

Measuring Computing Students' Perceptions of Social Presence and Engagement in Synchronous Remote v. In-Person Classes

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Abstract— The use of synchronous remote learning (SRL) by computing departments to teach classes is increasing. This paper reports survey results of U.S. computing students from 53 classes offered by in 21 U.S. institutions, assessing the extent to which SRL fulfilled their need for social connection. A reliable social presence importance composite variable was created from nine survey questions. Across all demographic categories, respondents report social presence is important and that in-person instruction is easier to accomplish it. Being able to safely sense and engage with peers socially and intellectually is both perceived as important and easier in in-person classes. Students were more likely to prefer the in-person setting for social expression, getting to know other students, and feeling an obligation to engage. A small majority of students prefer in-person learning to remote learning, with 66% finding it easier to learn in person and 47% stating that they would take all classes in person if given the option. Consistent with prior research, students older than 24 showed greater preference for SRL instruction ($p < .001$).

Keywords— *Synchronous Remote Learning, Social Presence, Undergraduate, Computing Education, Student Preferences*

I. INTRODUCTION

Remote learning has become increasingly prevalent over the past four decades in postsecondary studies and is expected to play an increasing role [9, 41, 43]. Students may increase demand [45] and institutions may seek decreased costs and other advantages [20, 43]. In computer and information science, online classes may be used to manage increasing enrollments [2, 55]. Online classes can take different forms, ranging from completely asynchronous (no real-time interaction) to completely synchronous, when the class meets using videoconferencing technologies in real time. Prior to 2020, online undergraduates primarily comprised a relatively narrow group: older (mean age 32), women, part-time students, and/or full-time employees [20]. However, most undergraduates around the world today have experienced synchronous remote learning (SRL) due to emergency remote teaching during the 2020-2021 COVID-19 lockdowns. This increased reach of SRL has provided a unique opportunity to gather insights from a more general group of computing students. Understanding students' experiences and perceptions of SRL can help educators design learning experiences that accomplish learning outcomes and retain students in classes and the field.

This paper reports on a survey-based study of computing students' perspectives of SRL environments through the lens of

A. Maintaining the Integrity of the Specifications

social presence. Social presence, described as the degree to which online learners and teachers perceive each other as real persons who can engage in interpersonal relationships, has a long history of scholarship linked to positive student outcomes [29, 37]. To understand how computing undergraduates have experienced and perceived social presence, we ask the following research questions:

1. Which social presence factors do undergraduate computing students feel are important? To what extent do computing students believe that SRL accommodates these social presence needs?
2. When choosing equivalent remote v. in-person classes, which do computing students prefer? Which class categories do they prefer to take remotely v. in person?

For each question, we explored the extent to which demographic groups varied in their responses. In the next section, we briefly review scholarship on social presence in SRL, followed by a description of our research methods and sample profile. We then present and discuss the survey results. We conclude by discussing the implications of our findings for CS departments deciding the role of continuing SRL in their curriculum, what this may suggest about positive course design, and areas for future research.

II. SOCIAL PRESENCE

Social presence theory has been widely used to ground studies of both synchronous and asynchronous remote learning for how well online settings support learning and development of high-quality relationships among students and instructors [28, 34]. First conceptualized in 1976, *social presence* describes the ability of communicators to perceive physical cues, share information, provide feedback, personalize a space, and establish connectedness with others [16, 42, 49]. From the viewpoint of social learning theories, education is a social accomplishment, requiring opportunities for developing positive relationships among peers and with instructors [30, 36, 51]. Thus, social presence studies examine awareness of relationships among members of an online setting and the resulting interpersonal and group social bonding. Social presence is critical for enabling interactions that support relationship, community, and identity building as a student becomes a member of a community of practice. Social presence

is accomplished and experienced through verbal, nonverbal, and paraverbal (e.g., tone, inflection, emphasis, etc.) interaction.

Social presence theorists often suggest that remote learning situations are deficient compared to in-person learning, where more social cues are naturally shared and perceived in real time [27]. We took a neutral standpoint when designing our survey, exploring the medium participants preferred for accomplishing social presence goals. This position is in line with social information processing theory, which suggests that given enough time in an online medium, participants will find ways to convey communicative information to accomplish their social goals. As a result, a face-to-face environment may not be perceived as better than a technologically-mediated environment [5, 44, 52].

