



Reshaping Teaching in the Era of AI: Embracing Large Language Models in Computer Science Education

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Abstract

This paper presents a case study on integrating Artificial Intelligence (AI) technologies into the Internet Programming course at the Polytechnic University of Guarda to address the evolving industry demands and enhance students' skill sets and AI literacy. With AI technologies like GitHub Copilot and ChatGPT becoming mainstream, there is a pressing need to adapt higher education practices to prepare students for an AI-augmented workforce. This is particularly important in computer science, where graduates are expected to master AI tools and skills. In this context, the course curriculum and assessment methods were revised to include practical applications of AI tools, emphasising problem-solving and coding efficiency in real-world scenarios. This study analyses the outcomes of these changes, based on student performance and feedback, to assess their effectiveness in fostering relevant skills. The results indicate increased student engagement and broad appreciation of AI tools for learning and academic project development, with over 70% of respondents rating them as useful or very useful. Moreover, the course's role in developing AI skills for employability received strong endorsement, particularly from female and international students. Additionally, 71% of students preferred the new oral assessment system over traditional exams, with female and international students demonstrating the strongest approval. This reflects a broader preference for interactive and continuous assessment methods. These findings pinpoint the effectiveness of integrating AI tools and innovative evaluation techniques in fostering an inclusive and industry-relevant educational environment, and the importance of adapting curricula to meet both market and student expectations.

Keywords: Artificial Intelligence Enhanced Education, Computer Science Education, Adaptive Assessment Methods, Higher Education Adaptation, Industry-Oriented Curriculum

1 Introduction

Over the past few years, Artificial Intelligence (AI) tools have become ubiquitous, with a high potential to disrupt most human activities. As businesses integrate these technologies into their activities, they expect graduates to be proficient with them. Consequently, professors, especially in higher education, must adapt their teaching methods, embracing novel strategies to meet industry expectations and adequately prepare graduates for this new world, ensuring their competitiveness in the job market (Slimi, 2023; Levitt & Grubaugh, 2023; Walter, 2024; Lau, Bonilla, & Gárate, 2019; Hutson et al., 2022; Chen, Chen, & Lin, 2020). This is essential not only for aligning with industry standards but also because AI is fundamentally reshaping educational practices, as evidenced by Chen et al. (2020).

In a recent interview, Nobel Prize winner Geoffrey Hinton stated that AI will make processes more efficient, driving a significant rise in productivity, which will result in job losses in sectors where demand is not elastic (Wall Street Week, 2024). The continuous innovations in the field of AI will reshape our society and especially the workforce, posing novel challenges to the labour market (Levitt & Grubaugh, 2023; Lau et al., 2019). To address these challenges, educational institutions need to embrace and incorporate AI technologies to equip students with the skills required to leverage productivity, which the industry increasingly demands (Levitt & Grubaugh, 2023; Slimi, 2023). Hence, many higher education institutions have already begun integrating AI into their curricula in order to prepare students for emerging job opportunities (Hutson et al., 2022; Akinwalere & Ivanov, 2022).

While only 5% of companies currently report using generative AI in regular production (Wall Street Week, 2024), this figure is expected to rise significantly. In this context, education will play a significant role in facilitating economic expansion and creating new job opportunities to mitigate potential job displacement.

Whether an AI-driven economy will simply replace the jobs lost due to increased productivity, transforming them into new career prospects, as many suggest (Slimi, 2023; Lau et al., 2019), remains to be seen. However, AI will undoubtedly play a crucial role in the future of higher education (Slimi, 2023; Akinwalere & Ivanov, 2022). Therefore, professors must embrace AI technologies in the classroom as soon as possible to prepare and upskill future generations of professionals (Levitt & Grubaugh, 2023; Hutson et al., 2022; Akinwalere & Ivanov, 2022; Lau et al., 2019).

In the field of computer science education, particularly in programming, where tools like GitHub Copilot and ChatGPT are becoming mainstream, integrating these technologies into the curriculum is crucial and yields tangible benefits (Liu, 2023). This approach enhances students' programming skills and problem-solving abilities, preparing them to effectively use these tools. By doing so, educators foster a deeper understanding of how these technologies can augment work in software development and beyond.

In this paper, we present a case study on the Internet Programming course, focusing on the following research questions: What are students' perceptions of AI tools in enhancing their learning and supporting academic endeavors? Do students perceive AI tools as relevant to the modern computer science job market, and does the Internet Programming course assist them in developing the necessary AI skills? How do students perceive the shift from traditional exams to regular oral evaluations to discourage exclusive reliance on AI tools? Are there different views across demographic factors such as gender and nationality?

Additionally, we highlight the specific changes made to the curriculum and assessment methods and argue for the need to adapt educational practices to better align with the evolving demands of students and the job market, ensuring the skills taught are relevant and

applicable in real-world scenarios. This approach not only enhances student engagement but also prepares graduates to meet industry expectations effectively.

