Integrating Philosophy Teaching Perspectives to Foster Adolescents' Ethical Sensemaking of Computing Technologies

Rotem Landesman*
roteml@uw.edu
University of Washington
Seattle, WA, USA

Jean Salac*
salac@uw.edu
University of Washington
Seattle, WA, USA

Jared Ordoña Lim
Georgia Institute of Technology
Atlanta, GA, USA
jlim419@gatech.edu

Amy J. Ko
University of Washington
Seattle, WA, USA
ajko@uw.edu

ABSTRACT

Background: The growing complexity of the impacts of computing technologies on adolescents' lives requires them to make similarly complex decisions around technology, fueling a rise in education efforts to look at the ethical implications of these advancements with young people. Though prior computing ethics education efforts integrate ethical perspectives, they have rarely drawn from scholarship on how to *teach* ethics and philosophy.

Objectives: We developed a cross-disciplinary pedagogical intervention that blends ethics-focused computing education efforts like *Youth as Philosophers of Technology* with tools and best practices from *Philosophy for Children (P4C)*, an approach for teaching philosophy to young people. We asked the following research questions: In a secondary computing classroom context, (1) How might adolescent students express ethical sensemaking when engaging with our pedagogical intervention? and (2) What opportunities for ethical sensemaking might our pedagogical intervention facilitate?

Methods: We implemented our intervention in a summer academic program in the northwest US for 10 secondary students (age 14-18) from low-income families and who would be the first in their families to pursue a post-secondary education (i.e. first-generation). We then conducted a qualitative analysis of student classwork and instructor reflections using a combination of inductive and deductive coding.

Findings: Students expressed their ethical sensemaking by considering multiple perspectives, questioning the status quo, wrestling with dissonance between their principles and actions, and rejecting the good/bad binary. These expressions manifested in three distinct opportunities for ethical sensemaking: when students made connections to their everyday life, engaged in supportive dialogue with their peers, and interacted with instructional scaffolds.

Implications: This study indicates the promise of drawing on pedagogies from philosophy when thinking about ethical sensemaking in computing education. Our identification of expressions of and opportunities for adolescents' ethical sensemaking while using this blended pedagogy advances our understanding of computing ethics education, and offers insights for other ethics education efforts in secondary computing.

CCS CONCEPTS

• **Social and professional topics** → **K-12 education**.

KEYWORDS

computing ethics education, Youth as Philosophers of Technology, Philosophy for Children (P4C)

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1 INTRODUCTION

The growing impacts of computing technologies on adolescents' lives and communities necessitate increasingly complex choices around these technologies[1], prompting a wave of ethics education efforts in computing. Previous efforts, most of which have been at the post-secondary level, have primarily drawn inspiration from the study of ethics [8, 23, 25], that is if they engage with the field of philosophy at all. Even if ethics education in computing does engage with ideas from philosophy, such engagement is often exclusionary and shallow. In many cases, learning ethics is subservient to learning computing in a hierarchy of knowledge, and often does not include a deeper engagement with varying ways of knowing, which is beneficial to meaningful ethical thinking [61]. For example, scholars have pointed to computing educators using common ethical dilemmas, like the Trolley Problem, in a manner that rarely accounts for the epistemological differences that stem from social and historical contexts, or cultural and developmental differences in the audience to whom this dilemma is presented [2, 28, 53, 79]. This singular example is among many others of computing educators doing their best to integrate ethics into their pedagogies, but

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[1]Throughout this paper, 'technology' refers to 'computing technology'.

in a manner that does not quite do justice to the rich history and potential that discussing these dilemmas hold.

Engagement with ideas and concepts from philosophy, as presented above, constitutes engaging with philosophy *content*. However, content knowledge is not sufficient for effective teaching; pedagogical knowledge (knowledge of how to teach generally) and pedagogical content knowledge (knowledge of how to teach specific content) are also necessary [30]. Even rarer than engagement with philosophy *content* in computing ethics education [61] is engagement with philosophy *pedagogy*, which precisely tackles questions around teaching philosophy with considerations for cultural, developmental, historical, and social contexts. Just as there is a distinction between knowing computing and knowing how to teach computing, there is a distinction between knowing philosophy and knowing how to teach philosophy. Teaching philosophy combines knowledge of teaching and learning with deep knowledge of discipline-specific philosophical content [11, 30]. Since ethics is explicitly a major branch of philosophy, scholarship on teaching philosophy has a long and rich history of ethics education, and thus may offer useful insights for the rising computing ethics education efforts to avoid a 'reinvention of the wheel'.

Given the impacts of technology on society, expertise sharing would be beneficial not only to computing education, but also to philosophy educators. In a similar interdisciplinary collaboration, Munro [49] argued that artists may benefit from knowing the rules of aesthetics to decide whether to adhere to or break them in their craft, while aesthetics philosophers may benefit from the techniques artists utilize while thinking about the composition of the world. Recognizing one another's expertise allows for an additional perspective which then enriches both philosophers and practitioners. Similarly, computing and philosophy educators with expertise in their respective topics could benefit from collaborations that highlight each other's best practices when they teach. Though technology is not the only aspect of students' lives requiring the deep questioning that philosophy pedagogies help cultivate, it is one with increasing impact and interests in the field of philosophy at large [58]. By engaging with computing educators, philosophy educators would gain the practical, technical knowledge needed to thoughtfully engage students in some of the most pressing current issues.

The integration of best practices and insights from both the philosophy education and the computing education perspectives are therefore beneficial to scholars and educators, but most importantly - to students. Students who learn both technological and ethical reasoning skills will be better equipped to use, critique, and create technologies in ways that promote justice and equity in their communities. Upholding calls from computing educators to support the development of ethical reasoning skills in conjunction with computing skills in youth [36, 48], this study investigated potential ways this interdisciplinary approach can scaffold the development of ethical reasoning around technology in youth.

More specifically, we draw from the practice of Philosophy for Children (P4C). P4C is an approach for teaching philosophy that supports youth in interrogating and discussing the philosophical queries they encounter in the world [42, 74]. Contrary to its name, P4C has been used with youth ages 6-18, with positive effects on their cognitive abilities, and affective and social skills [10, 12, 15, 21, 33, 39, 44, 46, 75].

A parallel attempt to integrate ethics in computing education for youth is an approach called Youth as Philosophers of Technology, which positions youth as active thinkers about technology's role in their lives [76]. This approach de-emphasizes key computing skills and concepts without devaluing them. Rather, it emphasizes youth learning to interrogate the multiplicities, inconsistencies, and ethical impacts of technology.

We designed a novel pedagogical intervention that combines techniques from P4C and Youth as Philosophers of Technology to facilitate adolescents' ethical sensemaking [54, 57]. We sought to answer the following research questions: In a secondary computing classroom context,

(1) How might adolescent students express ethical sensemaking when engaging with our pedagogical intervention?
(2) What opportunities for ethical sensemaking might our pedagogical intervention facilitate?

We implemented our intervention in a computing elective course within a summer academic program for low-income and first-generation (i.e. first in their families to pursue post-secondary education) secondary students (ages 13-18) in the northwest United States. We chose this study population because while technologies' negative impacts are often most felt in these economically marginalized communities, they are often the least equipped to combat these impacts [5, 19, 20], making it all the more crucial and urgent they learn to critically think about and examine technological advancements.

