ISSN: 1991-3494 (Print)
ISSN: 2518-1467 (Online)

SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS

№4
2026

ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print)

CENTRAL ASIAN ACADEMIC
RESEARCH CENTER

SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS

PUBLISHED SINCE 1944

4 (422)

July – August 2026

ALMATY, 2026

Scientific Journal of Pedagogy and Economics
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print).
Owner: «Central Asian Academic Research Center» LLP (Almaty).
The certificate of registration of a periodical printed publication in the Committee of information of the Ministry of Information and Communications of the Republic of Kazakhstan
№ KZ50VPY00121155, issued on 05.06.2025
Thematic focus: *«publication of the results of new achievements inthe field of fundamental sciences»*
Periodicity: 6 times a year.
http://www.bulletin-science.kz/index.php/en/

Scientific Journal of Pedagogy and Economics
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print).
Меншіктенуші: «Орталық Азия академиялық ғылыми орталығы» ЖШС (Алматы қ.).
Қазақстан Республикасының Ақпарат және коммуникациялар министрлігінің Ақпарат комитетінде 05.06.2025 ж. берілген **№ KZ50VPY00121155** мерзімдік басылым тіркеуіне қойылу туралы куәлік.
Тақырыптық бағыты: *«іргелі ғылым салалары бойынша жаңа жетістіктердің нәтижелерін жариялау»*
Мерзімділігі: жылына 6 рет.
http://www.bulletin-science.kz/index.php/en/

Scientific Journal of Pedagogy and Economics
ISSN 2518-1467 (Online),
ISSN 1991-3494 (Print).
Собственник: ТОО «Центрально-азиатский академический научный центр» (г. Алматы).
Свидетельство о постановке на учет периодического печатного издания в Комитете информации Министерства информации и коммуникаций и Республики Казахстан
№ KZ50VPY00121155 выданное 05.06.2025 г.
Тематическая направленность: *«публикация результатов новых достижений вобласти фундаментальных наук».*
Периодичность: 6 раз в год.
http://www.bulletin-science.kz/index.php/en/

CONTENTS

PEDAGOGY

ECONOMY

МАЗМҰНЫ

ПЕДАГОГИКА

ЭКОНОМИКА

СОДЕРЖАНИЕ

ПЕДАГОГИКА

ЭКОНОМИКА

SCIENTIFIC JOURNAL OF PEDAGOGY AND ECONOMICS
ISSN 1991-3494
Volume 4.
Number 422 (2026), 324-346

https://doi.org/10.32014/2026.2518-1467.1251

IRSTI: 14.01.85
UDC: 37.091.33:004.8

© Sambetova R.A.[1*], Veryaev A.A.[2], Uxikbayev Ye.Z.[3], 2026.
[1]International University of Tourism and Hospitality, Turkestan, Kazakhstan;
[2] Altai State Pedagogical University, Barnaul, Russian Federation;
[3]Khoja Akhmet Yassawi International Kazakh-Turkish University,
Turkistan, Kazakhstan.
E-mail: raushan.sambetova@iuth.edu.kz

GENERATIVE AI AND ITS EFFECT ON ACADEMIC PERFORMANCE IN COMPUTER SCIENCE EDUCATION

Sambetova Raushan — senior teacher of the Humanities school, International University of Tourism and Hospitality, Turkistan, Kazakhstan,
E-mail: raushan.sambetova@iuth.edu.kz. https://orcid.org/0000-0003-3601-911X;
Veryaev Anatoly — Doctor of Pedagogical Sciences, Professor of the Department of Theoretical Physics of the Altai State Pedagogical University, Barnaul, Russian Federation,
E-mail: veryaev_aa@mail.ru, https://orcid.org/0000-0002-4338-0811;
Uxikbayev Yerkebulan — teacher at the Khoja Ahmet Yasawi International Kazakh-Turkish University, Turkestan,
E-mail: erkebulan.uxikbayev@ayu.edu.kz , https://orcid.org/0009-0003-3868-6773.