This paper is organised as follows: Section 2 presents the background and motivation for integrating AI tools into the Internet Programming course. Section 3 details the specific curriculum changes and assessment methods implemented. Section 4 discusses the observed outcomes and feedback from students. Finally, Section 5 offers conclusions and future work.

2 Background and Motivation

The rapid advancement of AI-driven tools and technologies is reshaping the skill set expected of computer science graduates. Consequently, educational programmes are adapting their curricula and teaching methods to promote a more personalised and effective learning experience (Liu, 2023), ensuring students remain competitive in modern industry environments.

This paper focuses on restructuring Internet Programming, a third-year course within the BSc in Computer Science Engineering at the Polytechnic University of Guarda, to meet these emerging demands. The rationale consists of equipping students with hands-on experience in web development practices, while incorporating tools and methodologies essential for the AI augmented workforce. By doing so, the course not only aligns with industry expectations but also prepares students to integrate AI-enhanced workflows into their projects, promoting adaptability and advanced technical skills.

Building on this foundation, the course's learning objectives align with the broader goals of this paper: equipping students with foundational skills in dynamic web application development, secure data handling, and the ability to apply AI-driven tools effectively. The curriculum focuses on modern web application development, covering front-end and back-end integration, database management, data validation, and security. Furthermore, teamwork and version control are emphasised through Git, which is essential for real-world collaborative development environments. Overall, this course empowers students to build robust, scalable web applications with a focus on data integrity, addressing the increasing demand for developers proficient in secure design practices, as companies prioritise data protection and cybersecurity. Moreover, the course fosters real-world collaborative skills, critical for graduates working in team-oriented, AI-augmented work environments (Kumar, 2023).

The rationale is to maintain the core objectives while accommodating the industry's shift towards AI-enhanced development environments. To this end, the course incorporates AI-driven tools and methodologies into the curriculum, enabling students to gain practical experience with these technologies. This integration not only enhances their technical skills but also prepares them for the evolving demands of the job market, ensuring they are equipped to thrive in environments that prioritise innovation and efficiency.

3 Curriculum and Assessment Adjustments

The changes made to the Internet Programming course are twofold. First, the curriculum was enhanced to include hands-on experience with ChatGPT and GitHub Copilot, allowing students to actively engage with AI tools in practical scenarios. Second, assessment methods were revised, replacing the traditional exam with regular oral evaluations. This shift ensures students grasp the underlying concepts, preventing over-reliance on AI tools, a concern highlighted by Liu (2023). This dual approach aims to foster deeper comprehension of the

curriculum and encourage students to articulate their thought processes effectively while developing proficiency in using AI.

Traditional exams promote memorisation, often failing to accurately measure a student's understanding and ability to apply knowledge in real-world scenarios. Furthermore, they often neglect the development of key skills, such as critical thinking, creativity, communication, and collaboration, which are fundamental to graduates' success (Kumar, 2023; Swiecki et al., 2022; Slimi, 2023). Although the Internet Programming course includes a medium-sized project where students apply their skills in a realistic team setting, thus mitigating this aspect, the widespread availability of AI tools raises new concerns related to academic integrity (Yeo, 2023; Liu, 2023).

Students may be tempted to cheat by relying on these technologies to complete exam tasks rather than using their own knowledge. By adding oral evaluations alongside the project, the course promotes deeper engagement, encouraging students to articulate their thought processes and demonstrate their comprehension. This approach not only reduces the risk of cheating but also enables early detection of students struggling to grasp core concepts, enabling instructors to provide timely support and targeted interventions (Ward & Lou, 2020). Ultimately, these adjustments prepare students for the collaborative and fast-paced demands of modern software development, ensuring they build a robust foundation in critical skills essential for success in the field.

Another implemented change addresses situations where a student struggles with understanding or applying a particular concept. In this scenario, the professor provides additional clarification and instructs the student to interact with ChatGPT to request relevant exercises and verify solutions. The student must then submit a transcript of the chat session, allowing the professor to assess the student's grasp of the concept and identify any persistent challenges. This approach encourages independent learning while allowing the professor to monitor progress and provide targeted feedback, reflecting the findings of Chen et al. (2020), which suggest that AI tools can offer personalised support and tailored instruction.

In classes, the professor regularly incorporates tools such as ChatGPT and GitHub Copilot, demonstrating effective strategies, prompt refinement techniques, and the limitations of AI generated outputs. This approach highlights the importance of understanding core concepts to enhance the quality of AI interactions and maximise the benefits of AI tools.

