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Talk, Tech, and Togetherness: Ethnographic Insights into Siding in Introductory Computer Science

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Abstract: People learn in heterogeneous ways, yet this can be difficult to see in large-enrollment undergraduate courses like introductory computer science (CS1), where it might seem that the lecture experience is identical for all participants. It is important to understand how students engage with a lecture in different ways to support the design of learning environments that account for heterogeneity. One window into students' unique classroom learning experiences is siding, or students' side-talk and other backchanneling during class. Drawing on field notes from 14 hours of classroom observation, we thickly describe how siding emerged in a large-enrollment CS1 classroom to contribute novel design recommendations for university-level CS instructors. We also take a posthumanist approach to attune to what we call *digital siding*—siding that is mediated through students' computers, rather than occurring directly from peer to peer—which contributes to understandings of classroom discourse by recognizing interactions with technology as siding.

Introduction

How does learning happen in a large-enrollment, undergraduate computer science course? On the surface, it might seem that an instructor *deposits* (Freire, 1970) their knowledge into the students, who listen quietly to the lecture, then ask questions and discuss with their peers at designated times. But students are far from passive recipients of a course as it has been designed; they collaboratively create their own learning opportunities, even when it is not explicitly designed for. One window into this phenomenon is siding (Lemke, 1990), or side conversations between students that happen in parallel to an instructor's talk. Siding happens frequently (Lemke, 1990) and is important for learning, since it creates opportunities for each student to uniquely engage with course content (Ofri & Tabach, 2025). Understanding which aspects of a course's design afford particular siding interactions is important for designing undergraduate learning environments that support heterogeneity. Further, understanding the role of technology in these parallel discourses is especially important as students increasingly use technology and interact with artificial intelligence (AI) in the classroom, which we argue can also be siding.

Although siding can help us understand how students learn, studying it is methodologically challenging, which may partly explain why it has received limited scholarly attention. Some researchers have asked students to self-report their siding practices (e.g. Antia, 2017), but students may not remember or wish to disclose the frequency and contents of their side conversations, since side-talk is, by nature, both private and not officially allowed. Many more researchers have used audio and video recording to capture rich descriptions of siding in naturalistic settings (e.g. Bannink & Van Dam, 2013; Koole, 2007; Ofri & Tabach, 2025), though it can still be difficult to capture whispered conversations with audio recorders (Koole, 2007).

While some research has characterized what students do during an undergraduate computer science (CS) class (e.g. Barker & Garvin-Doxas, 2004), most of this work centers on students' overt participation, or "remarks or questions directed toward the instructor" (Weaver & Qi, 2005, p. 576). Siding has not been studied in this context, which is surprising since CS courses often include lectures that could make siding significant "as an outlet for other voices" (Antia, 2017, p. 185). Where siding has been studied, researchers found that it supports learning (Lemke, 1990; Ofri & Tabach, 2025) and fosters community (Bannink & Van Dam, 2013; Lemke, 1990). However, we know less about how a course's design creates space for supportive siding, so understanding how siding emerged in an undergraduate CS course can help us explore this space. In addition, although siding has been understood beyond peer-to-peer conversation to include non-verbal behavior (Koole, 2007) and passing notes written on paper or digital screens (Antia, 2017), there has not yet been a dedicated analysis of students' technology use through the lens of siding, despite its increasing prevalence in classrooms.

To address these gaps, we report on observations of 14 one-hour sessions of an introductory, undergraduate CS course (CS1) and associated field notes. We aim to (1) account for the many ways students actively learn and participate by siding with peers and with technology and (2) thickly describe how an expansive range of student participation emerged in a classroom that incorporated both groupwork and lecture. We found many similarities between CS1 students' *digital siding*—our term for students' interactions with computers in parallel to a main class activity—and siding between peers. We also found peer and digital siding could lead to qualitatively different learning experiences, which helps us better understand how students decide between siding with peers, technology, or both. In the discussion, we draw from these similarities and differences to argue for the need to better understand students' interactions with technology through the lens of siding. Also, by analyzing a representative vignette from one day in the focal classroom, we found formal and informal structures that influenced how and when students sided in CS1. This contributes a novel perspective on students' less visible interactions to CS education research and informs design recommendations for both course and technology designers to enable supportive siding in large-enrollment classrooms.

