Investigating an Automatic Assistant in Computer Ethics Education

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***Abstract*—This innovative practice paper introduces a novel approach that combines the automated assistant system, Packback, with computer ethics education to enhance the quality of educational outcomes in this field. As digital technology rapidly advances, it becomes imperative for educators in technology fields to prioritize ethical considerations. This priority stems from the potential risks associated with technological advancements and the necessity to ensure that these advancements positively impact society. In this context, deepening the understanding of the impacts of technology through computer ethics education is particularly crucial. This paper explores how automated assistant systems can be effectively integrated into computer ethics instruction through the application of Packback, an online educational platform. Packback stimulates students' curiosity and critical thinking by providing a question-and-answer-based learning environment, encouraging students to pose deep, insightful questions and explore answers with the help of their peers. The platform employs various automated text and language-based algorithms to facilitate discussions, enhance writing skills, and build critical thinking capacities. Compared to traditional teaching methods, our approach utilizes the capabilities of automated assistants and incorporates diary study methodology to emphasize reflective and interactive learning of course materials. We introduce three Packback assignments: Packback Discussion Questions, Packback Deep Dive, and Packback Diary Study. We found that most students have a positive attitude toward their overall experience through the comprehensive end-of-term questionnaire surveys. Feedback highlights that Packback has deepened their comprehension of computer ethics, offered a venue for reciprocal learning and exchange, and improved their ability to write arguments. However, some feedback also pointed out areas for improvement in the automated system, such as its over-reliance on the length of essays, which compels students to artificially expand brief sentences, thereby affecting the efficiency and quality of learning. Therefore, by summarizing feedback and experiences, we aim to provide valuable suggestions and practical cases for future integration of computer ethics education with automated assistant systems.**

***Index Terms*—Ethics; Computer Science Education**

I. Introduction

As technology becomes ubiquitous, it profoundly impacts people's thinking and behavior, making computer ethics education increasingly vital [1]. Social media platforms like Facebook and Instagram have not only transformed the modes of communication but also heightened ethical concerns related to data privacy and content moderation through incidents like the Facebook–Cambridge Analytica data scandal [2], [3] and the TikTok controversy [4], [5]. Furthermore, the widespread adoption of artificial intelligence tools such as ChatGPT [6], [7] and Sora [8] has sparked extensive debates about the moral responsibilities and reliability of machine decision-making. The application of virtual reality technology in video games has also escalated concerns over cyber violence, cyberbullying, and cybersexual crimes [9]. These issues are no longer confined to specific regions or nations; they represent global challenges that humanity faces in the new era. As legislative bodies and legal advisors explore and formulate relevant policies, the imperative for computer educators to enhance students' understanding of computer ethics has become pressing.

The time is upon us for critical computer science education [10]. The task of computer science educators extends beyond merely instructing students on how to read and edit code. More importantly, it involves cultivating students' ethical and critical thinking skills to deepen their understanding of the societal impacts of technology [11]. Consequently, educators face the challenge of how to nurture ethically responsible technology experts in this ever-evolving technological landscape. With the number of students majoring in computer science on the rise, this challenge has become increasingly urgent. Statistics show that from 2019 to 2023, the enrollment of undergraduate students in four-year colleges for computer science increased from 455,077 to 595,212, a growth exceeding 30% [12]. This surge compels us to reconsider traditional educational models, such as the reliance on lectures and textbooks for unidirectional knowledge transmission, which are no longer sufficient to address the complex ethical issues in computing or to meet the diverse needs of students. Thus, it is necessary to explore more engaged educational methods to adapt to this trend.

To explore this emerging trend, we selected an automated assistant system, Packback. Packback is an online educational platform that seeks to stimulate students' curiosity and critical thinking skills by providing a question-and-answer-based learning environment that encourages students to pose deep, insightful questions and explore answers with the assistance of their peers. The platform utilizes a variety of automated text and language-based algorithms to facilitate discussion, improve writing, and build critical thinking abilities. By integrating the Packback functionality with the diary study method, we have created a reflective and iterative learning space that emphasizes active student participation. This holistic teaching approach not only aids in students' deep and sustained understanding of complex online ethics issues but also cultivates their reflective abilities, preventing superficial or incidental learning outcomes. This deepens the personal connection between students and the subject matter, providing educators with profound insights into nurturing students' moral reasoning capabilities.

In this paper, we will (1) explore how automated assistant systems can be effectively integrated into computer ethics instruction to enhance students' clarity of expression and advanced argumentation skills and promote the development of their discussion abilities; and (2) delve into students' feedback on their experiences through diary study and questionnaire survey (N=100) to uncover their potential impacts and value in the teaching process.