Empirical studies on social presence in synchronous remote classrooms have focused on student satisfaction with the learning environment, perceptions of learning, how social presence develops, and improving social presence with technologies and pedagogical techniques [39, 46, 53]. A recent meta-analysis found that increased social presence is positively associated with students' satisfaction with the learning experience, perceptions of amount learned, and scores on assessments, all of which are associated with retention and motivation [39]. Findings suggest that social presence varies by discipline, but only a few studies are situated in computing.

Studies in undergraduate computing have focused on how to improve social presence online. A 2015 mixed-methods study with a small convenience sample found that social presence was increased when computing students already knew each other in person, had training with the online tools, and used an active learning approach [13]. Another single university study compared an online to an in-person programming class to explore the value of a system (Cocode) for sharing code editors and output for providing social presence [7]. The online students using Cocode perceived less social presence than in-person students, but more social presence than online students who did not use it. Similarly, another small study found that a system called PeerCollab supports students in interacting meaningfully with each other and establishing close relationships [21]. A larger multi-campus, survey-based study identified a lack of basic social support mechanisms as a source of stress in SRL environments [8]. However, this and similar "emergency remote learning" studies were conducted at the beginning of the COVID-19 pandemic, when instructors and students were unprepared for the sudden switch to online classes, a huge range of everyday social experiences were blocked, and fear was rampant. Our study is the second phase of a multi-method exploration of students' value for and experiences of social presence in SRL environments during more stable times.

III. METHODS

We present results from a survey conducted in April and May of 2021 to explore 125 undergraduate computing students' experience with SRL. Ninety-nine students completed all questions in the survey, with the other 26 partially completed. Thus, the number of responses to different items presented below will vary. The survey had two sets of questions about SRL, one asking students to compare their experiences in SRL and in-person classes in general. The other portion of the survey,

published elsewhere, asked students about faculty teaching practices and use of software features in one remote computing class of the respondents' choice. As mentioned below, this allowed us to estimate the number of classes and institutions represented by the respondents.

A. Survey Construction and Design

The survey was based on themes that emerged from interviews conducted by the lead author [15]. Both the interview and survey parts of the study received approval from the University of Colorado Boulder institutional review board; data are not available for re-use by other researchers. In thematic analysis of 32 semi-structured interviews of students' experiences with their SRL computing classes, we found that lack of engagement in these classes was consistently connected to dimensions of low social presence (e.g., "You can actually see the teacher; you can actually see the other students. There's the material, everyone's paying attention and focusing on learning. You've got no incentive to be on your phone scrolling through Instagram, you're actually more or less engaged with the material and trying to learn it."). Interviewees often expressed preferences for in-person classes, but conditional on the relationship of the class to their educational goals. It is important to note that social presence was an emergent theme in the exploratory interview data rather than the goal of the interviews. This survey investigates seemingly related social presence dimensions emerging from interview data that are likely to be of importance to computing students taking synchronous remote classes.

The survey was constructed with close adherence to best practices in survey design to achieve better quality data. This included: (1) defining terms (SRL) to avoid ambiguous interpretation by respondents; (2) Segmenting the survey based on topic area, using skip and display logic to ensure participants were only asked questions they could answer; (3) Asking specific questions on topics before general ones to better avoid anchoring effects; (4) Using qualitative scales to lessen cognitive load, including wording from the questions; and (5) Asking sensitive and demographic questions last [17]. The survey was piloted and iteratively refined with three undergraduate and graduate computing students to ensure had construct validity. The survey items developed from these themes help us to identify how well the qualitative results can be generalized to a larger audience.

B. Sample Development

We developed a list of all U.S. institutions that awarded at least one associate's or bachelor's degree in computer and/or information science using the U.S. Integrated Postsecondary Educational Data System [48]. Research assistants visited websites of each of these departments to create a list of faculty email addresses stratified by type of institutions in the U.S. (2-year, Historically Black Colleges and Universities, Hispanic-serving, liberal arts, research, and tribal colleges). We then sent email invitations with the survey link faculty members throughout the U.S. requesting that they distribute the survey to their students. We did not communicate directly with the participants, except in response to questions or concerns.