Background and theoretical framework

Siding

Our focus on siding stems from sociocultural theories, which understand learning as discursively mediated and situated in communities of practice (Vygotsky, 1978; Wenger, 1998). As one way of understanding the social nature of classroom learning, some researchers investigate how students communicate with one another when a teacher is talking. This has been called many things, including *side-talk*, *backchanneling* (Bannink & Van Dam, 2013), *covert interaction* (Ofri & Tabach, 2025), and *parallel activities* (Koole, 2007). We use the term "siding" (Lemke, 1990), and intend for it to include the many kinds of interactions that happen "to the side" of a main learning activity—like side talk, passing notes, and gestures. As with Antia (2017), we use "siding" to convey the "idea of an unauthorized or discreet practice… [without] assumptions of topical (ir)relevence" (p. 184).

Siding is rarely studied, as research has mainly focused on teacher-led or structured group interactions (Koole, 2007), despite general agreement on its benefits. While acknowledging that siding can be a distraction and that "students do not always use good judgment in deciding when they must say something" (p. 76), Lemke (1990) argues that forbidding siding would foreclose opportunities for students to engage and practice disciplinary language. Others also found that siding helps students spread disciplinary ideas (Ofri & Tabach, 2025) and connect their lived experiences with abstract academic content (Antia, 2017). Siding also helps to develop learning communities at the K-12 (Lemke, 1990) and university level (Bannink & Van Dam, 2013).

Studies have also identified several mechanisms through which siding emerges, providing directions designers might explore to enable siding that supports learning and community. When studying translanguaged siding, Antia (2017) found that intricate chains of antecedents shape how and when students side, including concern for discretion and relationships between students. Koole (2007) also found that even while engaging in a variety of "parallel activities," students maintain an orientation around the main activity of the class. Still, there has been less detailed study of how a teacher might set up a class to allow space for siding, particularly at the undergraduate level where siding may be an important way for students to share their voices (Antia, 2017).

Students' classroom technology use

As technology is increasingly integrated into classrooms, it is important to focus on its role in learning. The extent to which technology should be in classrooms is widely debated, with a primary concern being that it presents a distraction, as students who multitask on laptops perform worse on recall tasks (e.g. Hembrooke & Gay, 2003; May & Elder, 2018). Recognizing that classroom technology is likely here to stay, sociomaterial ethnographies of schools take a wider view to explore the interplays between human and non-human actors, finding that while digital technologies fit into existing structures for school organization (Selwyn et al., 2017), they still create new, rhythmic interruptions to students' attention and change our physical spaces (Alirezabeigi et al., 2020). When focusing on students' classroom experiences, others found that students pass digital side- notes to extend class discussions (Berry, 2019) and find new forms of parallel participation through smartphones (Sahlström et al., 2019). These works mostly focus on technology as a medium for peer siding, and we build on them to consider technology as a siding partner itself. To do so, we draw on posthumanist understandings of learning as co-constructed by humans and their social and technical environment, challenging rhetorics of human exceptionalism (Bayne, 2018) that might suggest only a human could be a siding partner. This lens is useful in this divisive context, as siding research uplifts students' interactions as legitimate by "not treat[ing] the teacher's activity as default and any other student activity as non-participation" (Koole, 2007, p. 498).

Ethnographic observation in CS education

Ethnographic observation is a method that is not often used in CS education research. Studies that employ this method do so at various scopes: understanding structural barriers to equitable participation in CS (Margolis et al., 2017), teaching practices (Fields et al., 2018; Ryoo, 2019), and student engagement and process in class activities and projects (Hundhausen, 2002; Ryoo et al., 2020; Wu et al., 2019). Other studies have explored classroom discourse, focusing on how students' overt participation contributes to classroom climate in CS (Barker & Garvin-

Doxas, 2004). Others still have focused on how students' experiences across the CS learning environment—from lecture to small-group settings—promote or limit their sense of belonging (Robinson et al., 2025). However, while these studies have explored students' overt participation in the classroom and in small, collaborative groups, there has been less focus on collaboration when it is not explicitly allowed.