Ultimately, integrating AI tools into the course creates a more dynamic and supportive learning environment, benefiting students, faculty, and the curriculum. AI-powered interactive tutorials and quizzes enhance students' understanding of key concepts, while personalised feedback and explanations offer crucial support for those struggling with the course content or lacking access to traditional resources, all while promoting independent learning (Liu, 2023).

4 Student Feedback and Perceptions

The Internet Programming course currently has 47 students enrolled, comprising 38 local Portuguese students and 9 international ERASMUS (EuRopean Community Action Scheme for the Mobility of University Students) students from various countries. To ensure inclusivity, classes are taught in both Portuguese and English.

Like other courses at the Polytechnic University of Guarda, this course faces challenges with student absenteeism. On average, approximately 30 students ($\approx 64\%$) attend each class, reflecting a 5% increase from the previous year's attendance rate ($\approx 59\%$). This rise in

attendance suggests a positive response, likely driven by the recent course adjustments that have boosted student engagement and interest.

To evaluate the effectiveness of the course modifications, a structured questionnaire was administered, comprising Likert scale items and closed-ended questions. The survey was conducted in full compliance with the European Union (EU) General Data Protection Regulation (GDPR). Participants were informed of the study's aims, data collection procedures, and data usage, and gave informed consent before participating. Anonymity was ensured, as the collected data were analysed in an aggregated manner, without using participant identifiers. A convenience sampling method was employed, targeting students attending a specific class session to ensure a representative sample of actively participating students. This resulted in a sample size of 31 respondents, representing approximately 66% of the total enrolled students in the Internet Programming course. This included both Portuguese and international ERASMUS exchange students from various countries.

Figure 1 depicts the demographic breakdown of the student respondents by gender and origin. Note that, although the survey included options for additional gender identities, none of these were selected by the participants. The collected data were analysed using Python, ensuring a robust and systematic examination of the responses. This analysis allowed for identifying the main trends, assessing the significance of observed differences, and presenting the results using graphics and figures to aid comprehension. It is important to note that the use of a convenience sample introduces a possible sampling bias. Consequently, the generalisability of findings may be limited to other contexts and course settings, as the sample is not random.

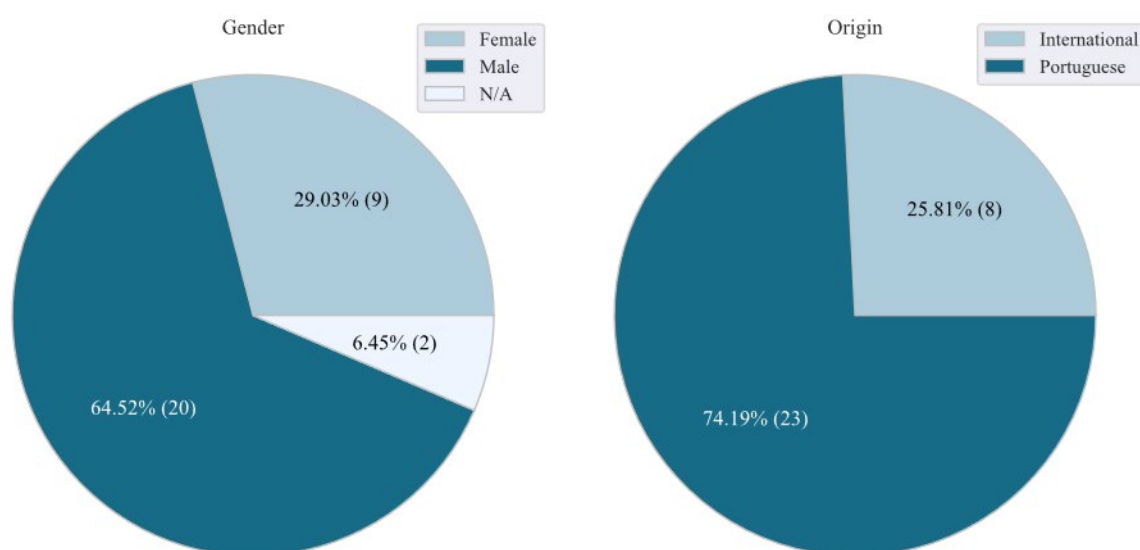


Figure 1. Student respondents by gender and origin

Figure 2 presents students' perceptions of the value of AI tools in enhancing learning. Over 70% of respondents rated these tools as either useful or very useful, while the remainder found them moderately useful, with a single respondent rating them as slightly useful. This widespread appreciation highlights the potential role of AI in modern education and reflects the impact of incorporating AI tools into the course. These tools support independent study by enabling students to ask questions, solve exercises, and receive instant feedback.

An analysis of responses by gender reveals distinct patterns. Male students reported the highest levels of satisfaction, with 85% rating AI tools for enhancing learning as either useful or very useful. Female students also expressed a generally positive view but exhibited a more balanced distribution of ratings, with 44.4% considering these tools only moderately useful. This suggests that while female students recognise the utility of AI tools, they may adopt a

more measured perspective of their role in the learning process. Students who did not disclose their gender gave lower ratings; however, the small sample size (two respondents) limits the reliability of conclusions drawn for this group.