The survey was fielded between April and May of 2021 using Qualtrics software, which was set up to maintain complete

anonymity of respondents. Standard bot protection measures were used. No incentive was offered to complete this survey. Since the request to take the survey was mediated by faculty goodwill, we cannot determine a response rate.

C. Sample Profile

Most respondents to this survey were students in computer science ($n = 102$, 82%), but respondents also identified a few other computing fields: computer engineering, computer information systems, electrical and computer engineering, networking, and information science. Because these fields represent so few students, we are unable to make comparisons across majors. We are also unable to identify the geographic location of our participants. However, the second portion of the survey asked respondents to name a course for that part of the survey, either by topic, title, or number (e.g., “Programming,” “CS 115 Computing for the Socio-Techno Web,” “CSCI 233”). Through thematic analysis of these responses, we were able to verify distinct computer science departments and different universities by looking for different computer science department code signifiers (e.g., “CSCI 101” vs “CS 101”), different course numbers for the same course (“CS 101: Intro to Python Programming” vs “CS 121: Intro to Python”), or different coding schemes (e.g., four v. three numbers: “CS 1010” vs “CS 121”). With this analysis, we determined that students came from at least 53 distinct classes offered by at least 21 universities in the U.S. About half of respondents (63) were enrolled in intermediate/advanced computing classes, 32 in introductory computing classes, and 12 in co-requisite classes (e.g., a required math class), with 18 participants’ enrollments unknown.

Among the 80% of respondents who were willing to share demographic information, age ranged from 18 to 54, of which 73 (74%) were aged 23 and younger and 26 (26%) were aged 24 and above. Nineteen (19%) respondents reported being in their first year, 23 (23%) reported being in their second year, 19 (19%) in their third year, 20 (20%) in their fourth year, and eight (8%) students in their fifth or more years. Ten respondents reported being graduate students.

Most respondents (54%) identified as men, 35 (35%) as women, and 7 (7%) as non-binary or gender queer, with 4 (4%) preferring not to answer. There is significantly higher participation of women in the survey than is reflected in the U.S. enrollment of computing majors. The number of non-binary/gender queer is too small to compare responses for that group. Half (49) of participants who responded to the ethnicity question identified as Non-Hispanic White, 17 (17%) as East Asian, 11 (11%) as South Asian or Asian Indian, nine (9%) as Hispanic or Latino, six (6%) as “Two or more races,” four (4%) as “Other,” and three (3%) as Black. Thus, students who identify as members of racial or ethnic groups historically marginalized in U.S. computing are also underrepresented in this sample. Most students were U.S. citizens (84%). Finally, 25% of respondents answered that neither of their parents had attended college. We created a new variable combining students who are members of U.S. historically marginalized/minoritized racial groups by combining the groups of Hispanic/Latino and Black students.

IV. RESULTS

The survey asked students three categories of questions to address the research questions. These categories are (1) sensing others’ presence, (2) engagement and self-expression, and (3) preferences for class mode. For the first two categories, students were asked to comment on the importance of a factor, then to indicate which class mode (SRL v. in-person) made the factor easier. Questions asking for agreement/disagreement used four-point Likert scales, with 1 corresponding to strong disagreement and 4 representing strong agreement. Questions asking about which class mode is better for accomplishing social presence goals and class mode preferences used nominal response options, presented below. A “don’t know” option was also given for all questions, but placed outside the scale rather than as neutral, because neutral items in surveys are difficult to interpret [35].

We compared responses between or among the groups listed in the sample profile using t-tests, ANOVA, chi-square, and correlation analysis. In all but one case, we found no statistically significant differences between/among these groups. Where there are differences, we report them below. In the tables below, we present data including the number of respondents, means, and standard deviations for Likert items, as well as visuals of distributions.