II. Background

In this section, we will introduce the relevant background of this paper from two perspectives. First, we will discuss the development of ethics education in the field of computer science. Second, we will provide a detailed introduction to the automated support system, Packback, and its functions.

A. Ethics Education in Computer Science

The origins and development of ethics education in computer science can be traced back to the mid-20th century when computer technology began to occupy a central position in society. In the 1960s, as computer science was established as an independent discipline, ethical issues began to receive attention from the academic community [13]. Walter Maner in the 1970s recognized that unique ethical issues arose from the intersection of technology and daily life that were not covered by general ethics courses. This led to the creation of a new academic field termed "computer ethics".

By the 1980s and 1990s, computer ethics began to be more systematically included in academic programs, especially as the use of computers and software expanded dramatically in society and issues like software piracy, privacy breaches, and the impact of computer technology on employment became more prominent. Universities started to incorporate dedicated ethics courses in their computer science departments to address these specialized concerns [15]. The evolution and integration of these courses often reflected the pressing technological issues of the times, adapting to include emerging topics like internet use and data security as technology evolved.

A major critique of current computer ethics education is its predominantly theoretical focus, which might not equip students adequately for the practical ethical challenges they encounter in technological environments. To bridge this gap, educational approaches such as those suggested by Gotterbarn and Miller (2017) [14], which advocate for the integration of scenario-based learning, can be instrumental. These methods encourage students to engage directly with ethical dilemmas through simulations that mimic real-life decision-making. Dennis and Harrison (2021) [16] propose a multifaceted approach to cultivating "cyber-wisdom", emphasizing the importance of literacy, motivation, perception, reasoning, practice, and reflection in relation to relevant virtues. Therefore, in the education of computer ethics, it is crucial to enhance practical teaching and understand real-world contexts. This approach can aid students in effectively applying their acquired knowledge to make ethical decisions when faced with actual ethical challenges in technological environments [17].

B. Automated Learning Assistants

Recent advances in technology make possible platforms that can serve as learning assistants to facilitate student exploration of multifaceted concepts. One such platform, Packback, is an online educational platform designed to stimulate students' curiosity and critical thinking through an automated assistant system [18]. It fosters a learning environment based on questioning and answering, compelling students to delve into profound issues and collaborate with peers in search of solutions. The platform allows instructors to create challenging questions that require students to provide thoughtful responses, rather than merely searching for answers. This approach seeks to encourage the development of independent thinking skills and enhances students' understanding of the material during the exploration process.

One of the core features of Packback is the curiosity score system. This system is engineered to enhance the quality of discussions by scoring questions and responses [19]. The Packback curiosity score evaluates student posts based on four main factors: curiosity, credibility, communication, and convention (See Table I).

Criteria	Description
Curiosity	The depth and intrigue of a student's post, encouraging open-ended and thought-provoking content
Credibility	The use of strong academic sources to substantiate claims.
Communication	Clarity through proper formatting and media usage
Convention	Although not factored into the score, convention is also monitored, guiding students in traditional grammar and writing styles.

TABLE I: Criteria for curiosity scores calculation

Each submission is given a score that reflects the extent to which it provokes thoughtful discussion and inquiry. This

scoring system encourages students to not only participate but also to engage deeply by crafting well-thought-out questions and responses that contribute to a rich academic dialogue. The aim is to cultivate a learning environment where critical thinking and inquisitiveness are rewarded, thereby driving students towards a higher level of academic engagement.

Packback offers a set of tools to enhance course management for educators and increase student engagement through automated assistance–seeking to not only improves teaching efficiency but also allows teachers to gain a deeper understanding of students' learning progress and personal insights through real-time feedback and detailed analytics. On the platform, educators can establish and manage a grading system for assignments that involves creating and regularly updating assignments, setting deadlines, and specifying the detailed submission requirements for each assignment (such as the number of required questions and answers). Additionally, educators can set a minimum curiosity score for assignments. If a student's post does not meet the preset curiosity score threshold, teachers can choose whether to award partial points or not score the post at all. These configuration options allow educators to adjust their teaching strategies based on course objectives and student performance.

III. Crafting a Deeply Reflective Course

The course objective of our junior-level computer science ethics course is to study the ethical, social, and professional concerns of the computer science field. It covers the social impact of the computer, implications and effects of computers on society, and the responsibilities of computer professionals in directing the emerging technology. Ongoing growth of the course size and added complexity of the ethical issues

We have selected Packback for its use in our academic program based on three primary considerations. First, the curiosity score feature of Packback emphasizes grammatical precision and the correct use of references, which facilitates the cultivation of students' rigorous academic writing habits. We believe that accurately summarizing and substantiating personal viewpoints can deepen students' understanding of ethical issues in computer science. Second, the community aspect of Packback shifts the learning paradigm from traditional teacher-led instruction to a student-centered model of autonomous learning and discussion. This model fosters interaction and communication among students and encourages them to engage deeply with ethical issues in computing, thereby facilitating knowledge sharing. Third, we aim to enhance students' awareness of ethical issues related to computer science. We encourage students to engage in reflective thinking about moral dilemmas, such as data privacy and biases in artificial intelligence, while routinely using the Packback software. Through such diary studies, it is envisaged that students will gain a profound understanding of a core principle: ethical issues in computer science are intimately connected with each individual. In the following sections, we will provide a detailed description of the course structure and the setups of the Packback assignments.