With little precedent for utilizing philosophy pedagogy in computing education, our knowledge on this topic is nascent and therefore, we opted for a qualitative analysis of student classwork and instructor reflections. This study's contributions are threefold. First, we developed a novel pedagogical intervention that blends approaches from both teaching philosophy and computing education, bringing together insights from two fields that have mostly been strangers to each other. Second, we documented the variety of ways adolescents might express the interrogation of multi-faceted, complex ethical issues while learning about technological topics, advancing our understanding of the knowledge and skills possible in secondary computing ethics education. Third, we identified potential opportunities for ethical sensemaking within our intervention, with implications for future instructional scaffolding around ethics education in secondary computing classrooms. Our hope is to catalyze further connections between philosophy and computing education, especially with the rising importance and urgency of ethics education in computing.

2 BACKGROUND

As our intervention blended approaches from both philosophy and computing education, we delineate relevant insights on ethics education from both fields. We conclude with important principles from funds of knowledge and sensemaking theories that ground our instructional approaches.

2.1 Ethics Education for Youth: Computing Perspectives

The burgeoning literature on ethics in post-secondary CS education has led to crucial contributions. These include surveys of ethics content in computing classes [8, 23], barriers educators faced in teaching ethics in computing courses [8, 68] , strategies for integrating ethics into computing classes (e.g. [6, 7, 9, 22, 62, 67]), as well as students' reception of computing ethics education [56]. Delving further into these insights is out of the scope of this current work, as we specifically focus on ethics in the computing education of secondary or adolescent students.

Scholars have critiqued commonplace terminologies like Computational Thinking (CT) — a concept prominent in primary and secondary computing education — for its narrow focus on computational concepts and skills. Iversen et al. offered an extension to CT that accounts for the social and ethical implications of computing in *computational empowerment* (CE), suggesting that CT cannot stand alone as an educational goal, as it lacks the wider contextual approach to technological, cultural, and societal challenges [35]. Unlike CT which centers youth's understanding of computational concepts and skills, CE highlights the importance of engaging youth in critical reflection on the broader societal and ethical questions that emerge from the roles and designs of computational technologies. Similarly, Kafai et al. offered framings of CT that decenter computational concepts and skills, namely situated and critical framings [36]. Unlike the cognitive framing of CT that emphasizes computational concepts and skills, the situated framing of CT emphasizes students' interests and learning communities, while the critical framing of CT emphasizes both an examination of and resistance to oppressive power structures in computing. Drawing from Freire and Macedo's conceptualization of literacies as vehicles to empower students to interrogate and combat power structures in their lives [27], Kafai and Proctor reframed CT towards more expansive computational literacies that not only include an understanding of key ideas and practices, but also its ethical and critical uses [37].

Scholars have therefore developed various approaches to center social and ethical implications in primary and secondary computing instruction. Morales-Navarro et al. [48] synthesized these computing education approaches into three categories. The first is inquiry, where students inquire on the implications of computing (e.g. [4, 78]). The second is design, where students (re-)design computing in ways that aspire towards justice and change (e.g. [3, 40, 73, 77]). The third is reimagination, where students rethink the present and past to reimagine computing to create more equitable and just futures (e.g. [34, 66]). In our work, we draw on one approach to critical inquiry which positions youth as philosophers of technology because it pedagogically prioritizes both computing and philosophical inquiry, enabling them to complement, not compete with, each other [61]. Youth as Philosophers of Technology decenters without devaluing computing practices to instead center 'learning how decode and unmake technology's relationship with power' [76]. In this approach, youth learn to wrestle with the multiplicities, inconsistencies, and ethical complexities of technology. This approach rests on three principles: (1) philosophizing through designing artifacts and relationality to lives, communities, and societies, (2) analyzing the 'stack' and 'street', meaning the technical aspects ('stack') and their interactions 'down the street' of the technology at hand, and (3) critiquing existing technologies and imagining towards liberatory principles. Pedagogically prioritizing both computing and philosophical inquiry cultivates *technological wisdom*, a form of knowledge that emerges from a scaffolded contemplation of ethical complexities and implications of technology [76]. Guiding youth to be philosophers of technology focuses on respecting their intellectual integrity [18] and ability to think critically about the world around them [63, 64].

2.2 Ethics Education for Youth: Philosophy Perspectives

Brown et al.'s review of computing ethics education papers found that most did not articulate a clear conception of 'ethics' [8]. Breaking from that trend, we use Paul and Elder's definition of ethical reasoning as asking or learning about "*What **should** the correct conduct be?*" [57]. This is distinct from moral reasoning, which is asking or learning about "*What **is** the correct conduct right now?*".

Recently, philosophers have attempted to reexamine the definition of what philosophizing is, and who is doing so outside of academia. Scholars [24, 43, 50] have challenged philosophers working in academia to reexamine the original purpose of philosophy alongside our assumptions about the types of thinking that philosophizing requires. They argued that anyone who engages in deep inquiry into the workings of life and the world can be a philosopher, regardless of age or background. Philosophy for Children (P4C) thus emerged as a praxis-based approach to engage children in representing, discussing, and working through fundamentally philosophical questions — ranging from the ethical to the epistemological queries they often encounter in their lives [42, 74]. Contrary to its name, scholars have used P4C on a wide age range, from kindergarten (age 6; e.g. [12]) to secondary students (age 13-18; e.g. [10, 15, 39, 44]). Fundamental to P4C are three principles: that (1) all youth are capable of critical and reflective thinking based on their lived experiences, (2) youth engage in P4C with their peers in a 'community of inquiry' (similar to the idea of leveraging relationality as youth become philosophers of technology [76]), and (3) P4C facilitators guide youth's philosophical thinking in the community of inquiry by creating a supportive climate [43]. P4C methodologies support youth in developing critical thinking and discourse skills, as well as teach them to reflect on their own positionality while listening to peers speak and respond thoughtfully [42]. Over time and with practice, these skills can encourage ethical reasoning among youth who engage in philosophical discourse.

A more specific model scholars use to analyze the processes that prompt and shape ethical reasoning in youth is the dialogical critical thinking (DCT) model. DCT combines critical thinking — thinking that doubts and evaluates principles and facts — with dialogical thinking, defined as constructive and responsible thinking [13]. DCT has four aspects: (1) *logical*, referring to formal and informal logic and is characterized by coherence in discourse and argumentation, (2) *creative*, referring to divergence in thinking and is characterized by novelty and unexpectedness, (3) *responsible*, referring to beliefs, actions, principles, and ethical and social values, and (4) *metacognitive*, referring to retrospection regarding thinking,

tasks, and behaviors. These four aspects of DCT map out to developmental process of ethical thinking recorded in youth, starting with (1) *egocentricity*, which centers personal experience, then (2) *relativism*, which takes others into account, and finally (3) *intersubjectivity*, which is oriented toward a common 'good'. Scholars sometimes use DCT as an analysis tool to examine pedagogical tools in philosophy education for youth as well as youth's ethical thinking processes [14].

2.3 Funds of Knowledge & Sensemaking Theories

The Funds of Knowledge (FoK) theory framed our instructional approach, partially because of the economic marginalization faced by the students in our study. FoK theory argues that learners, especially those from marginalized backgrounds, bring valuable knowledge and competencies from their lived experiences into the learning environment [29, 47]. However, the value of their knowledge and competencies is often invisible or illegitimate because of unbalanced power hierarchies in educational settings. Educators who choose to recognize their learners' FoK in STEM learning experiences have improved educational practices, learning outcomes, and connections between STEM practices and students' existing assets [16, 71, 80, 81]. Upholding Moll's call for educators to make visible and legitimize the FoK of marginalized learners [47], we intentionally designed our pedagogical intervention to offer our students multiple pathways to use their existing knowledge and competencies.