Methods

Setting

To collect data for this study, I (the first author) regularly attended lectures for a course typically taken by CS majors in their first year at a highly-selective university in the midwestern United States. I sat among the students in their classroom—the largest lecture hall on campus, with rows of auditorium seats and pull-out tray tables—choosing a new seat every class. There were regularly 100 to 150 students in attendance. The course was taught in Racket, a functional programming language, which departs from more typical imperative programming languages (e.g., Python, Java, C++) in that recursion and mathematical functions (i.e., Lambdas) are central to the language. By choosing this language, the course designers intended to "level the playing field" for students entering with different prior programming experiences, since it would be new to all students.

Because departmental policies limited out-of-class collaboration to discourage copying, the instructor actively set aside time for collaboration during her class. At the start of the academic term, the instructor, who has taught this course for over 10 years and holds a leadership role in the department, invited students to fill out a survey about who they knew in the class and their interests. Using this, she placed students in collaborative working groups and designated areas of the lecture hall where they could find one another each class. Classes lasted 50 minutes, and often included a mix of direct instruction from the instructor on stage at the front of the classroom and interspersed time for students to work on exercises. While I initially focused on capturing collaborations between students, I paid more attention to the role of their technology as the term progressed.

Data analysis

I observed 14, one-hour class sessions in one academic quarter, which accounted for over half the instructional days. Our main source of data is over 100 pages of written field notes. This approach follows a tradition of learning sciences research that prioritizes looking closely at learning as it happens through analysis of field notes (e.g. Nasir & Cooks, 2009; Vossoughi et al., 2021). I first recorded my observations in typed jottings while in the class, which I expanded into field notes immediately following each class to preserve my memories. I received IRB approval and never recorded identifiable information about students. To analyze the field notes, I first content-logged (Jordan & Henderson, 1995) them, inductively assigning descriptive codes to each sentence. I incorporated in-process memo writing (Emerson et al., 2011) to capture my impressions of the data as I was collecting it. Also throughout data collection, I wrote about excerpts from my field notes and elaborated some of these memos into structured excerpt commentary units (Emerson et al., 2011) where I developed analytic topics.

To supplement the field notes, I conducted member checks (Becker & Geer, 1957) by approaching students I was sitting near after class to see whether my understanding of certain moments aligned with theirs. I either obtained students' consent to audio record their responses or made a voice memo immediately after speaking with them to preserve as much of our conversation as possible. I also spoke around once weekly with the instructor. In these conversations, I aimed to develop a deeper understanding of her perspective on the class, her pedagogical decisions, and what she was interested in understanding about her class through my observations. I regularly revised my analytic memo writing in response to these conversations and interviews.

After completing data collection, I began to connect my observations of certain interactions between students with the construct of siding. To explore this further, I conducted a second, deductive round of content logging by applying a "siding" code to all instances of student interactions in parallel to the main activity. Examining overlaps between this code and inductive codes from my initial content logging (e.g., "peer to peer talk," "laptop screen," and "typing along with instructor") helped establish the structure of the findings.

Positionality and ethics

The field notes and analyses I share through this paper are shaped by my positionality. When I studied to be a CS teacher, being a cis white woman meant I experienced aspects of being both an outsider and insider in CS environments, which are often dominated by white men. I have also experienced a long-term illness, during which I was isolated from in-person social interaction, which sensitized me to the importance of engagement with technology in this work. The analysis was further shaped by my co-authors' distinct positionalities and expertise in human-computer interaction and CS education. Also, while my age made it possible for me to blend in with a class of undergraduates, I was transparent about my identity as a researcher with all students I spoke to.

Findings

We found three categories to be useful for understanding how students sided in CS1. For ease of exposition, we present them separately, though in practice people move fluidly between them. The first, "peer siding," are interactions between students that align with previous definitions of siding. The second, "digital siding," refers to when students use their technology in a way that is similar to peer siding in two key ways—the student does something and technology responds (*interactivity*) and this interaction happens in parallel to the main activity of the class (*context*). The third, "sociotechnical siding," is where both digital and peer siding entwine.

In the first section of the findings, we explore the similarities, differences, affordances, and limitations of each form of siding while arguing for seeing interactions with technology as siding. In the second section, we build from our description of the three kinds of siding to thickly describe how this expansive range of participation emerged in CS1 and point to conditions that enable siding that is meaningful for students' learning.