A. Course Structure

Our course spans a total duration of 15 weeks, with the initial 3 weeks dedicated to discussing the course objectives, the introduction of the syllabus, and the foundational concepts of computer ethics (aligned with the ACM Code of Ethics and Professional Conduct [20]). The course goal is to help students understand the importance of ethical decision-making in technology and computing. The remaining weeks are structured to explore real-world scenarios, case studies, and theoretical frameworks that challenge students to think critically about ethical issues in the digital age. The subsequent 12 weeks are segmented into 6 units, with each unit lasting 2 weeks and covering 2 sub-topics, allocated 1 week each for lectures. This sequence is designed to progressively deepen students' cyberethics knowledge from basic to advanced levels. The weeks are dedicated to exploring real-world scenarios and case studies that challenge students to critically evaluate ethical issues in the digital age. Detailed information about each unit and sub-topic is presented in Table II.

The course educators identified comprehensive reading materials for each chapter, incorporating detailed explanations of the topic's concepts, introductions and analyses of real-world cases, relevant video materials, and an open-book quiz. Students must complete these quizzes before class to ensure they possess sufficient knowledge to participate in classroom discussions. At the start of each session, educators first provide an exhaustive explanation of the day's background knowledge and concept definitions, followed by case study reports related to the theme, presented by two groups of students. Through this approach, students are able to delve deeply into practical cases and apply the knowledge acquired in class.

B. Assignments

In addition to reading quizzes and case study presentations, the course has three substantial assignments, corresponding respectively to each unit and sub-topics. All assignments need to be done through the Packback system. The three assignments are Packback Discussion Questions (Section III-B1), Packback Deep Dive (Section III-B2), and Packback Diary Study (Section III-B3).

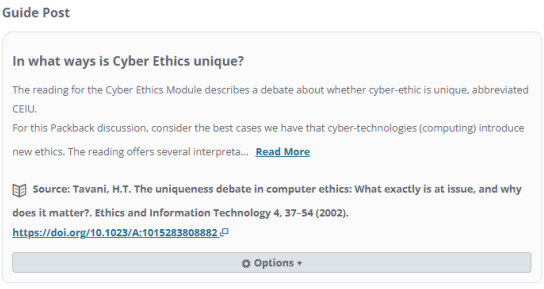


Fig. 1: Sample Packback Discussion Guide Posts

1) Packback Discussion Questions: Following the conclusion of each class session, students are allotted one day to post discussions on Packback, addressing the day's lecture

Unit	Topic	Details
ICT	Internet History	Examines regulatory and privatization controversies in ICT, focusing on tensions between free speech, free markets, and private interests in the context of Network Neutrality.
	Internet Regulation	
Intellectual Property	Copyrights	Explores how cyber technologies transform intellectual property, focusing on copyrights, patents, trademarks, "copyleft", licensing, and trade secrets in computing.
	Patents	
Privacy	In General	Delves into how cyber technology impacts privacy and social interactions, discussing policies, legal concerns, and the effects of surveillance and data mining on public privacy norms.
	In Public	
eCommerce	Persuasive Design	Discusses the significant impact of internet-based interactions on commerce and marketing, focusing on how design and neuromarketing influence consumer behavior and technology's societal role.
	Neuro Marketing	
Artificial Intelligence	Machine Learning	Covers recent developments and debates in AI, focusing on biases, statistical methods, automation, and parallels between human and machine intelligence.
	Algorithms	
Emerging Technology	Video Game	Addresses ethical challenges in social media and video games, exploring issues like privacy, misinformation, and user behavior.
	Social Media	

TABLE II: The six core units presented in the class and the detailed topics covered in each unit

content, assigned readings, or case study reports. These posts allow students to express their insights, pose questions, and engage in in-depth discussions. To assist students in effectively completing this assignment, a guidance post is provided (See Figure 1), which includes a review of the day's lecture topics, prompts for reflection, and recommended additional reading materials or video resources for reference. Additionally, each student is required to respond to at least two peers' discussion posts. To ensure the quality of the discussions, all posts and responses must achieve a minimum curiosity score of 50.