A. *Sensing Social Presence is Important and In-Person Classes Make it Easier*

We asked three questions about the importance of opportunities to sense the presence of others through communication cues in online learning environments. Communication cues are subtle, may be hard to remember, and can co-occur. As a result, these cues may be indistinguishable in terms of their salience. Instead of asking about specific behaviors such as facial expressions, gestures, or vocal emphasis, we relied on two popular terms that pilot testers of the survey uniformly understood: body language and “vibe.” Body language is a common term used to describe a range of nonverbal and paraverbal behaviors. Vibe describes the mood or social climate of a situation. Specifically, we asked in our survey about the importance of “reading” body language and sensing the vibe of the class. We also asked whether these are easier in SRL or in-person classes. Table 1 compares respondents’ beliefs about the importance of three sensing variables (blue background) with the class mode in which they find sensing to be easier (gray background). Distribution is shown by the sparkline column charts. Each column represents a possible response category.

TABLE 1: SENSING SOCIAL PRESENCE

Survey Item	N	Mean	SD
It is important for me to be able to read the body language (including facial expressions) of the instructor in class.	103	3.0	.87
In which class mode is it easier for you to read the body language of the instructor?	101		
It is important for me to be able to read the body language (including facial expressions) of students in class.	101	2.8	.93
In which class mode is it easier for you to read the body language of students?	96		
It is important to me that I can sense the vibe (social atmosphere) of a class.	102	3.1	.94
In which class mode is it easier to sense the vibe of a class?	97		

Importance: 4-point scales from 1-Strongly Disagree to 4-Strongly Agree; Ease: Much Easier in Person, Somewhat Easier in Person, Somewhat Easier SRL, Much Easier SRL

For the importance variables, the two columns on the right side of the sparklines indicate more importance for being able to sense social presence. For the ease variables, the two columns to the left indicate easier in person, with the two columns to the right indicating easier in remote classes. The mean values of the three importance variables, reading body language of students and of instructors and sensing the vibe of a class, are each close to 3, representing agreement that respondents find them important, though there is variation, as shown by the standard deviations and distributions. Respondents found that sensing instructor body language was more important than sensing the presence of other students, with a mean of 2.8, but still above the midpoint of 2.5. Respondents show a strong preference for in-person to SRL environments for sensing social presence, as shown by the left-side bars in the sparklines. A strong majority of students found it easier to read instructors' body language (92%), students' body language (90%), and classroom social environment (93%) in in-person learning environments. In summary, students find sensing others in classroom environments to be important and feel that it's easier to do so in in-person classes.

B. Classroom-Based Interaction Important; In-Person Classes Make it Easier

Findings for the importance of classroom engagement variables and whether the in-person or remote situation makes engagement easier have similar results to the sensing variables, with two exceptions. Table 2 compares respondents' beliefs about the importance of six classroom engagement variables (blue background) with the class mode in which they find sensing to be easier (gray background). The mean of 3.2 for four of these variables shows general agreement that respondents believe it is important to get to know people like themselves, make meaningful connections with other students in their classes, feel an obligation to engage in classes, and express themselves intellectually in class. Less important was expressing oneself socially in class with a mean of 2.7 (slightly above the midpoint of 2.5). Participants considered that "classrooms should be a safe place to explore ideas and opinions" to be the most important of the engagement variables, with a mean of 3.7, showing that 99% of participants agree or agree strongly.

As can be seen by the left-sided prevalence of columns in the sparklines, in-person classes were considered easier by most students for accomplishing the engagement goals with two important exceptions. Students varied more in their responses about the medium in which they felt safe to share ideas and opinions and could express themselves intellectually, with a little more than half finding the in-person setting easier for both. In-person classes were seen as easier to safely share ideas and opinions by 56% of respondents, with 55% finding it easier to express themselves intellectually in person. While perceived as less important than the other engagement variables, 69% of students found it easier to express themselves socially in person. Students also found the in-person setting easier to make meaningful connections with other students (89%), feel a stronger obligation to engage (80%), and get to know students similar to themselves (79%).

To summarize, respondents found engaging with others in a safe environment to be important and felt a stronger obligation to engage in in-person classrooms. Students were mixed in terms of whether the in-person or remote classes were easier for intellectual expression and sharing opinions and ideas, but more found the in-person setting amenable to getting to know other students in a meaningful way, expressing themselves socially, and feeling an obligation to engage.