Abstract. *Relevance.* The accelerating diffusion of generative artificial intelligence (GenAI) into higher education has substantially changed how computer science students study, write code, and seek academic support, yet evidence on how these tools influence measurable academic performance remains fragmented. *Aim.* The study investigates the impact of GenAI tools on the academic performance of undergraduate computer science students, with particular attention to coding proficiency, engagement, motivation, dependence on AI assistance, and the development of problem-solving competencies, while also examining the perspectives of teaching assistants who observe these processes directly. *Methods.* A descriptive quantitative design was applied using two parallel survey instruments. The student survey (n = 17) and the teaching assistant survey (n = 9) employed five-point Likert-scale items addressing ten constructs (ease of use, confidence, engagement, grade improvements, learning, dependence, concerns about plagiarism, help-seeking comfort, application of knowledge, and grading efficiency). Responses were exported from Google Forms, analysed in Python (matplotlib, seaborn), and visualised through scatter plots within each survey and

box plots for paired statements across the two surveys. *Results.* Findings indicate a generally positive association between GenAI use and perceived academic performance, particularly in the comprehension of complex programming concepts and in self-reported engagement. Teaching assistants reported a perceptible decline in students' reliance on human support and a rise in self-confidence. At the same time, the data reveal heterogeneous experiences, persistent concerns about plagiarism, and a tendency among many students to prefer GenAI assistance over human help. *Practical significance.* The study informs the design of balanced pedagogical strategies and institutional policies that integrate GenAI as a complement to, rather than a substitute for, human instruction in computer science education.

Keywords: Generative artificial intelligence, Computing education, Student achievement, Artificial Intelligence, Large language models, Computer science teaching and learning, Academic outcomes

For citations: Sambetova R.A., Veryaev A.A., Uxikbayev Ye.Z. Generative AI and its effect on academic performance in computer science education. Scientific Journal of Pedagogy and Economics, 2026. — No.4. — P. 324-346. DOI: https://doi.org/10.32014/2026.2518-1467.1251

© Самбетова Р.А.[1*], Верьяев А.А.[2], Уксикбаев Е.З.[3], 2026.
[1] Халықаралық туризм және меймандостық университеті,
Түркістан, Қазақстан;
[2] Алтай мемлекеттік педагогикалық университеті, Барнаул,
Ресей Федерациясы;
[3]Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті,
Түркістан, Қазақстан.
E-mail: raushan.sambetova@iuth.edu.kz

ГЕНЕРАТИВТІК ЖАСАНДЫ ИНТЕЛЛЕКТ ЖӘНЕ ОНЫҢ ИНФОРМАТИКАНЫ ОҚЫТУДА ӘСЕРІ

Самбетова Раушан — Халықаралық туризм және қонақжайлылық университеті, Түркістан, Қазақстан,
E-mail: raushan.sambetova@iuth.edu.kz. https://orcid.org/0000-0003-3601-911X;
Верьяев Анатолий — педагогика ғылымдарының докторы, Алтай мемлекеттік педагогикалық университеті, Барнаул, Ресей Федерациясы,
E-mail: veryaev_aa@mail.ru, https://orcid.org/0000-0002-4338-0811;
Ухикбаев Еркебұлан — Қожа Ахмет Ясауи атындағы Халықаралық қазақ-түрік университеті, Түркістан, Қазақстан,
E-mail: erkebulan.uxikbayev@ayu.edu.kz, https://orcid.org/0009-0003-3868-6773.

Аннотация. *Өзектілігі.* Генеративті жасанды интеллект (GenAI) құралдары жоғары білім беру жүйесіне қарқынды еніп, информатика мамандығының студенттері білім алу, бағдарлама жазу және академиялық қолдау