Our intervention and teaching approach also draws on sensemaking theory, which like FoK and P4C, upholds that all youth are capable of critical and reflective thinking when they draw from their lived experiences. Definitions for sensemaking abound. Dervin's definition from organizational research defines 'sensemaking' as individuals actively processing information from various sources to achieve understanding, rather than achieving an arbitrary pinnacle of knowledge [17]. Ford's definition from argumentation research, however, defines 'sensemaking' as critiques of new knowledge claims through generation and evaluation of alternative possibilities [26]. With its popularity in education research, Odden and Russ synthesized these definitions across different scholarly traditions to propose a coherent definition, claiming that 'sensemaking' is the process of building an explanation to resolve a perceived gap or conflict in knowledge [54]. This definition recognizes both students' existing knowledge and their agency in addressing inconsistencies between their existing knowledge and new information. Bridging Elder and Paul's definition of ethical reasoning and Odden and Russ' definition of sensemaking, we define **ethical sensemaking** as *the process of developing explanations for perceived gaps or conflicts in knowledge regarding what the correct conduct should be in a given situation.* Per this definition of ethical sensemaking, we aimed to characterize both (1) how students perceived gaps or conflicts in knowledge of what the correct conduct should be and (2) how students worked through explanations for those gaps or conflicts when looking for signs of ethical sensemaking in our classroom.

3 MORAL PRISMS: A PEDAGOGICAL TOOL FROM PHILOSOPHY FOR CHILDREN (P4C)

To elicit and scaffold ethical sensemaking with our students, we used a pedagogical tool from P4C called *moral prisms* [59]. Moral prisms describe and prompt thinking about common Western moral theories in a relevant way for secondary students (ages 13-18) by offering questions to ask of a specific situation through the lens of a moral theory, which students can then apply and ask themselves. Students are introduced to a moral 'palette' with seven ethical perspectives; seven questions to ask themselves, each representing a Western ethical school of thought to decide if a particular course of action is right or wrong. The role of the moral prisms is not for students to answer moral questions aligning with each prism's underpinning moral theory, but for students to ethically reason by forming questions highlighting varying ethical theories that act as scaffolds for discourse. With the moral prisms, students are offered a spectrum of moral reasoning, bringing a wide variety of perspectives to an issue. All seven moral prisms offers students avenues to engage in ethical reasoning, or ask "What should be the correct conduct?" [57].

We introduced students to the moral prisms using a local computing issue. During the time of this study, the local county was considering a law prohibiting businesses from not accepting cash (going 'cashless'), in response to a rising number of businesses exclusively accepting electronic payments (e.g. credit cards, mobile wallets like Apple Pay and Google Pay) [31]. Using the moral prisms, we walked our students through the different questions that can be asked of this issue while foregrounding differing ethical theories. The moral prisms, the moral theories each prism is based on, the key question for each prism to help students understand the underlying moral theory, and the example questions through each moral prism that we showed our students based on our local cashless business ban debate are summarized in Table 1. While we started with the potential cashless business ban in our county, students analyzed many other topics using the moral prisms throughout the class.

4 METHODS

4.1 Context

We conducted this study in an elective class during a 6-week summer academic program (July-August 2023) at a northwest US university targeting students from low-income families and who would be the first in their families to pursue a post-secondary education (i.e. first-generation) from local under-resourced schools. In many ways, this program was an extension of the academic school year. The required classes in the program mirrored classes in the school year, and students received official school credit for classes taken in the program. However, it was distinct in several ways. First, the students received lunch allowances and a stipend to offset the financial opportunity cost of summer employment. Second, teachers nominated students for program admittance. Third, the program fostered community through study groups and field trips in addition to classroom instruction. Lastly, since this program occurred during summer break, instructors of elective classes were actively discouraged from assigning students homework, so students completed all assignments during class time.

Moral Prism	Key Question	Example Questions on Cashless Business Ban
Existentialist (Existentialism)	What course(s) of action will set people most free?	Does going cashless infringe on people's banking freedom? Businesses' freedom to protect themselves against theft? Customers' freedom to choose?
Deontological (Kantian Deontology)	What would I do if everyone in the world were to do as I did?	What would happen if the whole world went cashless? Is it ok to go cashless if there is even one person who wants to use cash?
Ethics of Caring (Care Ethics)	What course(s) of action will best sustain and nurture a caring relationship between myself and others?	What relationships would going cashless impact (e.g. servers receiving tips, business owners with banks, customers who forgot their cards at home)?
Communitarian (Humean Communitarianism)	How would I act if everyone in my community knew exactly what I were doing?	How would people in my community react if they knew I preferred using cards, while knowing its possible negative implications?
Utilitarian (Utilitarianism)	What course(s) of action will best maximize total happiness in the world?	Would going cashless make the most people happy? Is someone's happiness more important than someone else's (i.e. business owners vs. non-bankers vs. card customers vs. government)?
Virtue Ethics (Aristotlean virtue theory)	What would the most virtuous person I know of do in this situation?	What are the virtues that emerge from going cashless (e.g. productivity, environmentalism)? What are the virtues that emerge from barring cashless (e.g. equity, accessibility)?
Egoist (Ethical egoism)	What course(s) of action will most effectively ensure that my short- and long-term goals are reached?	Whose goals are we optimizing for? customers? banks? government? un-banked? tech companies?

Table 1: Moral prisms, their underlying moral theories, the question each moral prism asks, & example questions based on our county's potential cashless business ban

Author 1 was the lead instructor of a technology elective class, while Authors 2 and 3 were co-instructors. Elective classes met four days a week for one hour. Our university institutional review board granted this study exemption because it was conducted as part of instruction. We managed informed assent by allowing students to assent to different levels of participation after explaining the nature of and associated risks of the research participation.

4.2 Student Demographics

All 10 students enrolled in the class assented to their classwork being analyzed for research through a form on the first day of instruction. The form also asked open-ended questions for students to self-disclose their gender identity, ethnic identity, languages spoken at home, disabilities, and other parts of their identity they wanted to share with the instructors. For students who assented to research participation, the form prompted students to select their own pseudonym. We used their initials if they provided a pseudonym too close to their actual names. To preserve their anonymity, one student disclosed mental health issues as part of disability and two students identified as young women, while eight students identified as young men. Students' ages, ethnic identities, and languages spoken at home are shown in Table 2.

4.3 Class Structure

In the month preceding the study, Authors 1 and 2 prepared to teach the class by closely reading the paper introducing the Youth as Philosophers of Technology approach [76] and meeting with the paper's lead author to discuss opportunities and pitfalls of their approach. We iteratively brainstormed P4C techniques to implement in our class, eventually landing on the moral prisms as the focal technique to support ethical sensemaking. Author 3 joined the project two weeks before the start of the study and prepared by reading and discussing the paper and the moral prisms with Authors 1 and 2.

In addition to introducing the moral prisms (see Section 3), we aimed to uphold the principles of P4C from the very first week of class. In Week 1, we intentionally worked to foster a trusting community among our students by asking them to collaboratively develop and decide on three class rules, as well as decide what the topics we would cover in the course. Every class throughout the summer also started with a short warm-up to prepare students for collaboration and discussion. We facilitated connections to their everyday lives by prompting students to draw a map of technologies in their homes. Based on these technology maps, students came up with questions they had about the technologies in their lives. From these questions, the students and instructors worked together to form a list of topics to explore for the rest of the class. Students then discussed with each other to decide on three topics. By the end of Week 1, they chose data privacy, social media, and AI.