Siding with peers and with digital technology

Each day in CS1, effectively every student had a laptop out. Typically, the instructor helped students start the day's exercises, which they worked on using their own computers and in their groups. Throughout the class, the instructor would occasionally explain parts of a problem; as she spoke, students frequently whispered to each other and almost always typed or clicked on their computers. So, we did not have to look far to see siding.

We begin this section with one example of a peer siding interaction that does not have clear analogies to digital siding, but that shows the value of attending to side interactions. Then, using our three categories of siding, we demonstrate how students can serve similar needs with different kinds of siding.

Co-construction of knowledge

Sometimes, peer siding did not have direct parallels to digital siding. One such case was when peer siding enabled students to co-construct conceptual understandings through extended exchanges. Before the following excerpt, Josh had just raised his hand and asked the instructor, *"I seem to remember that at one point you talked about Sussman form or lambda form, and I'm wondering how that plays in here."*

> The instructor smiled and said that there was a phrase that "sounded exactly like" what he just said, but that is not applicable in this case. She explained the difference between the two forms, saying, "For example, if you think that you will not need an entire procedure called square, you could just write it like," then typed: map(lambda(x)(* x x))(list 1 2 3)). Either Josh or Eli said, "Ohhhhhh." One said, in an aside to the other as the instructor kept explaining on the stage, "So you call it and it's on the list and then–" the other continued, "It takes in a procedure and applies it to the list so it just—so list is essentially the input. Or, list every–" and the other cut in "every list is–" and the first finished, "every object." The instructor finished talking, then asked if it made sense. Josh replied, "Yes, thank you." (Day 5)

To attend only to Josh's overt participation would be to miss a rich moment of collective sensemaking to the side. After hearing the start of the instructor's explanation, Eli and Josh made sense of her code independent of and in parallel to her teaching by building upon each other's sentences to add specificity. For example, one of them reworded "you call *it* and it's *on* the list" to include disciplinary language: "It takes in a *procedure* and *applies* it to the list" (emphasis added). This kind of dialogue, where a student extends another's ideas, supports learning (Azmitia & Montgomery, 1993) and shows the instructor's explanation alone did not lead to a concept making sense; rather, her explanation initiated siding through which students co-constructed understanding.

Josh was likely willing to side while the instructor answered his question since he thought CS1 was a "pretty safe environment" per his post-class interview, adding that the large lecture hall made it "easy to blend in." Josh also said he liked his group, which shows how the instructors' decision to let students pick their groups contributed to students' willingness to engage with each other. We likely did not see analogous interactions with technology because of how specific their siding was to the instructors' explanation and since their shared positionality as learners allowed them to both legitimately participate in the co-constructive exchange.

Soliciting clarification

Students frequently sided with both peers and technology to solicit clarification. For many students, peer siding was a way to get explanations from a student's perspective, which could be seen when *the instructor said she would start class with a review of functional programming before moving into imperative programming. Aaliyah asked lowly, "What's imperative programming?" A peer quickly answered her* (Day 8). Aaliyah's siding might be seen as a way of "looking up" a definition via her peers that is analogous to searching a term online. Many conditions contextualize her choice to side with her peers, including that they had built rapport from working in the same assigned group for multiple weeks and frequently sided without reprimand. Furthermore, by turning to her peers, Aaliyah got a response from a fellow student, who could give course- and context-specific support.

Another way students sided for clarification was by using technology to search for information. Will sided in this way when the instructor explained a certain list operation, and he *looked at a webpage in the Racket documentation titled "Mutable Pairs and Lists." Then he typed the word "rest" into a search bar on the page, scrolling through a list of hyperlinks returned by his search before clicking one* (Day 9). This is an example of digital siding because its *interactivity* and *context* were similar to peer siding. First, the *interactivity* of the webpage meant that the technology responded after Will searched for "rest." Since programmers working with a list often need to retrieve the rest of its members, we interpret Will's search as asking: "How do I get the rest of the list?" Second, the *context* of the interaction paralleled the main activity of the class. In both this moment and the previous, a student asked a question and received an answer as the instructor spoke, revealing similarity between digital and peer siding. Additionally, just as Aaliyah's relationship with her peers enabled her to turn to them for clarification, Will also needed familiarity with the domain and documentation to find an answer (Zhang et al., 2025). Yet unlike Aaliyah, who received an answer from a peer, Will got a response authored by experts in Racket. This has affordances—the information was accurate, which would not be guaranteed had he asked a peer—and limitations—Will had to filter through options and interpret their contents in terms of his question.