TABLE 2: ENGAGEMENT

Survey Item	N	Mean	SD
It is important to me that I take classes where I can get to know people similar to myself.	100	3.2	.72
In which class mode is it easier to get to know people who are similar to yourself?	105		
It is important to me that classes are a safe place to explore ideas and opinions.	97	3.7	.52
In which class mode do you feel more safe to share your ideas and opinions?	77		
It is important to me that I make meaningful connections with other students in my classes.	102	3.2	.72
In which class mode is it easier to make meaningful connections with other students?	102		
It is important to me that I feel an obligation to engage in my classes.	96	3.2	.87
In which class mode do you feel more of an obligation to engage in your classes?	102		
It is important for me to express myself intellectually (ex: talking about class content, theory, etc.) in my classes.	94	3.2	.74
In which class mode is it easier to express yourself intellectually?	80		
It is important for me to express myself socially (ex: telling a joke, talking about weekend plans, etc.).	93	2.7	1.1
In which class mode is it easier to express yourself socially?	87		
In which class mode is it easier to learn?	95		

4-point scales from 1-Strongly Disagree to 4-Strongly Agree, Ease: Much Easier in Person, Somewhat Easier in Person, Somewhat Easier SRL, Much Easier SRL

C. Social Presence and Engagement are Important for All Students

We created an “Importance of Social Presence and Engagement” variable by combining the nine survey items asking about importance (Table 1 and 2, blue columns). Although the two major categories of survey questions, sensing others and social engagement goals, each had “acceptable” internal consistency ($\alpha = .78$ and $.75$, respectively), the reliability of the measure increases to “good” when combining all nine items ($\alpha = .83$). This suggests that students tend to respond similarly to these questions and that taken together, the constructs represented by these survey items form an attitude toward social presence in classes. Only cases that responded to all questions in the composite variable are included. The mean response on the Importance of Social Presence and Engagement was 3.16 out of 4 with a standard deviation of .51 ($n=77$). We found no statistically significant differences across groups or correlation with hours worked to earn income. This result is not altogether surprising, but it is somewhat notable that group differences were not apparent in this research. Social presence and engagement in classes are considered important for all groups of students in this sample.

D. In-Person Classes Preferred, but Not By Older Students

We asked students in which class mode they thought it was easier to learn, using the same nominal response categories used for the “easier” in-person/remote questions above. About two-thirds (66%) of respondents felt it was easier to learn in person, and 34% felt it was easier to learn remotely (last row in Table 2).

To gauge whether students preferred in-person or remote classes in general, we asked, “Imagine COVID-19 were not a factor, and you had the option to take all your classes this term remotely, all of them in-person, or some of each. Which would you choose?” Seventeen percent of respondents indicated they would take all their classes remotely, 36% indicated they would take some classes remotely and some in-person, and 47% reported they would take all classes in-person. We found only one significant group difference: age. We split students into two groups, those who were under 24 and those who were 24 and older. As shown in Table 3, among students who reported their age, 8% of younger students would take all their classes remotely, 34% some of each, and 58% all in person. In contrast, 42% of older students would take all classes remotely, 39% some of each, and 19% all in person. This is a statistically significant difference ($\chi^2=18.995$, $df=2$, $p<.001$). A gamma test revealed a strong negative association between the variables, where age explains 68.7% of the variation in choice of modality ($\gamma = -0.687$, $SE=0.115$, $Tb=-4.128$, $p <.001$). The assumptions of gamma and chi-squared tests were satisfied. It is worth noting that there was no relationship between seniority (Sophomore, Junior, Senior) and preference for remote or in-person courses.

Finally, we asked students their opinions of taking in-person or remote classes for required versus elective classes. Only students who indicated they would choose to take some classes remotely and some classes in person were branched to this question, reducing responses to $n=36$. As can be seen in the sparkline distributions in Table 4, students leaned more toward

taking their major or minor requirements in person, taking general education requirements remotely, and free electives as some remotely and some in person.