In Weeks 2-4, we covered each of the student-selected topics. Each week followed the structure below (see Table 3):

Pseudonym	Age	Ethnic Identity	Languages Spoken at Home
J	17	Mexican	Spanish, English
EL	17	African-American	English
Indigo	16	Black, Hispanic	English
Aaron	Almost 18	South Asian	Bangla
Bartholomew	15	Chinese	English, Chinese
Z	16	Asian	English, Burmese
Anita	16	Vietnamese	Vietnamese
EC	15	Chinese	Three Languages
C	14	Asian	Chinese
Amiin	16	Somalian	Somalian

Table 2: Students' Self-Disclosed Demographic Information

(1) We first oriented students to the topic and its technological inner workings to provide the knowledge for stack and street analysis which preempts ethical sensemaking. Since we also valued understandings of the technological inner workings as required of 'technological wisdom', these activities sought to 'pull back the curtain' of these technologies — enough for our students to make sense of their ethical complexities.
(2) We next introduced students to a local ethical dilemma related to the topic. Our objective was to scaffold ethical sensemaking through discussing technological issues that were related to them and their communities, foregrounding relationality in the process. Students collaborated in groups of 3-4 to research the week's dilemma and form ethical questions using two or three of the seven moral prisms we introduced to them in Week 1.
(3) Lastly, each group presented their questions, while students in the audience wrote down further questions that they had based on the presentations. Students submitted audience questions anonymously so they could write without fear of judgment. We then discussed some presentation and audience questions as a class, engaging the community of inquiry and invoking students' critique and imagination.

Weeks 5-6 were dedicated to students' final projects. Students worked in groups of 2-3 to explore one ethical dilemma around technology. They first brainstormed several ethical dilemmas which involve technology in their lives and chose one to explore. Then, they came up with ethical questions that can be asked of this dilemma by using all 7 of the moral prisms. With their dilemma and questions in mind, we prompted them to storyboard two different stories, one of how the dilemma is addressed in the present and another of how the dilemma could be addressed in a more 'ethical' alternative future (Figure 1). Using their storyboards, they then represented those stories with their choice of medium. The class culminated in students sharing their story designs (Figure 2) with the whole class first and then the broader summer program, and looking back on the class as a whole in a written final reflection.

4.4 Data Analysis

Our data sources were student classwork and daily instructor reflections. Student classwork used in our analysis were worksheets that the students filled out during the class activities, presentations the students gave at the end of the week, and their final projects (see Table 3). After each class period, all instructors (Authors 1-3) individually completed a reflection with prompts based on the principles of Youth as Philosophers of Technology framework (below). The authors wrote for 15-30 minutes, and paid particular attention to their observations of:

- Philosophy through Design & Relationality: Students' ethical sensemaking through the design of artifacts (computational, artistic, narrative, etc) and/or their relationships with each other, families, friends, and communities
- Stack & Street Analysis: Students' analysis of both the tech stack (the tech itself, hardware/software) and tech's interactions within its cultural, political, and environmental contexts
- Critique & Imagination: Students' critique of technology and imaginations around alternative possibilities
- Other Observations

Our qualitative coding had two phases: inductive and deductive. During the inductive phase, Authors 1 and 2 open-coded a subset of instructor reflections and students' final reflections. We opted to start with students' final reflections because it covered their overall thoughts and reflections on the entirety of class. We then used affinity diagramming to develop the coding rules (Table 4). In the deductive phase, Authors 1-3 used the coding rules to deductively code all student classwork and instructor reflections. During this phase we adopted the principle of coding our data 'as-is', meaning that a phrase is sufficient to justify an application of a code, to minimize inference. No instructor coded their own reflections, and the other two instructors coded the remaining instructors' reflections (e.g. Authors 1 and 2 coded Author 3's reflections). At least two authors coded every piece of student classwork and documented their disagreements. The codes that needed the most discussion were:

- *Questioning the Status Quo*: This code was originally 'Questioning the Definitions' in the coding rules developed after the inductive phase, but after some discussion and disagreements early in the deductive phase, this code was expanded beyond definitions alone. Throughout the deductive phase, a common point of discussion around this code stemmed from ambiguity around what the 'status quo' was in student quotes.