The post-class discussion posts (See Figure 2) on Packback have educational implications, particularly manifesting in two aspects. First, this platform provides a space for voices that might be overlooked in traditional classroom discussions. In conventional classroom settings, time constraints and class dynamics may prevent some students from fully expressing their viewpoints. Packback forums, by offering a time-unconstrained online discussion environment, ensure that all students have the opportunity to thoughtfully express their insights and queries, thereby ensuring a broader and more diverse array of perspectives are heard and debated. This approach aids in promoting inclusive pedagogy, making each student feel an integral part of the classroom dialogue, thus enhancing their sense of participation and belonging.

Secondly, Packback facilitates learning through reciprocal discussion, creating a collaborative learning environment. Students on such a platform share their insights and respond to others' perspectives. Students gain different viewpoints and new information from their peers through this interaction, extending their cognitive boundaries. Additionally, this exchange of ideas sparks deeper discussions, enabling students to learn how to think critically and gain a more profound understanding of knowledge.

In conclusion, the discussion posts on Packback provide an avenue for marginalized voices to express themselves and enhance students' critical thinking and problem-solving skills through a collaborative and interactive learning model.

2) Packback Deep Dive: Packback Deep Dive is designed to evaluate and enhance students' independent research capabilities as well as their academic communication skills through long-form writing assignments, including essays, papers, and case studies. Deep Dive provides real-time feedback and guidance to assist students in composing clear, well-structured, and

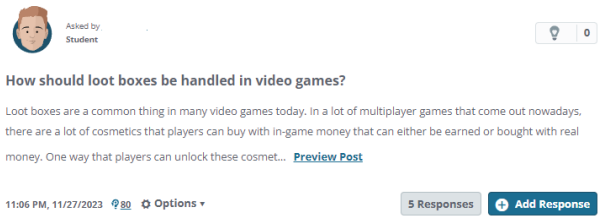


Fig. 2: Sample Packback Discussion Post

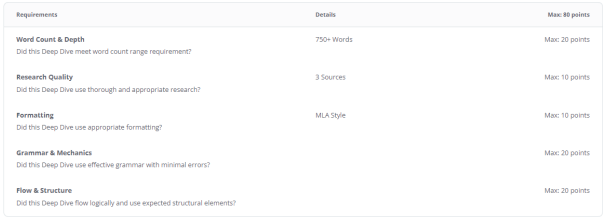


Fig. 3: Sample Packback Deep Dive Grading Criteria

in-depth academic papers. This tool has two primary functions. Firstly, as a writing assistant, students can utilize the "Digital Writing Tutor" feature to receive immediate writing feedback based on the educator's grading criteria (See Figure 3). This includes details on grammar, coherence of structure, and lexical diversity, thereby allowing a more accurate expression of their viewpoints. Secondly, as a research assistant, the "Digital Research Assistant" can instantly assess the credibility and quality of the references used and swiftly generate citations in APA or MLA format, enhancing the efficiency and quality of the work.

As a learning tool, Packback seeks to aid students in understanding and mastering issues related to topics such as computer ethics and morality. Through real-time interactive feedback and precise resource recommendations, students can delve deeply into the origins of ethical conflicts, enhance their critical thinking skills, and better comprehend the consequences of various ethical decisions. This method not only heightens their sensitivity to issues but also fosters the development of moral judgment skills.

Furthermore, the research assistant feature of Packback provides students with authoritative academic resources on

computer ethics, aiding in constructing a scientifically rigorous research framework. Through this approach, students learn how to adhere to ethical standards in practical applications, ensuring that technology use complies with the law while also respecting human rights and social morals. Such a learning tool empowers students to confidently face and resolve ethical challenges in their future professional careers.

3) Packback Diary Study: A diary study serves as a method for gathering qualitative data by asking participants to document their thoughts, experiences, and activities during a specified time frame [21], [22]. Diary studies have helped teachers critically reflect on instructional design and classroom teaching practices, and provided researchers with insights into learning processes and the factors that contribute to effective teaching and learning. Educational experts have underscored the application advantages of the diary study method in higher education, particularly regarding LGBTQ identities, faith, caring responsibilities, international students, socioeconomically disadvantaged students, and employability [23]. By examining these diary entries, educators can gain insights into students' thoughts, ideas, and debates.

Diary studies not only capture individual reflections but also track changes in perceptions and attitudes over time [24]. This dynamic view is particularly useful in educational settings where the progression of student understanding and skill development is key [25]. For instance, in computer ethics education, diary studies can reveal how students' understanding of ethical concepts evolves through direct engagement with real-world case studies and classroom discussions. Educators can use this information to adjust their instructional strategies, ensuring they address misconceptions and effectively reinforce key concepts.