Nationality also influenced perceptions. Local Portuguese students rated the use of AI tools positively, with responses ranging from moderate to high usefulness. However, international students rated the tools overwhelmingly positively, with over 60% considering them very useful. This contrast may reflect, among other factors, the value of AI tools in overcoming language barriers and supporting navigation within a foreign educational system.

These findings suggest that while AI tools are widely valued for enhancing learning, perceptions vary based on gender and background. Male and international students are among the most enthusiastic users. In contrast, female and Portuguese students appreciate the tools but adopt a more cautious perspective, suggesting they may benefit from further customisation or additional features aligned with their learning preferences. Understanding these nuances can help educators tailor AI-based resources to meet the diverse needs of their students, ensuring proper support and creating effective and inclusive learning environments for all.

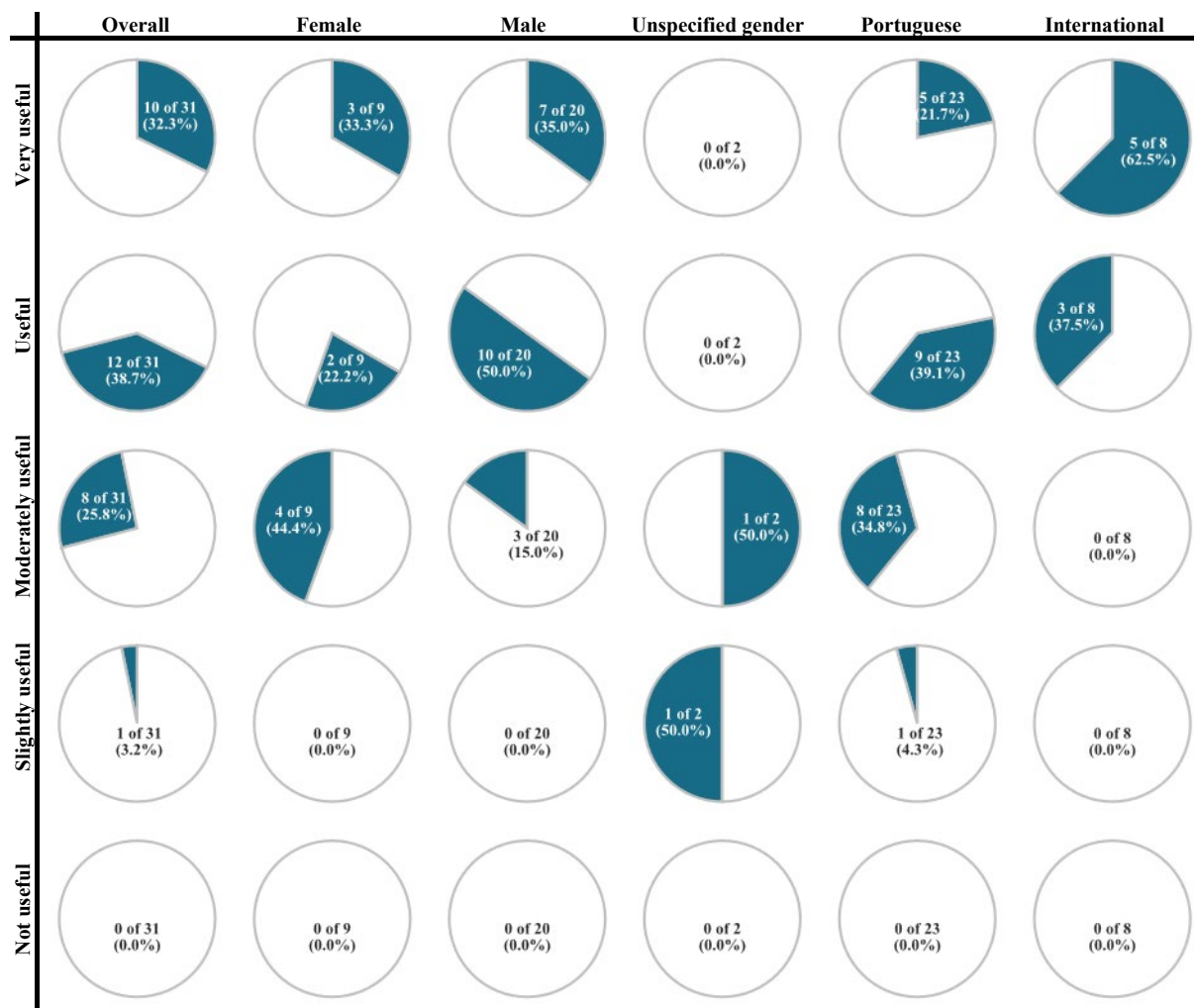


Figure 2. Students' opinions on the value of AI tools for enhancing learning.

