place on **March 7th, 2025**, and will last for **4 hours**. The schedule includes a pre-survey and post-survey, which will be conducted anonymously using **Google Forms** provided by SJSU. Each participant will receive a unique **research ID** to ensure their personal information is not entered into Google Forms. The same research ID will also be used to create accounts for participants to log in to the **Hedy platform**.

The team conducting the procedures includes the following research assistants: **Aarav Ghai, Yusuf Gadelrub, Harshitha Venkateswaran, Leqaa Deeb, Thien Kieu, and Purujit Hada,**

under the supervision of **Neel Asheshbhai Shah**. Neel Shah will manage the anonymous data collection and storage processes online.

Describe appropriate alternative resources, procedures, or courses of treatment, if any, that are available to prospective participants who choose not to participate or are excluded from the current study.

Hedy programming platform serves as an appropriate alternative resource. The platform offers **free access to programming lessons** online, allowing individuals to independently explore and learn programming concepts at their own pace. These lessons include structured activities with progressive levels, from basic input-output statements to more advanced topics like variables and conditional statements.

Participants can visit the Hedy platform's website, create their own accounts, and access the same materials without requiring involvement in the study.

Explain what activities will be required as part of the normal class activities and what activities will be voluntary as part of the research (be sure to include this information on your consent and/or assent document).

All activities related to the Hedy programming workshop are optional. However, participants who enroll in the study and later choose to withdraw will still have access to the standard programming resources available through the Hedy platform, which is part of their regular programming education and not contingent on participation in the research. This information will be clearly outlined in the consent and/or assent document.