While some clarifying questions can be answered by peers or technology, peer siding benefits from the shared context; in fact, some questions were so specific that only a person in the class could answer them. For example, *the instructor advised the class on how to approach open response questions on an exam, saying, "If you put down a bunch of answers, you'll get credit for how many are right out of how many total you put down." Kara whispered a question to Eli, who replied, "Because you didn't say the exact thing, you can't describe…."* (Day 5). Here, Eli sided to explain a grading procedure, adding his interpretation of the instructor's reasoning for the policy. Kara could not have turned to web search or AI, which lacks context, for an answer.

Tutoring

Students also sided with peers and technology to receive tutoring. Peer siding frequently helped students get personalized support, as the following excerpt shows. After the instructor answered Dev's question on brackets, *Dev turned to Nina while the instructor continued to answer other students' questions. He said something lowly, holding up his thumb and forefinger in a bracket, catching something on the instructor's screen in the web of his hand* (Day 3). It was important Dev sided so he could explain the instructor's response while the instructor's screen still showed the lines of code his question was about. He made use of this shared point of reference by embodying the brackets on the screen with his gesture, making the concept more tangible. After class, Nina explained she took this class since she knew Dev would help her. Because they chose to be in the same group, Dev was able to side with Nina to give the context-specific tutoring that made her feel able to take the class.

I observed one instance of digital siding where a student used AI as a tutor to explain and debug code. We include this case because it occurred just after the instructor told the class that she caught multiple students using AI to write code, suggesting that AI use may be more prevalent than this one observed instance. It is easy to see interactions with AI as digital siding because of the *interactivity* of chatbots, and this interaction occurred in a *context* parallel to the main activity of working with peers and instructors. Like other siding instances, it was not the intended way for a student to engage in a part of class. In this excerpt, Will sat alone and worked on an assignment, as around 20 students did on any given day, since the instructor did not regroup lone students.

> Will ran his code and the terminal went blank before floods of red text filled the console. After a moment, Will switched to an AI chat website (Claude.ai) with "You know the language Racket?" as a header. The rest of the page showed a text exchange, and in the most recent message, Will had written "btw the list will only contain posn, is that ok?" The answer came in word chunk by word chunk of generated text. He read through the response and typed something back before swiftly pulling up his code and the assignment document in split screen. He wrote a new line of code and ran it again—again, red text filled the screen. (Day 9)

As Will programmed, he received a large amount of error text, which can be hard for students using Racket to decipher (Marceau et al., 2011). In the absence of a peer group, Will asked AI for help understanding his code, like Nina turned to Dev for an explanation of the instructor's code. Also similar to Nina's established tutoring relationship with Dev, the existing conversation when Will opened the tool indicates that he had a pattern of seeking help from the AI. The strength of this pattern is underscored by his choice to ask AI to interpret code minutes after the instructor's warnings about using it to generate code, toeing the line of the course's AI policies.

Will's choice to use AI had both benefits and drawbacks. While it likely kept Will from entering the "pattern of disengagement" that can impact CS students when they work on a difficult task without help (Li et al., 2024), the value of AI in this scenario is precisely its weakness: Will could turn to it instead of a peer. This added friction to Will's learning experience since he had to assess whether the AI even "knew" Racket in his first message (the page's header). This is quite different from how Dev provided Nina with context specific mediation directly in relation to the instructor's screen. Turning to AI rather than a peer also had a longer term drawback in that it foreclosed an opportunity for Will to participate in a learning community with his classmates, which is important for the development of disciplinary identity (Bell et al., 2017).