іздеу тәсілдерін айтарлықтай өзгертіп отыр. Алайда осы құралдардың академиялық үлгерімге нақты әсері туралы дәлелдер әлі де бытыраңқы күйде. *Мақсаты.* Зерттеудің мақсаты – GenAI құралдарын қолданудың информатика бакалавриаты студенттерінің академиялық үлгеріміне әсерін, оның ішінде бағдарламалау құзыреттіліктері, оқу үдерісіне тартылуы, мотивациясы, тәуелділігі және мәселе шешу қабілеттеріне ықпалын кешенді түрде зерттеу, сондай-ақ осы үдерістерді бақылайтын тьюторлардың көзқарасын ескеру. *Әдістері.* Зерттеуде сандық сипаттамалық тәсіл қолданылып, екі сауалнама құралы әзірленді: студенттерге арналған сауалнама (n = 17) және тьюторларға арналған сауалнама (n = 9). Сауалнамалар бес балдық Лайкерт шкаласы бойынша он айнымалыны қамтыды: қолданудың қарапайымдылығы, сенімділік, тартылу, бағаның жақсаруы, оқу, тәуелділік, плагиатқа қатысты алаңдаушылық, көмек сұрауға деген жайлылық, білімді қолдану және бағалау тиімділігі. Деректер Google Forms арқылы жинақталып, Python ортасында (matplotlib, seaborn) өңделді; нәтижелер шашырау графиктері және салыстырмалы қорап-диаграммалар арқылы көрсетілді. *Нәтижелері.* Зерттеу нәтижелері GenAI-ды қолдану мен академиялық үлгерімнің оң байланысын, әсіресе күрделі бағдарламалау тұжырымдамаларын меңгеру және оқуға тартылу деңгейіндегі жақсарулардың бар екенін көрсетті. Тьюторлар студенттердің адами қолдауға тәуелділігінің төмендегенін және өзіне сенімділігінің артқанын байқаған. Сонымен қатар деректер тәжірибелердің әртүрлілігін, плагиатқа қатысты тұрақты алаңдаушылықты және көптеген студенттердің GenAI көмегін адам көмегінен жоғары қоятынын анықтады. *Тәжірибелік маңыздылығы.* Алынған нәтижелер информатиканы оқытуда GenAI құралдарын адами оқытудың орнын басатын емес, оны толықтыратын тәсіл ретінде енгізетін теңгерімді педагогикалық стратегиялар мен институционалдық саясатты қалыптастыруға негіз бола алады.

Түйін сөздер: Генеративті жасанды интеллект, есептеу білімі, оқушылардың жетістіктері, жасанды интеллект, үлкен тілдік модельдер, информатиканы оқыту және оқыту, академиялық нәтижелер

© Самбетова Р.А.[1*], Верьяев А.А.[2], Уксикбаев Е.З.[3], 2026.
[1] Международный университет туризма и гостеприимства, Туркестан, Казахстан;
[2] Алтайский государственный педагогический университет, Барнаул, Российская Федерация;
[3] Международный казахско-турецкий университет имени Ходжа Ахмеда Ясави, Туркестан, Казахстан.
E-mail: raushan.sambetova@iuth.edu.kz

ГЕНЕРАТИВНЫЙ ИСКУССТВЕННЫЙ ИНТЕЛЛЕКТ И ЕГО ВЛИЯНИЕ НА УСПЕВАЕМОСТЬ В ОБРАЗОВАНИИ В ОБЛАСТИ ИНФОРМАТИКИ

Самбетова Раушан — старший преподаватель, Международный университет туризма и гостеприимства, Туркестан, Казахстан,
E-mail: raushan.sambetova@iuth.edu.kz, https://orcid.org/0000-0003-3601-911X;
Верьяев Анатолий — доктор педагогических наук, профессор кафедры теоретической физики, Алтайский государственный педагогический университет, Барнаул, Российская Федерация,
E-mail: veryaev_aa@mail.ru, https://orcid.org/0000-0002-4338-0811;
Уксикбаев Еркебулан — преподаватель, Международный казахско-турецкий университет имени Ходжи Ахмеда Ясави, Туркестан, Казахстан,
E-mail: erkebulan.uxikbaev@ayu.edu.kz, https://orcid.org/0009-0003-3868-6773.

Аннотация. *Актуальность.* Стремительное распространение инструментов генеративного искусственного интеллекта (Generative Artificial Intelligence, GenAI) в высшем образовании существенно меняет подходы студентов компьютерных специальностей к обучению, выполнению задач программирования и получению учебной поддержки. Вместе с тем эмпирические данные о связи использования таких инструментов с академическими результатами остаются ограниченными и неоднородными. *Цель.* Цель исследования — оценить связь использования GenAI с воспринимаемой академической успеваемостью студентов бакалавриата компьютерных специальностей, их вовлеченностью, уверенностью, учебной самостоятельностью и готовностью обращаться за помощью, а также сопоставить эти результаты с восприятием тьюторов. *Методы.* Использован описательный количественный дизайн исследования с применением двух параллельных анкет — для студентов и тьюторов. В опросе приняли участие 17 студентов и 9 тьюторов. Анкеты включали утверждения, оцениваемые по пятибалльной шкале Ликерта, и охватывали десять конструктов: простоту использования GenAI, уверенность, вовлеченность, воспринимаемое улучшение академических результатов, поддержку обучения, зависимость от ИИ, опасения относительно плагиата, готовность обращаться за помощью, применение знаний и эффективность оценивания. Ответы, собранные с помощью Google Forms, были обработаны