In our educational exploration, it is desired that students perceive Packback not merely as a tool for completing assignments but as a means to engage in the practice of documenting and reflecting on their daily interactions with Packback, as well as their user experiences. This reflective practice aims to facilitate a deeper understanding of how computer ethics and morality manifest in real-world settings, thereby fostering a more comprehensive grasp of these issues. To facilitate this reflective learning process, a diary study approach has been adopted.

Our selection of the diary study methodology is based on three primary reasons. First, this approach fosters active learning and sustained engagement among students. By requiring students to document and reflect on their experiences using the technological platform Packback, they are able to learn ethical concepts from practice and apply abstract moral theories to specific situations. Such application helps deepen students' understanding of computer ethics and enhance their ability to analyze ethical issues in everyday technology use. Secondly, the diary study method provides a framework that enables students to continuously observe and record how technology impacts individual and societal behavior. Through this ongoing observation, students can more clearly perceive the ethical considerations behind technological decisions, understand the responsibilities of designers, and comprehend the long-term effects of technology implementation. This in-depth analysis and reflective process, which is difficult to achieve through traditional teaching methods, can stimulate students' critical thinking and cultivate their ethical awareness as future technology developers and users. Lastly, through specific case analyses and problem-solving, the diary study model motivates students to translate theoretical knowledge into practical operational skills. This model not only deepens students' personal understanding of computer ethics but also encourages them to judge more confidently and independently when faced with ethical decisions. Thus, the primary purpose of designing such assignments is to cultivate students' ability to apply ethical and moral principles in real-world environments through a cycle of practice and reflection.

To assist students in accomplishing this assignment, we designed a diary study template that incorporates a mixed-prompt format consisting of both Unit Focus prompts and fixed prompts. The Unit Focus prompts (See Table III) is designed to guide students in deeply exploring the core issues of specific units, thereby fostering the formation of targeted insights and understanding throughout their learning process. The fixed prompts guide students to record their experiences and interaction patterns while using Packback, and include three specific questions:

- Describe the special incidents and your reflecting emotions (good, bad, frustrating, surprising, fun, angering, boring, exciting) which you remember during the weekly usage of Packback.
- Give a detailed example of a subject you came across during the weekly usage of Packback that might have introduced something new, and explain it.
- Did the automation (including curiosity score) push you to dig deeper, or ask a better question, or add more resources, or write better, or be more engaged in response to your classmates' posts?

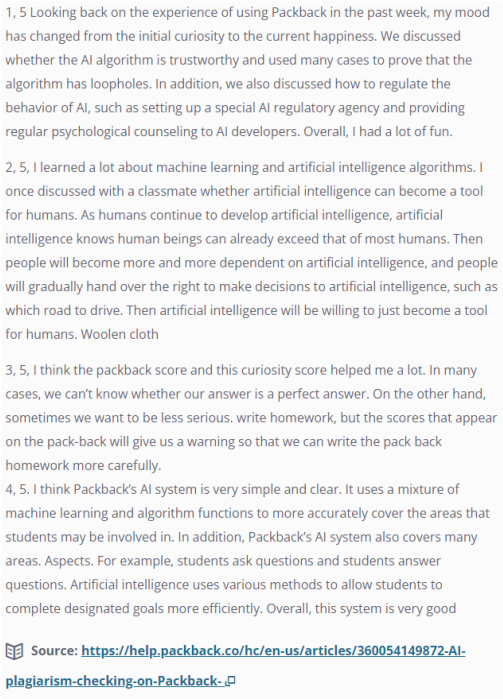
In the context of the study, students are required to compose a brief paragraph for each question and employ a 7-point Likert scale (7 = Completely Satisfied, 1 = Completely Unsatisfied) to evaluate their experiences.

IV. Student Composition and Response

This section aims to expound on students' self-reflections regarding the use of the Packback tool to better understand the role and function of such automated aids in the education of computer ethics. For this purpose, we designed an end-of-semester survey, inviting students to rate their experience and learning outcomes with Packback using a 5-point Likert scale (5 = Very Satisfied/Helpful, 1 = Very Dissatisfied/Unhelpful), and requested detailed personal feedback. The survey was conducted on a completely anonymous and voluntary basis to ensure that the feedback collected was not influenced by external factors. The survey results indicate that a total of 100 students completed the questionnaire, including 1 fifth-year student, 35 seniors, 62 juniors, 1 sophomore, and 1 transfer student. The average age of the students was 20.92 years, with