Connecting with peers

Students also peer sided in ways that fostered interpersonal connections. For some, peer siding was a way to share the difficulty of learning CS. This could be seen as the instructor explained how to code a graphic, saying, *"The hard part is the color, of course." June whispered to Mia, "The colors are the hard part for me." June leaned into Mia's side and they both looked at Mia's screen, saying something about "the green" before separating* (Day 2). By siding, June and Mia connected about a challenge June had, creating an opening for her to physically lean on Mia as they made sense of some code. As the instructor first normalized the difficulty, her pedagogy helped make this siding possible, since June only had to agree with her to get a peer's support.

For others, peer siding was also a way to connect about topics beyond the class. While in this paper, we have focused on students' siding when it clearly supported their learning, it was not uncommon for both peer and digital siding to not directly relate to class. For example, as the instructor discussed functions that would be useful for an assignment, *Maya started talking with Leah about whether her parents are coming to visit and wondered aloud about what time she would get to the airport* (Day 2). In this instance, Maya connected with Leah on a personal level by sharing information about her family and life outside the classroom.

Although it may be paradoxical for a student to create interpersonal connections with a peer through digital siding alone, they were often created in sociotechnical systems. This siding was also not usually directly related to classroom learning. For example, as the instructor explained how she would approach a problem using recursion, *Olive held out her phone over the empty seat between herself and Leah, showing a photo of an event invite on Instagram. They leaned in close together and exchanged a few words, smiling* (Day 8). Here, we can see how technology was a conduit that allowed students to interact with the world beyond the classroom (Alirezabeigi et al., 2020) while a main activity continued. Still, by sharing this post, Olive and Leah developed a friendly relationship, which can have long-term benefits for learning and belonging (Picton et al., 2017).

Debugging

As noted in the previous example, peer and digital siding were not mutually exclusive. Students often sided with both peers and technology in sociotechnical systems, especially when debugging. We can see this when the instructor explained her code, and *Ben looked between the instructor's screen and his own, completing a line of code and running it. After a second, he bumped his shoulder into Caroline's. She ran her mouse over her screen, highlighting various lines as Ben watched* (Day 4). All students in CS1 wrote code in an integrated development environment (IDE), a tool that helps programmers write, test, and debug code. By clicking a button to run his code, Ben solicited and received feedback (*interactivity*) from his IDE in parallel to the instructor's explanation (*context*), making this a case of digital siding. We can see how intertwined technology is with peer siding about debugging when Ben immediately turned to Caroline after receiving feedback from the IDE, likely to get help interpreting it. When Caroline drew Ben's attention to parts of her code by highlighting, her computer was a medium through which she communicated with Ben. In isolation, this might not be considered sociotechnical siding, since how Caroline used her computer to point and highlight was only *interactive* in the way a piece of paper is when students underline something for a peer to see. However, viewing this interaction as a whole helps us see the broader sociotechnical system, where peer siding built on digital siding to support debugging.

Sometimes, students only used digital siding, not peer siding, to debug. Ben did so as the instructor explained recursion while *he tried to run his code. An error was flagged, and he added the word "else" to the front of a line. It ran without an error. In the output pane, text read, "4 of the 8 tests failed. Check failures: actual value 64 differs from 8." He looked up at the instructor's screen and erased what he had written at the start of his "else" line so that only the same text as was on the instructor's screen remained. Still 2 of the 8 tests failed* (Day 4). Ben digitally sided with his IDE, *interacting* with it to receive feedback about a bug in a *context* parallel to the instructor's teaching. The IDE flagged a line of code as having an error, similar to how a peer might point to an error being "somewhere on that line." Ben resolved the issue, but then had to interpret new feedback about his code failing tests. While the message about failed test cases gave feedback about the code's functionality, it gave less insight on next steps. So, Ben sought information beyond the IDE by matching his code to the instructor's. Although it may seem Ben was working "alone" on his computer, he managed a complex environment by siding with his computer in parallel to the instructor's coding and explanation.

One day in CS1: A representative vignette

To understand how siding unfurled through a rich tapestry of interactions, we follow one group over a single day of class. By following them, we can see how formal class structures interwove with informal communication webs to create consequential opportunities for students to learn together—with each other and with technology.

Our focal group consists of Claire, Daniela, and Ethan, from a larger group of five students. Before class began on Day 1, near the start of the quarter, the five friends talked in groups of two and three. Once class began, the instructor explained the learning outcomes and gave the class five minutes for a warm up question. The focal group worked quietly, and the auditorium was hushed, save for the scattered sounds of typing. Ethan did not have a computer and looked between Daniela's screen and the instructor's IDE projected at the front.