в среде Python с использованием библиотек Matplotlib и Seaborn; результаты визуализировались с помощью диаграмм рассеяния и сравнительных диаграмм размаха. *Результаты.* Полученные данные указывают на в целом положительную связь между использованием GenAI и воспринимаемой академической результативностью, особенно в части понимания сложных концепций программирования и учебной вовлеченности. Тьюторы также отмечали снижение частоты обращения студентов за непосредственной поддержкой преподавателей и повышение их уверенности в собственных возможностях. Вместе с тем выявлены неоднородность пользовательского опыта, устойчивые опасения относительно академической честности и тенденция части студентов предпочитать использование GenAI обращению за помощью к преподавателям или сверстникам. С учетом небольшого объема выборки результаты следует рассматривать как пилотные и интерпретировать с осторожностью. *Практическая значимость.* Полученные выводы могут быть использованы при разработке сбалансированных педагогических стратегий и институциональных регламентов, предусматривающих использование GenAI как вспомогательного инструмента, дополняющего, но не заменяющего взаимодействие студентов с преподавателями.

Ключевые слова: генеративный искусственный интеллект; GenAI; компьютерное образование; академическая успеваемость студентов; программирование; академическая честность; цифровое обучение

Introduction. The rapid advancement of artificial intelligence has permeated virtually every layer of society, with education representing one of the sectors most profoundly affected by this technological shift (Pedro et al., 2019). The increasing adoption of generative artificial intelligence (GenAI) among university students has prompted a fundamental change in how knowledge is acquired and applied (Hou et al., 2024; Vafadar and Amani, 2024). Of particular significance is the capacity of GenAI to generate code and address coding challenges, which has substantially altered how computer science students approach their assignments and projects (Prather et al., 2023). For example, students are increasingly inclined to rely on GenAI to produce code on their behalf rather than attempting to solve tasks independently (Dickey and Bejarano, 2023). This shift extends beyond the academic context and has begun to reshape the professional landscape, particularly within the software industry (Eynon and Young, 2021; Prather et al., 2023). Notably, GenAI has contributed to enhanced productivity in software engineering by automating routine coding tasks, thereby enabling professionals to devote greater attention to complex problem-solving and innovation (Parikh, 2023). It is therefore essential to examine the consequences of GenAI's growing prevalence among students.

The primary aim of this research was to investigate the coding capabilities of GenAI and their influence on computer science students, while intentionally excluding other functionalities such as essay generation or image creation. Prior

to the widespread uptake of ChatGPT, students demonstrated a stronger tendency to seek guidance from teaching assistants (Hou et al., 2024). However, the emergence of GenAI appears to have diminished the need for such human support. Consequently, it is of considerable importance to conduct a thorough investigation into the effects of this evolving dynamic on computer science students. The research question guiding this study was: "What impact does generative AI have on students' academic performance in computer science education?"

Within this research context, academic performance is understood as the degree to which students attain their educational objectives. This construct is typically operationalised through indicators such as grades or the highest level of educational achievement (Martin Sanz et al., 2017). It is important to acknowledge that academic performance is shaped not only by intellectual ability but also by factors such as emotional intelligence, personality traits, and a sense of purpose (Poropat, 2009). Furthermore, the impact of GenAI was evaluated by examining a range of dimensions associated with its growing use among computer science students. All variables were assessed through survey instruments, offering a comprehensive account of how generative AI influences students' academic outcomes. A detailed description of the methodology is provided in the Materials and Methods section.

To situate the present study, this introduction also reviews existing research at the intersection of generative artificial intelligence and education. Generative AI has attracted considerable scholarly attention in recent years, with a growing body of literature examining its implications for education, particularly within the field of computer science.