TABLE 3: AGE AND MODE PREFERENCE

Imagine COVID-19 were not a factor, and you had the option to take all your classes this term remotely, all of them in person, or some of each. Which would you choose?		N
23 and Younger		73
24 and Older		26

Column position: Left-All SRL, Center-Some of Each, Right-All in Person

TABLE 4: MODE PREFERENCE

Survey Item		N
Imagine COVID-19 were not a factor, and you had the option to take all of your classes this term remotely, all of them in person, or some of each. Which would you choose?		100
Which sorts of classes would you choose to take remotely? (General Ed.)		36
Which sorts of classes would you choose to take remotely? (Major/Minor Requirements)		36
Which sorts of classes would you choose to take remotely? (Free Electives)		36

Column position: Left-All SRL, Center-Some of Each, Right-All in Person

V. DISCUSSION AND IMPLICATIONS

A. Summary of Findings

Using the social presence and engagement composite variable, we found that most students feel that social presence factors in classes were important. Students found that sensing others in class environments is important and is easier in in-person classes. Similarly, respondents found engaging with others in a safe environment, both socially and intellectually, to be important and felt a stronger obligation to engage in in-person classrooms. Notably, all demographic categories of students felt that these qualities of social presence were important, and no statistically significant difference was found between any demographic groups. Students were mixed in terms of whether in-person or remote classes are easier for accommodating intellectual expression and for sharing opinions and ideas. More students found the in-person setting amenable to getting to know other students in a meaningful way, expressing themselves socially, and feeling an obligation to engage. A small majority (66%) of students find it easier to learn in person. Younger students are more likely than older students to choose in-person classes over remote classes. If students could choose class modes, 47% would take all their classes in person, and 17% all remote. The 36% who would take some of each would be more likely to take computing requirements in person, leaned toward taking general education classes remotely, and would take some free electives remotely and some in person.

B. Implications for Teaching

Universities, faculty, and students may face hard choices of whether to offer classes using synchronous remote or traditional in-person environments. While the study presented here

suggests that overall, students prefer in-person to synchronous remote classes, it also reveals that SRL remains popular with older students. Older students often have many time-consuming obligations beyond being a student, performing multiple social roles in addition to their role as a student (e.g., caretaker, partner, worker). In addition to time demands, they may find the social expectation to perform an additional role (student) to be burdensome rather than rewarding, a phenomenon referred to as role strain [22]. Further, many older students have been shown to take a more problem-centric than subject-centric approach to their learning goals [40], and might prefer the slimmed down approach to learning some remote classes can offer. A study on a MOOC-based master's degree offered by MIT found that remote learning can help a program attract an older applicant pool than would have attended otherwise [33]. Our study and the MIT study are consistent with demographics on online class-taking [19].

Alternatively, there is evidence that youth-centric blank slate approaches to teaching used extensively by colleges and universities can be patronizing to older students [10]. It may be that older students opt towards problem-centric learning and out of in-person classes partially due to these environments being abrasive or unaccommodating to their educational needs. Some evidence suggests that older students are more engaged and affected by learning paradigms that allow them to explore their personal experiences [11], indicating that different learning approaches explicitly tailored towards these older students may provide a more optimal environment for learning. With these older students making up between 38-73% of undergraduate students in the United States depending on how the group is defined, this is an option that should be readily explored in future work in both synchronous remote and in-person learning in computer science education [10, 12].

Sensing other students can be accomplished by creating opportunities for students to talk to each other using collaborative learning in classes. Collaborative learning does not have to take the form of a graded assessment, but instead can be part of in-class exploration of concepts such as peer instruction [38], part of practicing in lab such as pair programming [24], or full-class approaches like POGIL [54]. These approaches have been successfully used in SRL environments, including for students with disabilities [4, 23, 25, 31]. Educators also use breakout rooms, chat, and collaborative documents to substitute for informal conversation where students can work together synchronously.

Still, keeping students engaged in SRL, both in lectures and in breakout rooms, has proved to be a challenge. SRL environments have more distractions and cognitive load demands than in-person classrooms [15]. However, strategies for keeping students engaged and involved with instructors have been described in the literature. These include: (1) Using online whiteboards or writable screens, a practice which has empirical support for lecture videos; (2) use of technologies designed for engendering collaboration in MOOCs [26]; (3) and using collaborative code editors [7, 18, 21, 50].