Unit	Prompts
ICT	Read and understand the Packback Curiosity Scoring Algorithm. The Packback Curiosity Scoring Algorithm currently scores individual posts based on three main criteria: Presentation, Credibility, and Effort. Do you feel the score was fair, consistent, and understandable?
Intellectual Property	Who owns the data (weekly discussion ideas/essay/this diary report)? You? Instructors? University? Or Packback? Will the ownership of Packback (Commercial Product/University Tools/Open Source Software) affect your response?
Privacy	Packback does not have a feature for private replies/posts. Do you feel embarrassed, proud, by your post, and might others be? Would this cause you to have concerns and prevent you from fully expressing your true opinions or thoughts?
eCommerce	Consider the needs and interests of various groups, such as commercial/Packback companies, users/students, instructors/graders, and those with disabilities. Based on your daily usage, select at least two groups. Discuss what you believe are their needs, consider which needs Packback has met, and identify areas where there might be room for improvement.
Artificial Intelligence	Read Packback AI introductions. Describe the transparency and explainability of Packback AI. Can you imagine how some of the various algorithms work here (simple to complex)? Is it clear and reasonable to users/students?

TABLE III: Diary Study Unit Focus Prompts



1, 5 Looking back on the experience of using Packback in the past week, my mood has changed from the initial curiosity to the current happiness. We discussed whether the AI algorithm is trustworthy and used many cases to prove that the algorithm has loopholes. In addition, we also discussed how to regulate the behavior of AI, such as setting up a special AI regulatory agency and providing regular psychological counseling to AI developers. Overall, I had a lot of fun.

2, 5, I learned a lot about machine learning and artificial intelligence algorithms. I once discussed with a classmate whether artificial intelligence can become a tool for humans. As humans continue to develop artificial intelligence, artificial intelligence knows human beings can already exceed that of most humans. Then people will become more and more dependent on artificial intelligence, and people will gradually hand over the right to make decisions to artificial intelligence, such as which road to drive. Then artificial intelligence will be willing to just become a tool for humans. Woolen cloth

3, 5, I think the packback score and this curiosity score helped me a lot. In many cases, we can't know whether our answer is a perfect answer. On the other hand, sometimes we want to be less serious. write homework, but the scores that appear on the pack-back will give us a warning so that we can write the pack back homework more carefully.

4, 5. I think Packback's AI system is very simple and clear. It uses a mixture of machine learning and algorithm functions to more accurately cover the areas that students may be involved in. In addition, Packback's AI system also covers many areas. Aspects. For example, students ask questions and students answer questions. Artificial intelligence uses various methods to allow students to complete designated goals more efficiently. Overall, this system is very good

Source: https://help.packback.co/hc/en-us/articles/360054149872-AI-plagiarism-checking-on-Packback-

Fig. 4: Sample Packback Diary Study Student Response

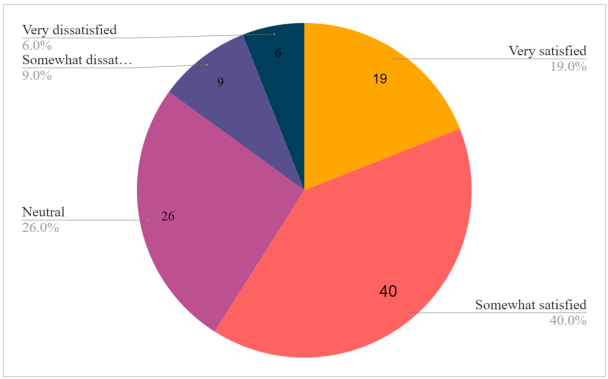


Fig. 5: Student Satisfaction with Packback

a standard deviation of 1.32, the oldest being 26 years and the youngest 19 years. All students were majoring in Computer Science. The survey results will be elaborated and analyzed in the following text.

A. Satisfaction with Packback

Firstly, examining the students' experiences with the Packback platform, it has been observed that a vast majority hold either positive or neutral attitudes towards it. Specific data indicate an average satisfaction score of 3.57 (out of 5, SD = 1.08), with 59% of students expressing positive views, 26% remaining neutral, and only 15% expressing dissatisfaction.

Such data distribution underscores the practical viability of automated assistant tools like Packback in computer ethics education. The positive feedback provides rationale for integrating automated assistance tools more extensively into computer ethics education. The students' optimistic attitudes suggest a willingness to learn through educational tech aids, which not only enhances interactivity of teaching but also increases interest and participation. Through Packback, students are able to autonomously expand their learning domains in an environment that encourages in-depth exploration and inquiry, a method that has garnered recognition and support from the students. Moreover, this automated learning mode allows students to access resources anytime, anywhere, and engage in real-time discussions with peers, offering flexibility and convenience beyond traditional teaching methods. Students' high acceptance and active participation demonstrate the substantial potential of automated assistant tools in the application of educational technology. Therefore, these user satisfaction metrics reflect the general acceptance of Packback as a teaching tool and point towards a transformation in teaching models. Given the high acceptance and positive response to such automated tools by students, there is good reason to believe that continuing to integrate this technology into teaching computer ethics will significantly enhance students' learning efficiency and the quality of education. This provides a valuable reference for innovation in future educational models.