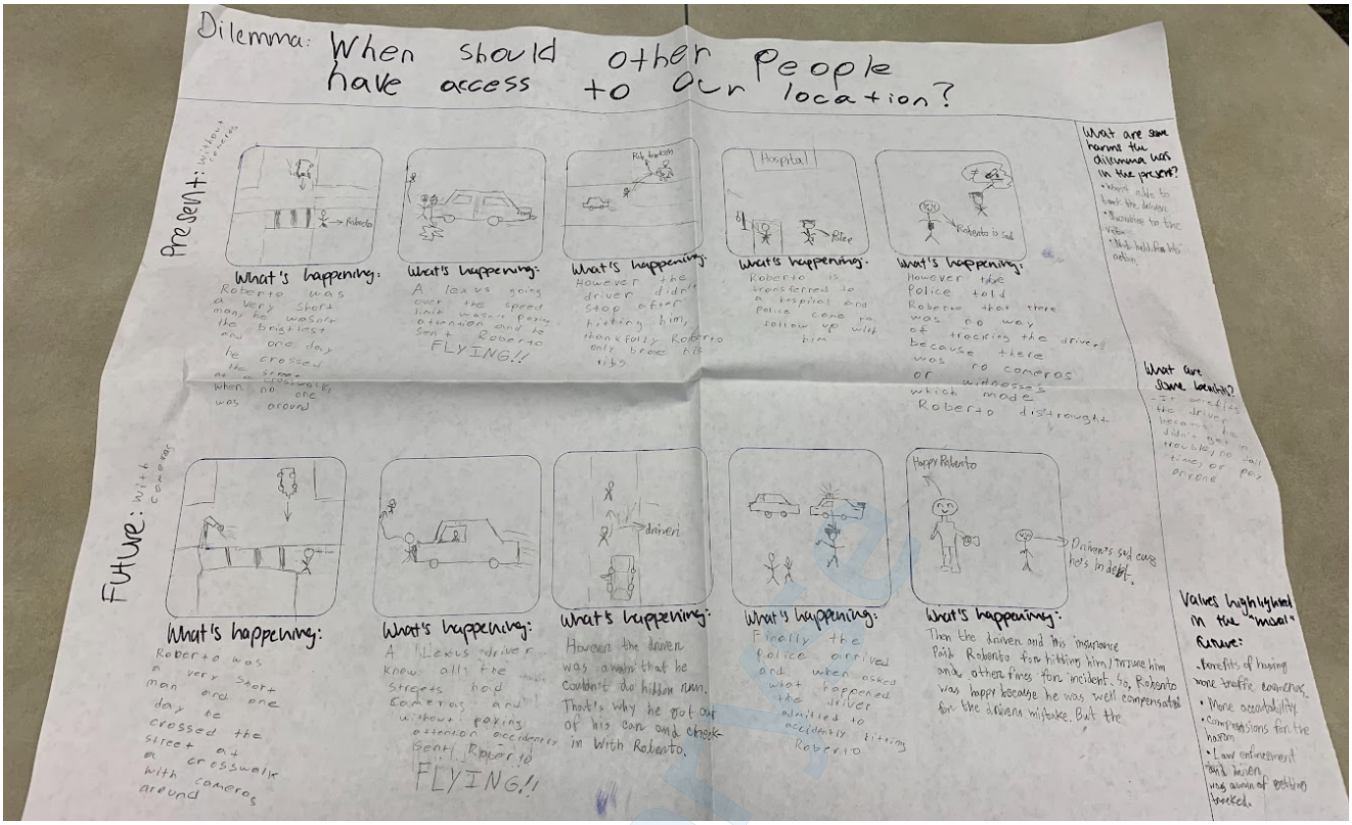

Figure 1: Example storyboard from J & Aaron's final project on location sharing

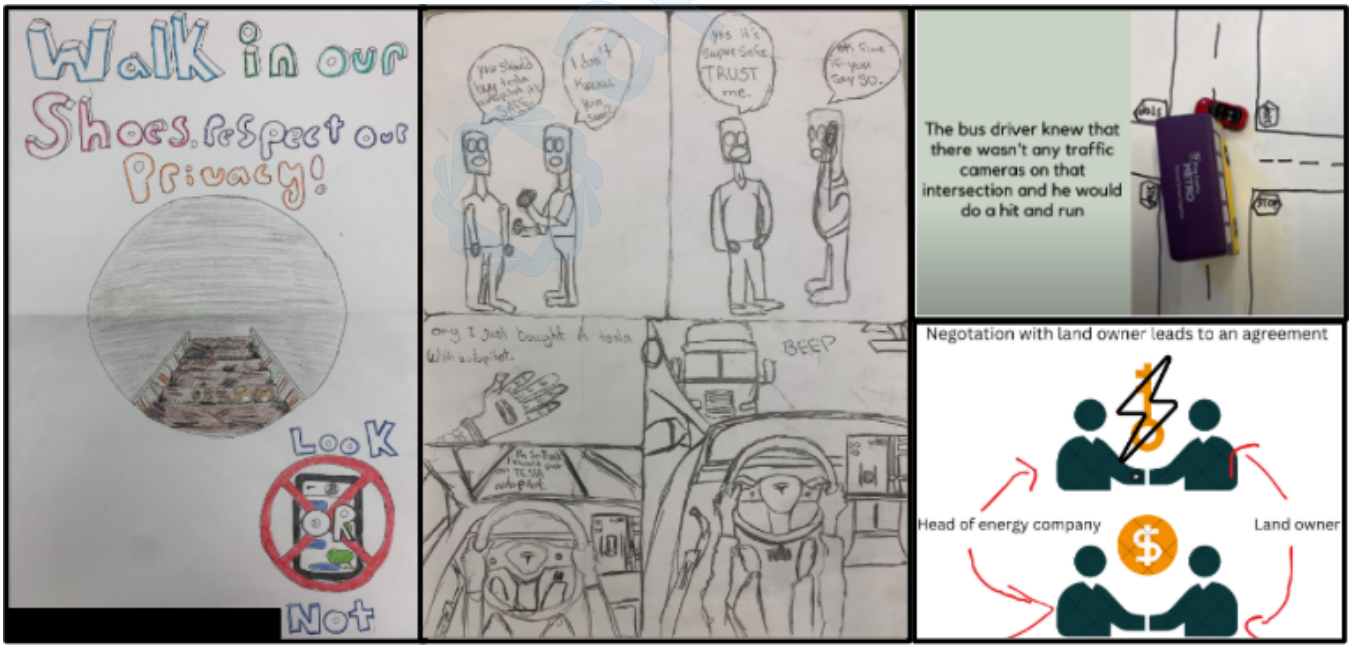

Figure 2: Excerpts from Students' Final Projects (left to right): Indigo, EL, & EC's project on parental access to children's devices, Amiin, C, & Z's project on self-driving cars, J & Aaron's project on location sharing (top), Bartholomew & Anita's project on sustainable energy (bottom)

Week (Topic)	Activities
Week 1 (Intro)	Community of inquiry through student selection of class rules & topics for the class Connections to everyday life through Technology Map activity Introduction to the Moral Prisms through debate around local county's potential ban on cashless businesses [31]
Week 2 (Data Privacy)	'What is my Digital Footprint?' Activity covering concepts like cookies, geolocation, & metadata 'Stalk Yourself' Activity to see what information there is about themselves online Analysis & Discussion of state bill to protect children's rights in parent-influencer content [70]
Week 3 (Social Media)	'Social Dilemma' Activity on the design of social media sites based on 'Social Dilemma' documentary [51] 'Social Media Scavenger Hunt' Activity to survey people on campus about their behaviors & perceptions of social media Analysis & Discussion of local school district's lawsuit against Social Media companies [38]
Week 4 (AI)	'Train your own ML Model' Activity to train their own ML model using *Teachable Machines* [1] 'Break ChatGPT' Activity to develop & test their own prompts to break ChatGPT Analysis & Discussion of local school district's ban on ChatGPT [52]
Weeks 5-6	Final Project: Analysis, Storyboarding, & Design of an Alternative Future story on a student-selected contemporary ethical dilemma on technology

Table 3: Overview of Class Activities

- *Rejecting the Good/Bad Binary*: Due to language idiosyncrasies, there were some student quotes where it was unclear if students were upholding or rejecting the good/bad binary.
- *Considering Perspectives*: Some student quotes required discussion around how specific the conceptualization of the person to whom those perspectives belonged to needed to be.

Rather than calculating statistical agreement metrics like inter-rater reliability [45], we resolved disagreements by building consensus through discussion, abiding by Hammer and Berland's position on qualitative coding. Hammer and Berland posited qualitative codes as tabulations of thematic claims about data [32]. Adhering to this position, we do not treat qualitative codes as data, but instead as outcomes of the data analysis process. Just as it would be inappropriate to run statistics on p-values in quantitative analysis, we do not report any statistical metrics on the codes themselves, instead opting for thick descriptions [60].

4.5 Positionality

Author 1 came into this work with experience teaching philosophy for children, and an immense curiosity to the potential of discussing the ethical dilemmas technology poses with teens. She immigrated to the US at a young age and grew up in a bilingual home. Contrary to the cities she grew up with which are rife with technological innovation, her background is in traditional philosophy and the social sciences. The author got involved with this project because of her complementing expertise in teaching philosophy and working with teens to the Author 2's technological knowledge, and prioritized giving space to the technological parts of the curriculum that she believes are necessary in order for meaningful and contextual ethical sensemaking to occur. In her teaching, she strives to create a safe communal space for the students by showcasing her own process of questioning, especially in a summer program such as this one where the students are in a new learning environment.

Author 2 approached this work with familiarity. She had taught in this academic program before, so she was familiar with its dynamics. She immigrated to the US as a teenager, grew up with economic challenges, and was the first in her family to attain a post-secondary education in the US, similar to the students in the study. Like most computer scientists, she was trained in computing cultures that prized computational concepts and skills at the expense of sociotechnical ones. With significance and urgency of ethics in computing, she wanted to interrogate the priorities of her own research and teaching praxis. While teaching this class, she remained intentional to also prioritize ethics, instead of defaulting to only prioritizing computing because of the hierarchy of knowledge she was acculturated in. She co-led this project with Author 1 because their respective expertise complemented each other in productive ways.

Author 3 approached this work with local knowledge of students in this study. He was born in the US and was born to immigrant parents, where he grew up in a bilingual, middle-class family, and lived in the same geographical region as the students who participated in this study. He recently graduated with an undergraduate degree in a computing-related field, where he also taught as a teaching assistant for an undergraduate-level ethics in technology course at the institution in which the study occurred. This was his first time teaching in this particular program, but drew from prior teaching experience in academic tutoring in algebra for youth and adolescents. While teaching the class, he made efforts to leverage his local knowledge to adapt the curriculum and class activities for the students' geographical and cultural context. He co-taught and conducted data analysis with Author 1 and 2 because of his expertise in teaching assistantships in college-level ethics courses and local knowledge of students' culture and background.