Figure 3 presents students' perceptions of the usefulness of AI tools in supporting academic project development. Similar to their views on AI tools for learning, the overall sentiment is positive, with over 70% of students rating these tools as either useful or very useful.

Once again, male students were the most enthusiastic, with 80% rating AI tools as useful or very useful. Female students exhibited a more varied perspective: while over half found the tools useful or very useful, a third rated them as moderately useful, and one respondent considered them slightly useful. Among students who did not disclose their gender, responses were split between moderately useful and useful.

As before, nationality played a significant role in shaping opinions. International students expressed strong approval, with 62.5% rating the tools as very useful and 25% as useful. Portuguese students also provided positive feedback, but their ratings were more dispersed. This broader distribution may reflect past experiences and different levels of familiarity with such tools.

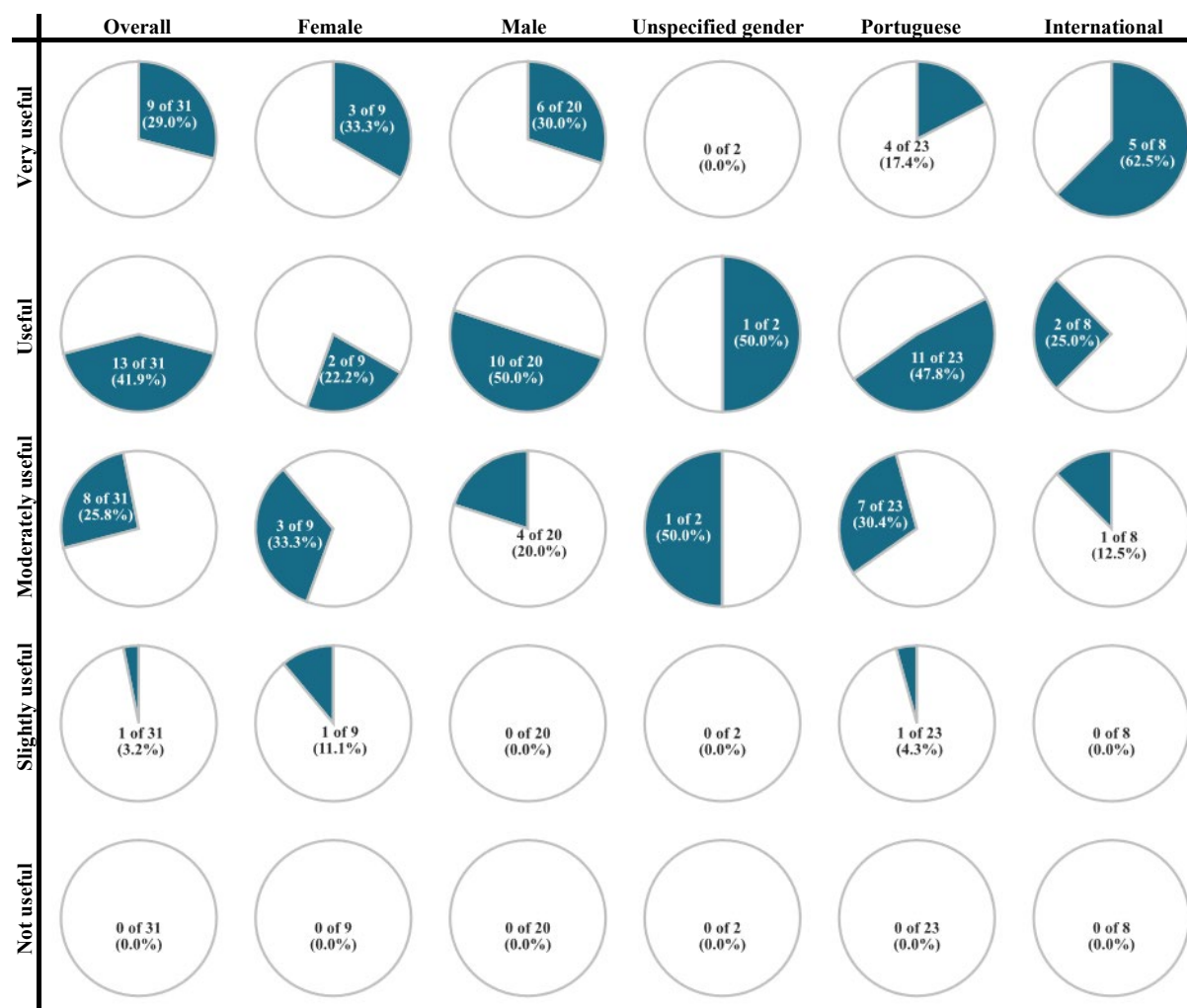


Figure 3. Students' opinions of the value of AI tools for assisting in the development of academic projects.