As the instructor began to explain her process, the focal students only had one course-related side. This happened when *a student asked Claire about "signatures" after the instructor described how she "always starts" by writing one. Claire explained in a whisper, holding her hands up like two brackets as she spoke*. This siding echoes an earlier excerpt where Dev used gestures as he tutored a peer, bringing the course material to a more personal level. The students also sided in less course-related ways when, for example, *Claire looked at a university news website and nudged Daniela, pointing to something. Daniela laughed*. Attending more fully to what led up to these excerpts, especially the quietness of the room and the exercise being a "warm-up," helps us see why there was only one course-related side. Namely, the hushed room would have made it more difficult for students to side unnoticed, and the easier task meant students might need less peer support to understand it.

After the instructor explained the exercise, she directed students to work on a more complex, 30-minute activity. Claire, Daniela, and Ethan collaborated in ways that laid the groundwork for their later siding, which could be seen 10 minutes into the work time, as they fixed an error on Daniela's laptop. *Ethan said that the problem was a certain line, which he pointed to with his finger before highlighting it using Daniela's trackpad. Claire agreed, "Yeah, it's that line!" Daniela changed something, then Ethan exclaimed, "It runs!" pointing to the output and laughing. He suggested, "We should—" and Daniela made another edit, and hit run. As text was output, they giggled. Daniela took out her notes, and Ethan put his hands on the keyboard."* Ethan and Daniela's relationship of co-authorship with input from Claire was perhaps most visible when Ethan couched a suggestion in the phrase "we should," but it was also clear in how Ethan and Daniela exchanged ownership of the computer. During this time, the students also entered a sociotechnical system as they attended to feedback from Daniela's IDE to adjust their code. This feedback even became a site of joy, as seen in their laughter when the code ran.

These patterns fed forward into siding once the class transitioned from group work to lecture. *The instructor offered that if anyone is "cruising" on the problem, "feel free to tune me out and keep working."* This explicitly created an opening for students to side, which our focal group did much more than before. As the instructor gave her explanation, the group's siding was a point of interpersonal connection as they reacted to the unfurling solution. This could be seen when *the instructor said that she was moving on to the "hard part," and Claire whispered to Daniela, "This is what I did— if I actually… that's crazy!"* Meanwhile, Daniela and Ethan continued siding to debug, as *Ethan said, "This syntax is—" and Daniela responded, "Well, actually this is…" She highlighted lines on her screen and typed. As the instructor continued explaining, Ethan exclaimed, "You put down 'cat,' that's what the teacher is doing!" he smiled. "She's goated bro, she's goated!"* Here, Daniela and Ethan collaborated like they did in structured group work time, with Ethan pointing out potential issues that Daniela fixed. The laptop remained an important resource, but now that their interaction occurred in parallel to lecture, this interaction became sociotechnical siding, echoing previous examples where students received feedback from the IDE, highlighted code, and compared the instructor's work to their own. Then, like Claire, Ethan shared his excitement when their code aligned with the instructor's explanation, giving Daniela credit.

Sustained, supportive connection through siding has potential to improve students' CS self-efficacy. After finishing her explanation, the instructor polled the class on how the exercise went: *"Eyes closed, who got it on your own?" Claire raised her hand. After a moment, Ethan reached over to grab Daniela's wrist and raised her hand for her, smiling* (Day 1). The instructor often asked students to share how they did, since she said it helped her adjust her teaching. Though the instructor experimented with other phrasings over the quarter, this question privileged students who got it "on [their] own," potentially contributing to Daniela's reluctance to raise her hand. Yet, as Ethan raised Daniela's hand for her, he communicated his view that the code they wrote together, both in group work and siding, merited her claiming that she "got it." This final side, and the joy and connection that suffused it, ultimately may be important for Daniela's confidence on this assignment and in CS1.