B. Learning Outcomes

Building on this foundation, we strive to understand the impact of Packback on student learning outcomes. Our survey reveals that only 8% of students felt that Packback had no benefit to their (See Figure 6). The majority of students reported that using Packback enhanced their learning efficiency and quality to varying degrees (Mean = 3.09, SD = 1.02). Student

feedback primarily focused on three aspects: it fostered deeper engagement with the subject matter, provided a platform for mutual exchange and learning, and enhanced writing skills in argumentation. However, there were also concerns expressed about the automated system. These issues will be discussed in detail in the following section, along with a presentation of representative student comments.

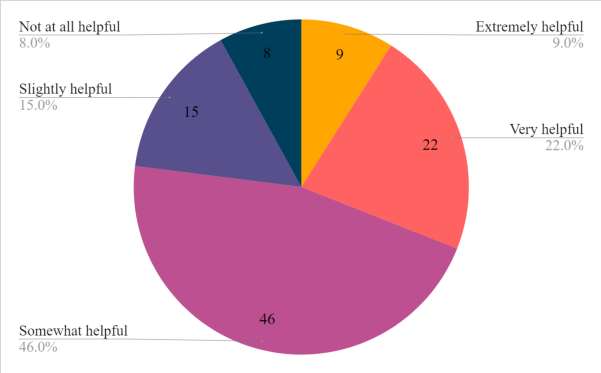


Fig. 6: Student Learning Outcome Feedback with Packback

1) Ethical Exploration: Packback provides students with an environment that encourages them to answer questions and motivates them to delve deeply and argue their answers effectively. On this platform, students are inspired to pose challenging questions while also reflecting on and responding to the perspectives of others. This mode of interaction enables students to move beyond merely memorizing concepts of computer ethics to thoroughly understand and evaluate how these concepts apply in real-world scenarios. Through active communication and sharing, students are able to examine ethical issues in computing from multiple diverse perspectives. In this interactive process, students not only raise questions but also gain exposure to their peers' varied viewpoints and solutions, thereby broadening the depth and breadth of discussion and enriching overall comprehension of the issues.

- *"In general, Packback enhanced my understanding of ethical concepts in computer science by providing a safe medium for open discussion. The requirements set by Packback, such as elaborating more on posts or providing a reference, encourages the user to dive deeper into a subject and gain more understanding."*

Packback's curiosity score system effectively fosters a deeper exploration of ethical knowledge by assessing the depth and quality of student discussions. This system awards lower scores to superficial or insufficiently detailed responses, thereby motivating students to engage in more extensive research and reflection. In this process, students are encouraged to seek external resources to enrich and deepen their answers and understanding, developing more insightful perspectives. This feedback mechanism ensures that students can transcend basic understanding when discussing ethical issues, achieving a higher level of analysis and critical thinking. Such research-driven learning is particularly crucial for understanding complex issues in computer ethics.

- *"Ultimately, the curiosity score was an aspect of the grading that motivated me to do more research on topics that I was responding to. This helped me understand the topic much more when I did external research on it."*

Although the curiosity score system might sometimes be perceived as burdensome because it requires students to refine their answers to meet scoring criteria continually, this process actually cultivates students' abilities to engage in deep thought and critical analysis of complex issues. This sustained reflection and ongoing improvement not only enhance students' academic expression but, more importantly, deepen their understanding and awareness of ethical issues in computer science, providing a solid knowledge foundation for facing ethical challenges in the future.

- *"I have mixed feelings about Packback. On one hand, it gives me an opportunity to think about complex topics and reflect on them. On the other hand, at times, it feels like a chore to complete and the auto-grader sometimes forces you to write just because it thinks your response isn't good enough."*

2) Mutual exchange and learning: Packback provides students with an effective avenue for sharing opinions and ideas. Traditional classroom discussions often suffer from time constraints, preventing some students from voicing their perspectives during class. Packback offers a platform unrestricted by time and space, allowing students to express their insights and queries at any time, thereby ensuring that each student's voice has the opportunity to be heard. This format is particularly beneficial for students who may feel shy or overlooked in face-to-face discussions. They are afforded more time to organize their thoughts and arguments and can participate fully prepared. This helps enhance these students' confidence and increases engagement and motivation. Furthermore, it allows their unique perspectives to gain attention and provoke discussion within the class, thereby enriching the overall learning experience for the entire group.