Figure presents students' perceptions of the relevance of AI tools in today's computer science job market. Over 80% rated these tools as either relevant or very relevant, with only one student considering them slightly relevant. Interestingly, in this case, both male and female students rated the relevance of AI tools similarly, with female students evaluating their role in modern careers marginally higher. This consensus reflects a shared recognition of AI's importance for employability.

When segmented by nationality, differences become more pronounced. Although both groups view AI tools as relevant in today's job market, international students place significantly greater importance on them, with 62.5% rating them as very relevant. This disparity

highlights how international students may perceive AI tools as a critical advantage in global job markets.

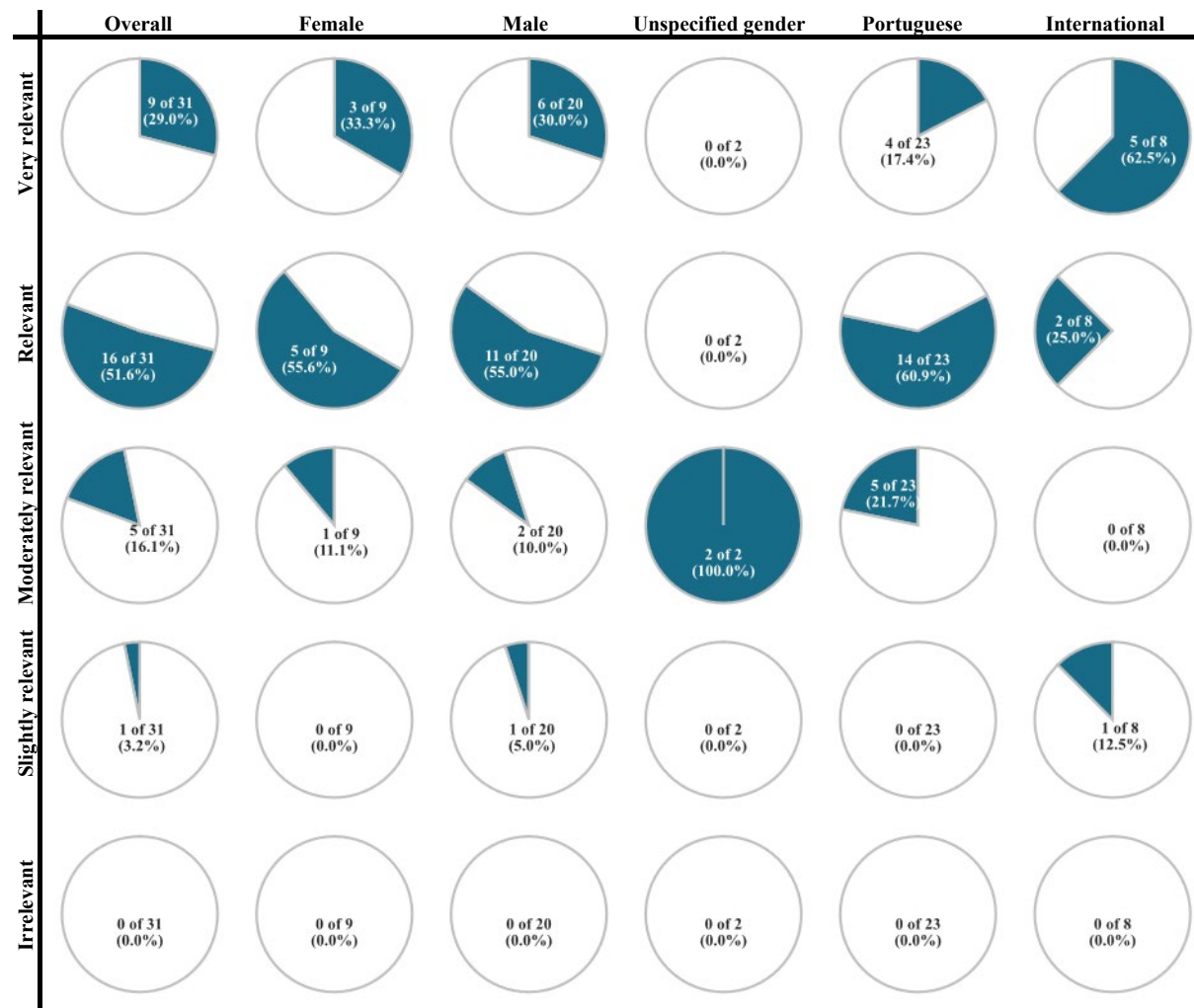


Figure 4. Students' opinions on the relevance of AI tools in today's computer science job market.