Ghimire, Prather, and Edwards (2024) explored educators' awareness, sentiments, and the factors shaping their attitudes towards generative AI in educational settings, offering valuable perspectives on how educators perceive these tools and how they might be meaningfully incorporated into computer science curricula (Ghimire et al., 2024). Zastudil et al. (2023) investigated the viewpoints of both students and instructors regarding the role of generative AI in computing education, contributing to a broader understanding of how these stakeholders engage with and perceive such tools (Zastudil et al., 2023). Hou et al. (2024) examined the influence of generative AI on the help-seeking behaviours of computer science students, shedding light on how learners utilise these tools as a source of academic support (Hou et al., 2024). Chan and Hu (2023) foregrounded student perspectives on generative AI, with a particular focus on perceived benefits and challenges within higher education contexts (Chan and Hu, 2023). Yilmaz R. and Yilmaz F.G.K. (2023) assessed the impact of generative AI-based tools on students' computational thinking skills, programming self-efficacy, and intrinsic motivation (Yilmaz and Yilmaz, 2023). Prather et al. (2023) addressed the broader implications of the generative AI revolution for computing education, outlining both the challenges and opportunities these technologies present to educators in the field (Prather et al., 2023). Lo (2023) further synthesised emerging evidence on ChatGPT in higher education, documenting both promising learning gains and

the rapid pace at which institutional responses must adapt (Lo, 2023). Raihan et al. (2025) conducted a systematic literature review of large language models in computer science education, reporting that thoughtfully scaffolded GenAI use can improve novice learners' conceptual understanding while highlighting unresolved concerns about over-reliance and assessment integrity (Raihan et al., 2025). Crawford et al. (2023) raised parallel concerns about academic integrity, arguing that institutional policies need to evolve in tandem with detection technologies and student literacy in responsible AI use (Crawford et al., 2023).

Although these studies collectively offer meaningful insights into the application of generative AI in educational settings, a notable gap persists in the literature. In particular, there remains a scarcity of research that directly examines the impact of generative AI on students' academic performance within computer science education. Given the accelerating integration of GenAI tools into educational practice, understanding how these technologies influence academic outcomes is of considerable importance.

Materials and methods. This research employed two survey instruments targeting students and teaching assistants, respectively, with the aim of capturing GenAI's influence on academic performance. Both surveys incorporated Likert scale items, enabling the quantification of participants' perceptions and experiences and thereby facilitating systematic analysis and comparison of the collected data (McLeod, 2023). Likert scale items are particularly well suited for measuring attitudes and subjective evaluations. In addition, demographic questions were included to ensure that the sample adequately represented the target population, which is an important consideration for the validity of the findings and the derivation of meaningful conclusions from the data (Hughes et al., 2022). The demographic items across both surveys addressed the following variables: participants' age and gender, their programme of study, educational level (e.g., Bachelor's, Master's, or PhD), and current year of enrolment.

Upon completion of data collection, responses were exported from Google Forms into CSV file format for subsequent analysis. The analytical approach centred on visualising the relationships between the variables described later in this section. Scatter plots were utilised to map variables against one another, offering insights into potential correlations and trends across different factors. Box plots were additionally employed to compare analogous data derived from the two surveys, enabling a clear visual comparison of distribution patterns and variation within the responses. The Python libraries matplotlib and seaborn were used to generate graphical representations of the findings.

The student survey yielded a total of 17 respondents, providing a preliminary snapshot of the demographic composition within the study. Participants' ages ranged from 19 to 27 years. The sample included both male and female respondents; however, there was no representation from individuals identifying as non-binary or with other gender identities. The reported fields of study were predominantly technical and business-oriented, with the majority of participants enrolled in either

Technical Computer Science or Business Information Technology, which together accounted for 76.5% of the sample. All respondents were pursuing Bachelor's-level education, with varying years of study reported at the time of participation. Notably, no first-year students were represented in the sample; all participants were in their second or third year of study. While the sample of 17 respondents offers useful preliminary insights, certain limitations should be acknowledged, including limited diversity with respect to gender and field of study. Furthermore, as all respondents were enrolled at the Bachelor's level, the generalisability of the findings to other educational contexts may be constrained. A more detailed discussion of the study's limitations is provided in the Discussion section of this paper.