- *"I thought it was useful in keeping up with the topics in class and getting varying opinions."*

The design of Packback provides a supportive environment by encouraging students to engage in deep inquiry and responses, thereby enabling the free exchange of knowledge and ideas. This interaction facilitates collaborative learning by promoting the acquisition of new insights from educators and peers and enhances mutual learning through exploring issues and sharing diverse solutions. Consequently, students absorb differing perspectives, fostering a more comprehensive and varied understanding. Moreover, Packback's discussion board allows students to cite and evaluate their peers' viewpoints while answering questions, further enhancing the interactivity of learning. This peer-review-based system deepens students' understanding of specific topics and hones their critical think-

ing and argumentation skills. Throughout this process, students learn how to construct arguments, refute opposing views, and rationally respect and embrace diverse opinions, laying a solid foundation for academic and personal growth.

- *"It provided a place to ask questions as well as share opinions on difficult subjects that may not necessarily have a correct answer."*
- *"It was good to use in place of a discussion forum for a virtual class. Nothing can beat in-person talks but it did a good job of sharing new ideas and being able to share thoughts."*

3) Improve writing skills: The Packback curiosity score system assists students by providing timely feedback to identify and rectify grammatical and structural issues in their writing. In the instruction of computer ethics, it is particularly crucial to articulate complex ethical views and technological issues clearly and with rigorous structure, as students must accurately discuss these in their posts. As students have indicated, this feedback mechanism not only aids in improving their grammar but also enhances their attention to the precision of language and clarity of expression when composing in-depth explorations and discussion posts. This is vital for learners to understand and address ethical issues in computer science, especially when analyzing controversial cases where precise language can help clarify the core issues, reducing misunderstandings and ambiguities.

- *"I loved the instant feedback that Packback scores, allowing me to further improve on my writing. Also, this tool helped improve my grammar in writing the deep dive and discussions."*
- *"I like the AI graded system, made it easier to write out what I wanted to say in a good style and format with instant feedback."*

In discussion of computer ethics, students are often required to evaluate moral consequences of technological decisions, necessitating solid technical knowledge and the capacity for moral reasoning. Packback facilitates development critical thinking and ethical judgment by emphasizing the quality and depth of writing. The immediate feedback from the curiosity score system prompts students to reconsider argument validity and the evidence's sufficiency before submision. This cyclical process of writing and reflection is crucial for cultivating students' ethical sensitivity and decision-making abilities.

- *"I found Packback's AI system exremely helpful in providing valuable comments to improve my writing by prompting to think deeper and write thoughtful sentences to diary reports and weekly packback assignments."*

4) Concern regarding curiosity score: The curiosity score system aims to stimulate students' curiosity and exploratory spirit through its innovative assessment methodology. However, some students have reported that the system excessively relies on the length of articles, which diminishes learning efficiency and affects the quality of content.

- *"The algorithm clearly favored longer responses and citing sources. The patterns in grading made it easy to follow a "formula" for a good grade, which put emphasis on length and just having a source rather than crafting a well thought-out response."*
- *"The AI needs to be more tailored towards grading the quality of the writing. Right now it weights the length of the writing too much and it makes it seem like a word count."*

The system's preference for longer articles encourages students to artificially expand writings to achieve higher scores. This practice can result in verbose, repetitive content, diminishing information accuracy and the intrinsic quality of articles. To adapt to the grading criteria, students sacrifice the conciseness and directness , which not only impacts the fluidity of their expression but also hinders reader understanding. Furthermore, this excessive emphasis on length could mislead students into believing that writing quality icorrelates with length, overlooking depth of content and strength of arguments. This misconception may impede development of precise and effective argumentation skills, crucial for academic and professional writing. Additionally, the need to pad content to meet length requirements makes writing more laborious and less efficient. This scenario could reduce students' interest in engaging in discussion posts, particularly for those who could express their views succinctly and clearly.

In summary, despite the curiosity score's positive role in fostering student curiosity and assessing engagement, the issues it reveals in practice necessitate adjustments and improvements to the scoring mechanism [26]. Future improvements should include optimizing the scoring algorithm to assess students' academic performance more fairly and effectively rather than relying on article length. This would better reflect students' learning outcomes and writing capabilities, enhancing both the efficiency and quality of the learning process.

V. Conclusions

In this paper, we examine the practical effects of applying the automated discussion assistant tool Packback in computer ethics education. As an educational tool, Packback, through its question-and-answer platform and intelligent scoring system, not only provides students with an open space for discussion, allowing voices that may be overlooked in traditional classrooms to be expressed, but also significantly enhances students' writing skills through real-time feedback and stimulates in-depth exploration into the ethics of computing. However, despite positive educational impacts of Packback, its curiosity score system still faces issues related to dependency on article length, reminding us that fine-tuning its algorithms is necessary when employing such tools for student assessment. Future research should focus on improving scoring mechanisms to ensure fairness and effectiveness in education and explore emerging technologies to optimize educational practices, cultivating future leaders capable of making ethical decisions in a world of continuous technological evolution.

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