Figure 4 illustrates students' perceptions of the Internet Programming course's role in developing the AI skills needed for today's job market. A significant majority (70.9%) rated the course as either important or very important, reinforcing the effectiveness of the implemented changes. This result indicates strong alignment between the course content and students' expectations.

Interestingly, while female students rated the usefulness of AI tools for enhancing learning and academic project development lower than their male counterparts, they expressed the highest proportion of positive evaluations regarding the course's role in developing the AI skills needed for the job market. Specifically, 55.6% considered it very important, and 44.4% rated it as important. This suggests that female students may view AI tools as supplementary rather than central to learning, leading to lower ratings for the tools themselves but to a stronger appreciation for the course, which integrates AI into a broader and more structured learning framework. Male students also acknowledged the course's value, with most rating it as either useful or very useful, although one student considered it not important. Meanwhile, responses from students who did not disclose their gender reflected mixed views, with equal representation in the slightly important and important categories.

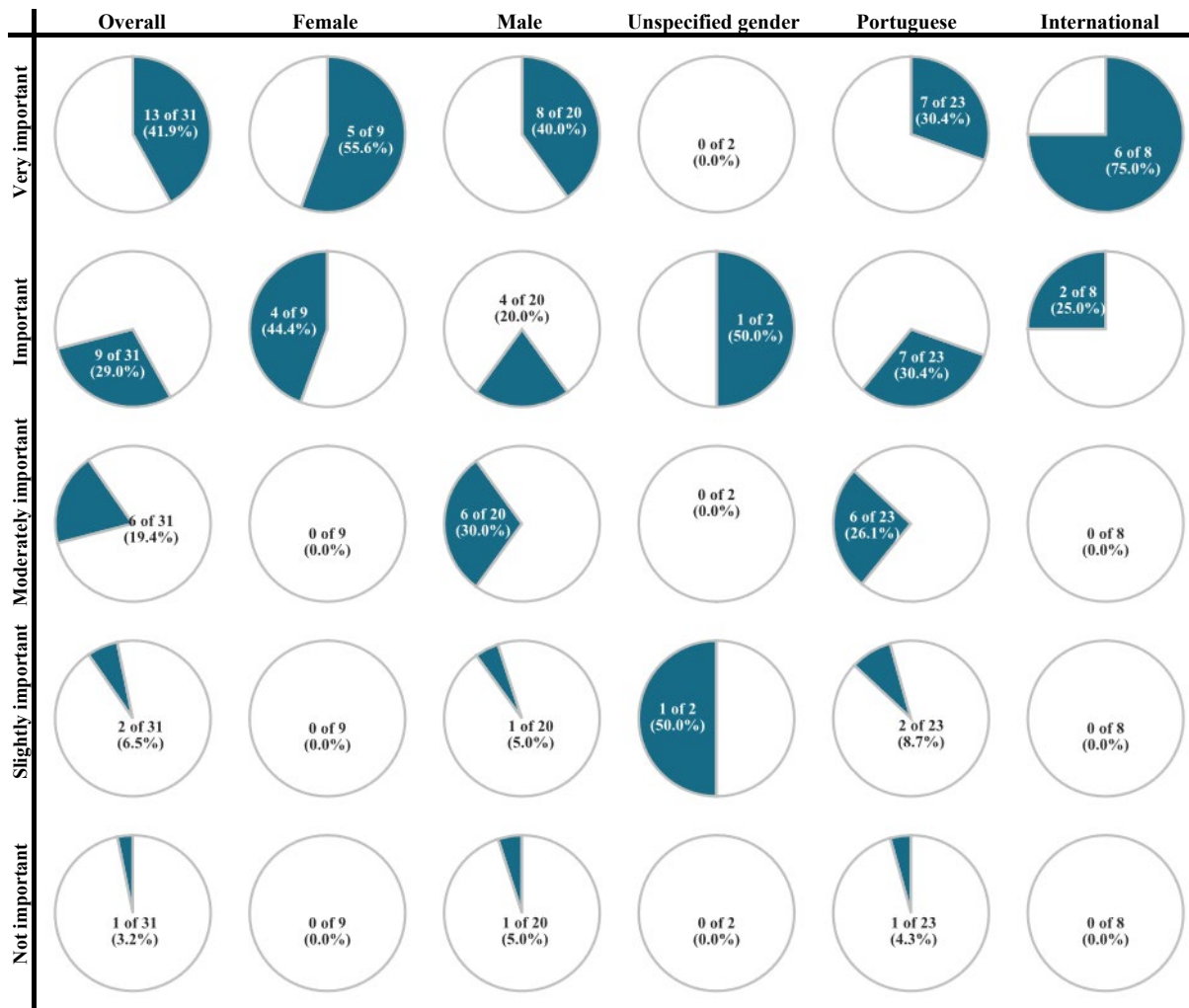


Figure 4. Students' opinions on the importance of the Internet Programming course for developing the AI skills needed in today's job market.