The teaching assistant survey comprised 9 respondents, reflecting a similarly modest sample size to that of the student survey. Consistent with the student sample, all respondents were enrolled at the Bachelor's level, and their reported year of study was either the second or third year. However, the demographic profile of the teaching assistant sample differed in several respects. Participants' ages ranged from 19 to 22 years. In contrast to the student survey, this sample included only one female respondent, and no participants declined to disclose their gender. All respondents were enrolled in the Business Information Technology program. As with the student survey, the potential limitations and biases inherent in this sample should be taken into account when interpreting the results. Further discussion of these limitations is presented in the Discussion section of this paper.

The analytical framework was constructed around a set of variables representing key constructs that may influence the academic performance of students in computer science education, particularly in relation to the use of generative AI. These variables, along with their corresponding Likert scale statements as presented in the surveys, are detailed in Table 1. The specific survey from which each statement was drawn is denoted in brackets within the table, with "TAs" referring to the teaching assistant survey and "Students" referring to the student survey.

Table 1 — Variables and survey statements accordingly

Variable	Likert-scale statement(s)
Ease of use	Students: “I find generative AI tools straightforward and easy to use.”
Confidence	– Students: “Using generative AI tools makes me feel more confident in my abilities.” – TAs: “Since students began using generative AI tools, they appear more confident in what they can do.”
Engagement	– Students: “I feel more involved and motivated in my studies when I use generative AI tools.” – TAs: “After generative AI tools were introduced, I have observed higher student engagement.”
Grade improvements	– Students: “I believe my grades have improved as a result of using generative AI.” – TAs: “I have seen students’ grades improve since generative AI tools were introduced.”

Learning	– Students: “Generative AI tools help me better understand difficult programming concepts.” – TAs: “Students seem to grasp complex concepts more effectively when they use generative AI.”
Dependence	– Students: “I depend on generative AI tools to finish my assignments.” – TAs: “Since generative AI tools emerged, I have noticed students relying less on teaching assistants.”
Concerns	Students: “I worry that using generative AI tools could lead to plagiarism in my work.”
Help-seeking comfort	Students: “I feel more comfortable asking generative AI for help than asking a peer, TA/mentor, or professor.”
Application	TAs: “Generative AI tools help students apply what they know more effectively.”
Grading efficiency	TAs: “Generative AI tools have made grading assignments faster and more efficient.”

This study further examined the relationships among these variables. Selected variables were combined and plotted against one another in order to gain a deeper understanding of their interactions and their collective influence on students' academic performance.

Results. This section is organised into two subsections. The first presents graphical representations of the correlations between variables within each individual survey, offering insights into how these variables interact and relate to one another. The second provides a comparative analysis of variables across the two surveys, specifically examining and contrasting the perceptions of students and teaching assistants.

Within the student survey, the first relationship explored concerns the correlation between engagement and perceived grade improvements. This analysis specifically examines the association between the statements "I am more engaged in my studies when I use generative AI tools" and "I believe my grades have improved because of generative AI."

Students who experience greater engagement through the use of GenAI tools may develop a deeper understanding of the material, approach problem-solving more efficiently, and consequently perceive improvements in their academic grades (Chan and Hu, 2023). Conversely, a lack of engagement may limit these potential benefits. Accordingly, examining the correlation between students’ engagement with generative AI tools and their perceptions of grade improvement can yield valuable insights into the educational impact of such tools (Karpouzis et al., 2024).