Author 4, a professor at the institution at which the study occurred, was positioned at some distance from both the youth in the study and the program they were in. However, she had taught

Code	Description
Expressions of Ethical Sensemaking	***What did ethical sensemaking look like?***
Questioning the Status Quo	Students interrogating 'the way things are', social norms or constructs, normative definitions of ideals and principles (e.g. 'happiness', 'good')
Rejecting the Good/Bad Binary	Students moving beyond something being only 'good' or only 'bad' or acknowledging the gray area between 'good' and 'bad'
Wrestling with Dissonance	Students wrestling with contradictions or inconsistencies between different values and actions
Considering Perspectives	Students accounting for other people's perspectives
Opportunities for Ethical Sensemaking	***When did we observe ethical sensemaking?***
Connections to Outside Life	Students relating in-class materials to life outside the classroom. Must be specific conceptions of lives outside the classroom beyond generic mentions of 'people'
Community of Inquiry	Students using group discussions or activities to support their ethical sensemaking
Engagement with the Scaffolding	Students working with the instructional scaffolding to support their ethical sensemaking

Table 4: Coding Rules

in the summer program for several years, often works with teachers at their schools, and is broadly aware of the socioeconomic forces shaping their school resources and learning experiences around computing. However, Author 4 shared lived experience with the youth, as a mixed-race, transgender person with lived experiences with poverty, racial marginalization, and multicultural family tensions. Finally, she was the supervisor of all three of the other authors, placing her in a position of power over the team. She managed this positionality by playing an advisory role for the rest of the teaching and research team, offering guidance on research design, methods, and reporting, but keeping distance for the team to best respond to the learning contexts without interference, and always with guidance when they decided they needed it.

5 RESULTS

We first present characterizations of our students' ethical sensemaking, which we termed 'expressions of ethical sensemaking' (RQ1). We follow with the opportunities for them to ethically sensemake, as facilitated by our intervention (RQ2). Many quotes from students and instructors had multiple codes so using one quote to illustrate a specific code below does not mean that it does not represent another code. Quotes from student classwork and instructor reflections were attributed accordingly, but audience questions based on weekly presentations were anonymous (see Section 4.3).

5.1 Expressions of Ethical Sensemaking

We observed our students express ethical sensemaking by questioning the status quo, considering multiple perspectives, wrestling with dissonance, and rejecting the good/bad binary. We grounded each expression with the definition of ethical sensemaking in Section 2.3.

5.1.1 ***Questioning Status Quo.*** Through interrogating normative constructs and definitions of ideals, students noticed gaps or conflicts in knowledge regarding what the correct conduct should be, and proceeded to reason about these gaps. We called this expression of ethical sensemaking questioning the status quo.

For example, when working on their presentations to analyze the ChatGPT ban, students questioned what 'freedom' meant:

> Bartholomew, C, EL, Indigo: *"Is freedom defined by the ability to choose between using ChatGPT's services freely or not?"*

Similarly, during the social media unit, after students presented their moral prism questions, one student in the audience anonymously questioned the definition of happiness:

> Anonymous: *"What makes people happy? Is this happiness long-lasting?"*

In their final projects, students also questioned the status quo when they deliberated on ethical dilemmas involving technology in their everyday lives.

> EC: *"Should children be more happy if parents have access to their kids' chats? Is it restricting of kid's freedom?"*
>
> EL: *"Would big tech companies continue exactly as they have with their voice activated AI if everyone knew what they were doing?"*

In the quotes above, the students expressed deeper inquiry and ethical sensemaking by explicitly questioning the definitions or status quo of the concepts that were brought up throughout class.

5.1.2 ***Considering Perspectives.*** Students also ethically sensemade when they expressly made a point to examine the perspectives of multiple stakeholders. This is an expression of ethical sensemaking because when students actively interrogated different perspectives, we observed them both perceive gaps or conflicts in their own knowledge, as well as interrogate explanations for these gaps or conflicts for what the correct conduct should be in different situations.

For example, students expressed various perspectives in their presentations, allowing them to delve into discussions about the 'right' course of action for different stakeholders:

> Bartholomew, Amiin, Anita, Z: *"If I were to make a law against adults making content and without consent use their children in the content, would families that rely on content for financial stability suffer and be against it?"*
>
> Aaron, EC, Z: *"Will ChatGPT affect the relationship with your parent? [...] with other students?"*

Students also expressed different perspectives of issues during class discussions. For instance, an instructor observed students perspective-shift during a discussion of the local county's potential ban on cashless businesses, which we used to introduce the moral prisms in Week 1.

> Instructor 1: *"One of the students brought in an example of what their parents thought of the cashless issue [...] and another thought about how they feel when they go with or without cash."*

In their final class reflections, students expressed that learning about their peers' perspectives helped them 'see the bigger picture' of technology-related dilemmas differently that they may not have though of were they not in the class:

> EL: *"whether we are thinking about it through moral prisms or just having a class discussion, I feel as I have developed a liking for more in depth thinking and looking at bigger pictures through smaller lens."*
>
> Amiin: *"We all tend to see things through only our perspective but looking through others perspective like how would the best person I know do or think in this situations and because of this it gives a broader point of view."*

5.1.3 ***Wrestling with Dissonance.*** When developing explanations for perceived gaps or conflicts in knowledge as part of ethical sensemaking, some students wrestled with contradictions or inconsistencies between different values and actions. This rarely occurred in their moral prism presentations and class activities, but most obviously occurred when students deliberated on their final projects.

For example, in their final project Indigo & EC grappled with the dissonances between their own perspectives and their parents' in the context of parents having access to children's chat messages.

> EC & Indigo: *"Would kids be resentful towards their parents if they had access to their online chats? Would the parents be doing it out of love? Is it beneficial or negative for the online relationship if it weren't private?"*

Similarly, J & Aaron expressed dissonance when they contemplated the dilemma of location sharing for their final project, engaging with the existentialist moral prism.

> J & Aaron: *"Will most people be free if everyone had access to everyone's location ? [...] What action can make people state of being free while accessing our location whole time?"*

While there were limited to no expressions of dissonance in the moral prism presentations and other class activities, our instructor reflections indicated that students wrestled with dissonance between values and ethical perspectives during class discussions, especially when those discussions prompted students to draw on relationality, or connect the topics to everyday life as an opportunity for ethical sensemaking. For example, students grappled with their caring for others and their social media usage:

> Instructor 1: *"Students talked about how they would never give up social media even if they knew others struggled with mental health"*

Students also expressed dissonance when they discussed their own social media usage, despite knowing the effects it may have on mental health:

> Instructor 2: *"Indigo said that they chose social media as a topic in class because they all know it's bad, but they still use it."*
>
> Instructor 3: *"They described the concept of mindless scrolling without us actually having to prompt them about it. And also how social media allows them to connect with friends and share life updates."*

5.1.4 ***Rejecting Good/Bad Binary.*** Some students expressed ethical sensemaking by thinking beyond whether a technology is exclusively good or bad, and expressed more nuance and acknowledgement of different ideals when thinking about ethical quandaries. This expression of ethical sensemaking is crucial as the students learn to grapple with multiple ethical perspectives, and realize that what is 'good' depends on factors like values, worldview, etc. For instance, some students rejected this false dichotomy when analyzing AI and ChatGPT, departing from common tropes glorifying or villainizing them:

> Bartholomew, C, EL, Indigo: *"What kind of things would the most virtuous person consider when determining whether if AI is good or bad?"*

Aaron & J similarly departed from common tropes glorifying or villainizing location-sharing technology in their final project brainstorm:

> Aaron & J: *"If everyone were being recorded on traffic cameras would it make everyone keep under observation? If everyone has a choice of sharing their location or not, then how would emergency services, parents, law enforcement people track our location?"*

The instructor reflections further corroborated how students rejected the good or bad binary during class discussions or activities. For instance, this rejection of the good and bad binary emerged in the class discussion following the data privacy presentations:

> Instructor 2: *"Students were starting to think about the tensions between the parental rights within the home and governments' right to regulate"*

Another example was in the social media unit, where students did a scavenger hunt activity asking people on campus their thoughts on social media. After participating in this activity, we observed students expressing both the acknowledgement of a 'grey' area between social media usage and mental health:

> Instructor 1: *"The group I was with talked about why they themselves don't stop using social media even though they know the down sides (and then integrated those questions into their interviews, which was fun to see), and brought up the idea that though they are aware of seeking validation through these platforms, they are not necessarily willing to stop doing so"*

5.2 Opportunities for Ethical Sensemaking

Alongside expressions of ethical sensemaking, we identified opportunities for students to engage in ethical sensemaking throughout the class: when they made connections to their lives outside the classroom, worked with their peers in a community of inquiry, and engaged with instructional scaffolding.