International students were particularly enthusiastic about the course's value, recognising its importance in developing AI skills essential for navigating the global job market, with 75% rating the course as very important, and the remaining 25% as important. In contrast, only 30.4% of Portuguese students considered the course very important. This disparity may suggest that the course effectively addresses global industry expectations, aligning more closely with the perspectives of international students.

Figure 5 presents students' preferences regarding the assessment method. A significant majority (71%) prefer the new evaluation system, which replaces the traditional exam with regular oral assessments. This suggests a strong preference for a more interactive, continuous assessment approach over a single, high-stakes exam.

Analysing the data by gender reveals a notable trend: 88.9% of female students prefer the new evaluation system, compared to 65% of male students. This preference may reflect broader trends in women's engagement with more collaborative, communicative learning environments, which oral evaluations facilitate. These assessments provide opportunities for personalised feedback and allow students to articulate their understanding more effectively.

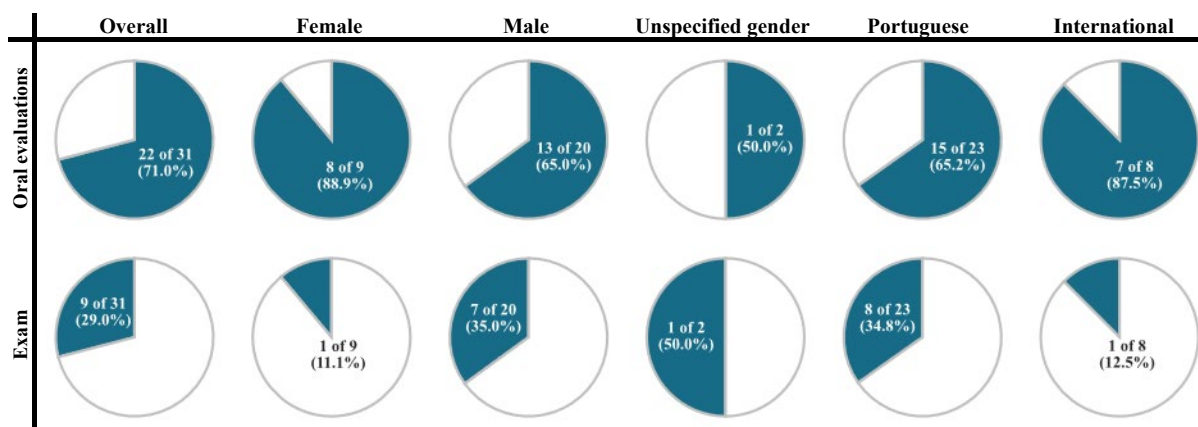


Figure 5. Students' preferences regarding oral evaluations versus the traditional exam assessment.

The majority of international students (87.5%) prefer the new evaluation system, compared to 65.2% of national students. This suggests that international students may find the oral evaluation format more aligned with their learning style, or possibly feel it provides a better platform to demonstrate their knowledge and engage more directly with the instructor, fostering clearer communication and a deeper understanding of the material.

5 Conclusion

The data from the student feedback survey indicate that AI tools are highly valued by students. However, differences in perceptions based on gender and nationality highlight the need for personalised approaches to integrating AI tools into the curriculum.

The preference for oral evaluations over traditional exams signals a shift towards more interactive and continuous assessment methods. This is especially relevant in an AI-integrated course, where students engage with learning materials and receive ongoing feedback. The positive reception of this assessment method suggests it fosters a deeper, more collaborative learning environment, potentially more effective than a single, high-stakes exam.

The integration of AI tools into the Internet Programming course at the Polytechnic University of Guarda has positively impacted student engagement, learning outcomes, and perceptions of the course's relevance to the job market. Student feedback indicates that while AI tools are broadly valued, there are distinct patterns in how different demographic groups perceive their usefulness. International and male students tend to rate AI tools more positively, while female students express a more measured appreciation, indicating the need for further customisation. Additionally, students' preference for oral evaluations over traditional exams reflects a broader shift towards more interactive, ongoing assessment approaches.

These findings highlight the potential of AI tools to enhance computer science education, particularly in developing the skills needed for the modern job market. As AI continues to evolve, it is vital for educational institutions to adapt, ensuring that AI-based resources align with the diverse needs of students and create inclusive and effective learning environments. Overall, this experience demonstrates the importance of understanding student feedback and continuously adjusting the curriculum to meet both educational and industry demands.

Future work will focus on refining the integration of AI tools into the curriculum, with emphasis on customisation tailored to the specific needs of students. Additionally, expanding

the study to include more courses and institutions could offer broader insights into the role of AI in higher education and its potential to transform teaching and assessment practices.

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