Discussion

Through ethnographic observations of CS1, we found that students sided frequently and in different ways. This aligns with prior work, though we elaborate on how siding manifested in particular ways in CS. This contributes to limited ethnographic research on CS classes in universities, and is the first study of siding in that context. We argued that, especially in CS1, we can see interactions with technology through the lens of siding, since students get *interactive* feedback from their technology in a *context* that parallels the main activity of the class, which is analogous to peer siding. However, there were still differences between digital and peer siding. For one, peer siding benefitted from shared context, while its absence in digital siding often introduced friction. Peer siding also enabled the co-construction of knowledge and community in ways that digital siding did not. Still, digital siding let students access systematic and consistent feedback, especially when they had no peer to turn to.

Our work contributes to research on classroom technology use by adopting researchers' view of siding as a legitimate, commonplace form of participation, and applying it to digital contexts. This is timely, as technologies like AI are increasingly integrated into classrooms and amplifying questions about their role in learning (e.g., Lodge et al., 2023). We agree with Selwyn (2011) that research on classroom technology tends to paint these tools as revolutionary, and to engage more critically with these tools' current role, we should strive to see them as a participatory, not central or secondary, part of classroom learning. Adopting siding as a lens helps us do this, and can ultimately help us recognize how even students who are silently on their computers during lecture are actively learning, even if it is less visible than side-talk (Sahlström et al., 2019).

Our findings also strengthen research on siding. Noticing digital siding helps us better understand the affordances and limitations of peer siding in comparison to it, extending research on how students decide to side (e.g. Antia, 2017). Aligned with prior work, we found that students peer sided to trial ideas, recontextualize lecture content, and build community (Antia, 2017; Bannink & Van Dam, 2013; Koole, 2007; Lemke, 1990; Ofri & Tabach, 2025). While we saw digital siding similarly offer ways for students to engage with course content, the way peer siding affords community-building is accentuated by digital siding's lesser ability to do the same. Researchers have also seen teachers cue in to side talk to adjust their teaching (Bannink & Van Dam, 2013; Lemke, 1990), an affordance absent in digital siding, which is often less visible to teachers (Sahlström et al., 2019). Still, peer siding can distract other students (Lemke, 1990) and cause students to lose common ground with teachers (Koole, 2007). These limitations may be present to a lesser extent in digital siding, since it is quieter and may distract others less, and digital tools can give rapid feedback that may help students stay on the same page as a lecturer.

A limitation of our study is that our main data source was written field notes. Future work should extend ours by capturing audio/visual recordings to produce more detailed descriptions of digital siding. Furthermore, we observed different students each class, and future studies should follow students over longer periods to see how siding changes over time within a group. Finally, we observed siding in a context that integrated technology in very particular ways, which means digital siding may look different in other contexts. Studies could investigate online classes and non-CS courses to understand if and how our findings transfer.

Still, we offer practical insights that can inform university instructors' pedagogy. To cultivate an environment where students can side in ways that are consequential for learning, instructors might adopt these practices, which we observed to be effective in CS1: (1) group students with friends or others with similar interests, so they can form relationships in a community of learners (2) incorporate group work, so students can practice discussing ideas; (3) signal when direct instruction is interruptable, so students can sensemake as an explanation unfolds; (4) use a microphone or strong vocal presence to be heard over side-talk. A shortcoming in CS1 was that some students sat alone, so instructors might implement structures to *keep* students grouped so a student never has to digitally side simply because they have no peer to turn to. Echoing others (e.g. Lemke, 1990), we recommend allowing siding for its ability to support learning and community. However, how and to what extent siding should be facilitated via course design is an area for future research.

Designers should also explore how to support digital siding. We saw value in students having tools that could (1) supply "official" definitions, helping students gain familiarity with professional tools and information; (2) provide on-demand tutoring, potentially helping avert patterns of disengagement; (3) give immediate feedback, allowing students to rapidly iterate on their work; and (4) invite in the world beyond the classroom, enabling students to form connections that extend beyond the class. We acknowledge risks of these tools, including that AI tutors may foreclose the human connection that is so integral to learning (Hou et al., 2025), and that digital tools may make it easier for students to disengage with classroom learning. Yet, we agree with Sahlström et al. (2019) that disengagement is not a *new* behavior created by technology. As digitized classrooms are here to stay in CS, research should explore how to make the most of these potentially beneficial uses of technology and design tools that fit with how students actually integrate them into their classroom activities.

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