5.2.1 ***Connections to Outside Life.*** One opportunity for students to ethically sensemake was when they were making connections between classroom activities and discussions to their own lives outside of the classroom. For example, this group of students discussed the local school district's ChatGPT ban by relating it to their personal lives:

> J, Anita, Amiin: *"If everyone knew that I was using chatGPT on my assignments would I still use it ? If everyone knew that I stopped using chatGPT would it encourage others to also stop using it"*

Another group of students introduced race into their discussion when training their own ML model as part of the AI unit, framing the conversation within their own experiences:

> Instructor 3: *"[EC] and [Indigo] began touching on how trained data can sometimes not recognize the race of that person; since [EC] was Asian and [Indigo] was Black, they wondered how their ML model (only trained on their faces) could see the race of other people; [Instructor 3] looked similar to [EC] (approximately 90%+), along with [Instructor 2], but [Instructor 1] was split evenly between both [EC] & [Indigo]."*

As the instructor reflection shows, the opportunity for the students to engage in ethical sensemaking emerged when students explored the impact of image classifiers on recognizing their own and their peers' races. Once the students realized the model may not be as apt in recognizing races as they thought, a class discussion emerged about the dangers of the fallibility of ML models on society. This is an example of an opportunity where students were encouraged to ethically sensemake by making this connection to their peers and lives outside the classroom.

5.2.2 ***Community of Inquiry.*** Another opportunity for ethical sensemaking was when students engaged in class discussions, using the community of inquiry with their peers to work through ethical dilemmas.

This opportunity for ethical sensemaking was captured largely by the instructor reflections, rather than in the students' classwork. Because of the nature of the presentations, where students collaborated to analyze a computing topic with the moral prisms, none of them explicitly mentioned engaging with their peers in their classwork. After every presentation, students chose to discuss some of the questions from the presentations and audience questions. Instructors took careful notes of these discussions, which were not recorded to protect students' privacy and create an environment of trust, but proved to be a rich opportunity for ethical sensemaking through the course.

During the social media unit, for example, students engaged in discussions while thinking through the impact of social media on adolescents through an existentialist lens. The discussion, captured by the instructor reflection below, portrayed how students worked together to more deeply discuss the balance between freedom and mental health and grapple with the tensions that a specific ethical perspective may bring up:

> Instructor 3: *"The class and Amiin co-constructed existentialist questions, where Amiin suggested (paraphrase) that sometimes, we as a society need to intervene into a teenager's freedom when it impacts the mental health of that person."*

Similarly during the data privacy unit, students leaned on their community of peers to discuss data privacy and the ethicality of looking people up before meeting them, expressing both dissonance and different perspectives. The discussion spurred out of the students talking about what they would do and challenging their peers with hypothetical situations. The instructor reflection highlights how the differing opinions within the community of inquiry inspired further conversation rather than rifts, alongside active ethical sensemaking on the part of the students:

> Instructor 2: *"Students discussed the situations when they looked people up online, i.e. when friends have a crush, when they want to figure out mutual friends. Students discussed how their online activities were in support of sustaining relationships with their families and friends. Students expressed disbelief when Bartholomew said that they didn't do something online because he cared about privacy."*

5.2.3 ***Engagement with the Scaffolding.*** The scaffolding of the moral prisms throughout the class, but especially in their presentations, afforded students opportunities for ethical sensemaking. For instance, one group of students used the communitarian prism to analyze the ChatGPT ban in schools, asking the following question in their presentation:

> J, Anita, Amiin: *If everyone were to use ChatGPT in schools without consequence would there be any creativity or any distinguish in the classrooms?*

While students made sense of the technology-related dilemmas with the scaffolded presentations, we found that the ensuing class discussions were often a more fertile opportunity for students to exhibit deeper ethical sensemaking. For example, based on their presentations on ChatGPT in schools, students discussed if using ChatGPT was cheating.

> Instructor 2: *"Students are definitely more comfortable discussing with each other [than with the instructors]. The debate around 'If everyone's a cheater, then no one's a cheater' or 'If everyone's a cheater, everyone's still a cheater' came up pretty organically."*

Other times, the scaffolded warm-ups and articles based on the dilemmas facilitated students' ethical sensemaking. For instance,

one warm-up during the data privacy unit prompted students to think of things that were fair, unfair, both fair and unfair, and neither fair nor unfair. During this warm-up, students discussed the fairness of labor rights and taxes. Afterwards, they used an article from the instructors to analyze the rights of social media influencers' children and their rights. Students both made connections to their everyday life and considered different perspectives of the given topic while engaging with the scaffolding to support their ethical sensemaking:

> Instructor 1: *"Exploring the 'wait I don't understand why I need to be paying someone to protect my rights' [...] are important stepping stones in being generally inquisitive. When they talked about their own paychecks, thinking of things in them that were fair or unfair, perhaps that was one of the few times that they've thought about the fairness of the world [...] I also saw some sensemaking through relationality [...] when thinking about what they would like their rights to be were they children of influencers."*

6 DISCUSSION

6.1 RQ1: In a secondary computing classroom context, how might adolescent students express ethical sensemaking when engaging with our pedagogical intervention?

The novel pedagogy presented in this paper blended insights and tools from teaching philosophy disciplines (P4C) together with a computing education framework that foregrounds both ethical sensemaking and computational ideas and skills (Youth as Philosophers of Technology). In summing this research question, we return to the definition of ethical sensemaking introduced at the start of this paper: *the process of developing explanations for perceived gaps or conflicts in knowledge regarding what the correct conduct should be in a given situation* [54, 57]. Notably, students showed signals within their reasoning processes that indicated ethical sensemaking was taking place in several ways (Table 4). Our students questioned the status quo and considered the perspectives of various stakeholders to notice gaps or conflicts of knowledge. To develop explanations for these gaps or conflicts, our students accounted for multiple stakeholders' perspectives, and also negotiated dissonance between different values and actions, and rejected the good/bad binary.

Unlike the other expressions of ethical sensemaking, we did not observe students wrestling with dissonance in their classwork, we only observed it through class discussions and students' final projects. Dissonance may be the exception due to evaluation norms around classwork. Although we worked to reduce pressures around grading, such pressures are deep-seated in a formal classroom environment. Dissonance asks students to wrestle with inconsistencies between their values and actions; students could have felt that admitting such inconsistencies in their classwork would reflect poorly. In contrast, class discussions were neither recorded nor resulted in tangible outputs that students could be 'judged' on by their peers or instructors. Therefore, students may have felt more comfortable expressing dissonance during class discussions. Nonetheless, we observed some students wrestling with dissonance during their final projects, perhaps because those students may have felt more trusting of their peers and instructors after 5-6 weeks of instruction.

Unlike Vakil and McKinney de Royston [76], we did not observe our students express ethical sensemaking through the design of their final projects. This may be due to their extended instruction in one particular medium, compared with our students' open choice of medium for their final projects. Our students may have needed deeper knowledge in their medium of choice to make design decisions that would reflect their ethical sensemaking. This highlights how instructional context can shape how students express their ethical sensemaking.