Important to our survey respondents was ensuring that learning environments are safe places to express ideas and opinions. One way to accomplish this is to explicitly frame a

classroom climate by establishing expectations for existing knowledge and learning, describing wrong answers as common misconceptions and useful for discussion, and using randomized turn-taking techniques such as cold-calling for getting all students to participate in class [3, 14].

Well thought through and communicated teacher course design and instructional support have also been shown to promote emotional and cognitive student engagement in remote classes, as well as explicit attempts of instructors to facilitate classroom discourse [32]. In addition, integrating remote classes with multimodal features such as chat, screen sharing, and breakout rooms have been shown to be positive practices for increasing social presence, engagement and belonging in classes [14, 32, 47], as well as increased attention to individual students and attention to students' emotional well-being [47]. A mixture of asynchronous and synchronous technologies is also recommended as a way of giving student multiple ways and times to engage with the course content [1, 14]. Creating ways of allowing anonymous input may also help students to participate when they know that wrong answers cannot be attributed to them personally. Finally, the use of new videoconferencing and digital communication technologies are likely to improve social presence as time goes on and should be experimented with in synchronous remote classes, but with consideration on how uneven distributions of implementation can create and heighten digital divides in computer science education [1].

VI. CONCLUSIONS, LIMITATIONS, AND FUTURE WORK

SRL classes will continue to be offered in undergraduate computer science education. However, departments will often not be able to offer students the choice of learning mode due to cost, class size, and limitations in teaching faculty/staff. Understanding computing students' experiences and perceptions of SRL can help departments and educators choose mediums for classes and design learning experiences that accomplish learning outcomes and retain students in the major when teaching through a screen. The findings of this study suggest that computer science departments should regularly integrate classroom-based mechanisms to support social presence in SRL learning environments. Additionally, students often have little real-time power or influence over which medium required classes are offered in. This research suggests departments should attempt to offer in-person options to classes—particularly for major and minor requirements—with SRL options being more valued in general education classes. It is important to note that this research does not attempt to comment on all online educational mediums, just the widely used SRL. Asynchronous learning and various hybrid mediums offer different affordances to SRL and should be studied in future research.

This study contributes a nine-question “Importance of Social Presence and Engagement” composite scale, grounded in social presence theory and semi-structured interview data, and tested in this survey with good reliability. Made up of the blue highlighted questions in Table one and Table two, the entirety of the survey with exact wordings will be provided in link form if this paper is published. This can hopefully be used in future educational survey research to measure how important these social presence factors are across educational contexts. **In this**

study these constructs are demonstrated as important with good reliability, empirically affirming these dimensions of social presence as a relevant conceptual framework related to classroom engagement, sensing others in an environment, and student perceptions of classes and their learning experiences.

As results came from 53 classes in 21 different programs, they are unlikely to include effects of particular classes. However, as participants completed our self-report survey voluntarily; we cannot argue that they are representative of computing students. Indeed, it is possible that the faculty member asking the students to take the survey was especially well regarded by certain students, who then felt socially obligated to participate. There is no significant variation in responses based on gender, or U.S. ethnic/racial groupings. However, in many cases our sample size disallowed comparisons of students based on individual racial and ethnic groups (black students, non-binary/gender queer students). A research study focused on obtaining a larger sample of some groups is an opportunity for future research.

Anonymity, while allowing students to respond honestly, disallows us from making comparisons across institutional types. These could be interesting areas for future work, particularly in light of research showing that U.S. historically marginalized students feel a lower sense of belonging in predominantly white institutions, where a majority of Black students attend college [6]. Another productive avenue for future research could be to investigate whether social presence needs are different based on seniority, as it is possible that first-year students in introductory classes have differing needs than older and more experienced students. Another lens could be class size as a variable, to consider what impact enrollment size has on students' feelings of social presence and modality preferences. Finally, further investigation is merited into the group of students who preferred to take some classes in-person and some SRL.

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