The expressions of ethical sensemaking we observed may signal a fledgling technological wisdom in our students (see Section 2.1) [76]. With the guided inquiry facilitated by the moral prisms and the instructors, we found our students begin to wrestle with the nuances, multiplicities, and contradictions of the ethical implications of technology. This suggests that our intervention facilitated deeper considerations for other ways of knowing that support ethical thinking, addressing critiques of existing computing ethics education efforts [61]. The scale of our study precludes us from proposing any sort of 'framework' for ethical sensemaking. Nonetheless, these expressions of ethical sensemaking could serve as the *start* of such work, similar to Iversen et al.'s archetypes of Computational Empowerment [35] or Antle et al.'s framework for critical reflection [3].

6.2 RQ2: In a secondary computing classroom context, what opportunities for ethical sensemaking might our pedagogical intervention facilitate?

We observed our students sensemake about ethical dilemmas when they made connections to their lives outside the classroom, engaged in discourse with their peers, and leveraged instructional scaffolds.

These opportunities for ethical sensemaking reified principles from both Youth as Philosophers of Technology [76] and Philosophy for Children (P4C) [74]. The importance of relationality, or sensemaking in ways relevant to youth's everyday lives, echoes previous work [48, 76], which names relationality as both a sign and an outcome of ethical sensemaking. Similarly, work in P4C shows discourse held in a safe community of inquiry and scaffolded with developmentally relevant interventions can induce ethical sensemaking [43], reflective of the two other opportunities for ethical sensemaking we observed. Offering our students avenues to draw from their funds of knowledge[29, 47], both through connections to their everyday lives and their community of inquiry, supported them in their sensemaking process. Unlike the other two opportunities, we only observed mentions of the community of inquiry in instructor reflections, as a proxy for class discussions. This highlights a conflict between assent/consent and data collection practices for computing ethics education research; recording class discussions could have resulted in more 'precise' data but could also have made students more reticent to share their thoughts authentically.

Finally, the fact that we observed students ethically sensemake while using the instructional scaffolds may be indicate their potential to facilitate ethical inquiry, offering insights for the design of

further efforts of ethics education in secondary computing. Since these opportunities are represented in both previous work and our work[48], we may cautiously point to the benefits of using a framework inspired by best practices on teaching philosophy in a computing classroom. Pedagogical interventions like ours which blend teaching computing knowledge alongside providing opportunities to ethically sensemake about technology allow students to engage meaningfully in the content and start to develop an ethically minded perspective on the technologies they interact with.

All three opportunities did not have to coincide for students to ethically sensemake; a subset could have facilitated students' ethical sensemaking. Sometimes, the opportunities complemented each other, such as when students were working with the Virtue Ethics prism (Table 1):

> Instructor 2: *"Amiin, Anita, & C were better able to think about the Virtue Ethics prism when we asked them to think about the best person they knew & what they would do in the situation."*

This quote highlighted how connections to their everyday lives — specifically thinking of the best person in their lives — enhanced our students' engagement with the scaffolding provided by the moral prisms. This example showcased a synergistic relationship between two opportunities, that while only one opportunity could have been sufficient to support ethical sensemaking, the alignment of opportunities could deepen their ethical sensemaking in insightful ways.

6.3 Limitations

Our choices in study context, instructional design and methodology led to limitations in both the internal and external validity of our results.

For internal validity, our formal classroom environment inherently introduced power dynamics between instructors and students whenever there are expectations of grades, despite our mitigation efforts such as assigning grades based on completion, rather than evaluation. Additionally, although the instructors completed reflections immediately after each class, they were only three perspectives on class discussions, a crucial part of the learning experience. We chose not to record class discussions because (1) not all students assented and (2) we wanted to mitigate the Hawthorne effect, opting for instructor reflections as a proxy. Finally, the schedule of the summer program hindered our data collection during the last week of instruction. With the end of the program drawing near, our students faced pressures from the required classes in the program and were understandably anxious about their grades in those classes. This affected their time and capacity in the last week of class when they were finishing their final projects.

For external validity, our students only represent their own experiences and sensemaking processes within this particular classroom context. Our students were also nominated to join this academic program, chose this class as their elective, and were from a city with a prominent technology industry, introducing some selection bias. Nonetheless, with little precedent for blending philosophy and computing pedagogy, our priority for this study was not generalizability, but instead to generate deep characterizations for a nascent approach [60, 69]. Given the low-income backgrounds and ethnically and linguistic diversity among our students, our study did shed light on the funds of knowledge that adolescents of similar backgrounds may bring into computing ethics learning experiences. Lastly, like most of philosophy [55] (and frankly, even computing [41, 65]), there is a Western bias in the moral theories that the moral prisms are based on. There are emerging efforts to integrate non-Western philosophies, such as Ubuntu ethics, in computing ethics education, which will be exciting to build upon in future work [72].

6.4 Implications & Future Work

This study demonstrates the viability of a blended pedagogical technique drawing from both philosophy and computing education to scaffold for ethical sensemaking among secondary students. By making space for students' Funds of Knowledge [29, 47], our technique allowed students to draw knowledge from their everyday lives, knowledge that is often rendered invisible or illegitimate in educational settings, in their ethical sensemaking. The descriptions of expressions of ethical sensemaking provide insights for characterizing the skills and competencies that youth can acquire through a blended computing ethics instruction. Additionally, our identification of possible opportunities for ethical sensemaking demonstrate how the principles proposed by both Youth as Philosophers of Technology [76] and P4C [43] may be enacted in a computing context, offering guidance for the instructional design of future computing ethics education efforts.

Our study heeded calls from computing education scholars [48, 76] for cultivating in youth a deep inquiry into computing's sociotechnical impacts and liberatory possibilities. Of the main conceptualizations of this deep inquiry is an active philosophical interrogation and contemplation of the way technology impacts the contemporary world [76]. To create pedagogical scaffolding that supports this type of inquiry, we turned to the scholarship on teaching philosophy, more specifically P4C [43]. The P4C principles we adapted into the Youth as Philosophers of Technology [76] framework and the resulting pedagogical insights are an invaluable resource to computing education research, as they embody a long and rich history of working with youth to explore philosophical fields, among them ethics. A successful blending of pedagogy from both philosophy and computing education, one that allows them to complement rather than compete with each other, offers an accessible way for more secondary computing educators to integrate evidence-based best practices for teaching ethics from philosophy into their curriculum. Such synergy between both fields supports educators in approaching this inquiry in a rigorous and meaningful manner, where ethics is pedagogically prioritized alongside computing [61]. This deeper inquiry equips students to face the ethical issues around computing they will inevitably encounter in a more thoughtful manner, supporting the goal that students use, critique, and create with technology in ways that positively impact their communities and promote a more just society at large.

To promote these visions of a different computing education, future work could investigate how the blend of Youth as Philosophers of Technology and P4C would work with different study populations and different educational contexts, and how the expressions of and opportunities for ethical sensemaking would change. With

the centrality of our students' funds of knowledge, some differences would be expected, but what those differences are would be an interesting area for future study. Another area for future work would be incorporating non-Western moral theories into the moral prisms and how those alternate perspectives shape youths' ethical sensemaking. Finally, our study is just scratching the surface of what P4C and other philosophy pedagogy can offer to computing education. Future work integrating insights from philosophy may also benefit from other areas of study beyond ethics, such as epistemology, aesthetics, and metaphysics. Just as computing touches every area of our lives, so do these fields questioning the world around us. Working through these questions with young people in a computing context can only strengthen their resolve in the face of the fast-paced, technological environment they are growing up in, and empower them to take control of their lives within it. We hope that this paper catalyzes computing education researchers to find connections between these two fields of scholarship and for computing education practitioners to explore implementations of ideas and techniques from P4C and philosophy pedagogy more broadly when teaching computing ethics.

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