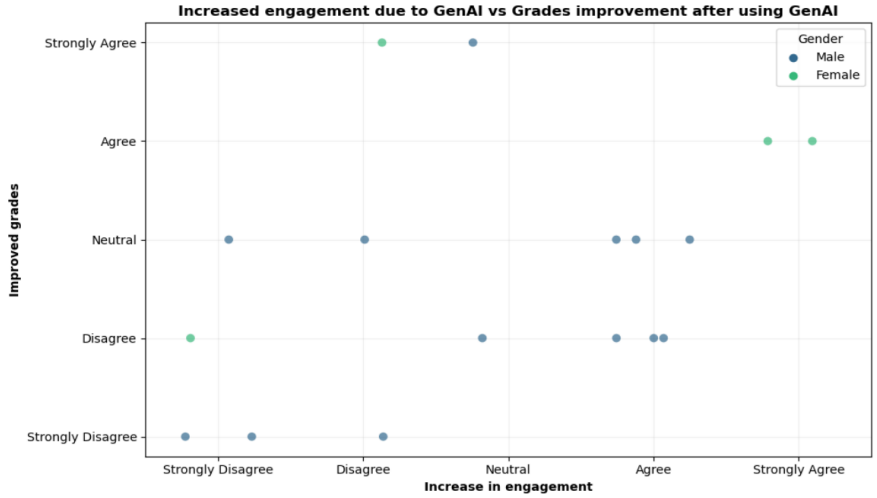

Figure 1 — Engagement and grade improvements variables

The scatter plot presented in Figure 1 illustrates a varied relationship between heightened engagement attributable to generative AI and perceived grade improvement among student participants. Male students in the sample appear more evenly distributed across different levels of agreement and perceived grade improvement, suggesting a range of experiences with GenAI. A notable cluster of male students can be observed who agree that their engagement has increased but express neutral views regarding grade improvement. Female students, by contrast, predominantly either strongly agree or agree that their grades have improved, with 50% of female respondents strongly agreeing that their engagement has increased. This suggests a generally favorable perception among female participants regarding the impact of GenAI on both engagement and grades. Overall, while the data point towards a broadly positive impact, the responses also reveal a diversity of experiences, underscoring the nuanced effects of GenAI in educational contexts.

The subsequent variables examined were learning and dependence, represented by the statements "The generative AI tools help me understand complex programming concepts better" and "I rely on generative AI tools to complete my assignments."

Generative AI tools have the potential to assist students in comprehending complex programming concepts, which may in turn lead to increased reliance on these tools for assignments and problem-solving. When used appropriately, such tools can enhance understanding, efficiency, and academic performance by offering instant feedback, accommodating individualised learning paces, and exposing students to diverse coding approaches (Kotsiovos et al., 2025). However, excessive reliance without a solid grasp of the underlying concepts could impede the development of independent problem-solving skills, which are essential in computer science education (Zastudil et al., 2023). By examining the relationship

between these variables, it is possible to determine whether students who perceive GenAI as beneficial for understanding complex concepts also tend to rely on it for completing their assignments.

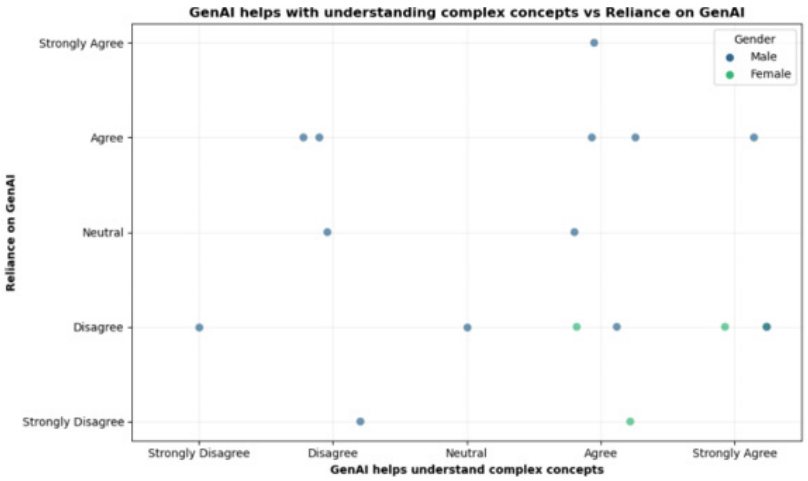

Figure 2 — Learning and dependence variables

As illustrated in Figure 2, the relationship between students' reliance on generative AI tools for completing assignments and their perception of these tools' effectiveness in facilitating the understanding of complex programming concepts is similarly diverse. Both male and female students express a range of opinions spanning from "Strongly Disagree" to "Strongly Agree" on both dimensions. Nevertheless, a concentration of responses can be observed among students who agree that generative AI tools aid in understanding complex concepts and who simultaneously rely on these tools for their coursework. This suggests that students who find generative AI tools beneficial for grasping difficult programming concepts are also more likely to depend on them for academic tasks. The scatter plot also reveals an additional noteworthy finding: the majority of students perceive GenAI as helpful in understanding complex concepts, as evidenced by the greater concentration of data points on the right-hand side of the graph. This may reflect the positive impact that generative AI can have on students. The distribution across gender categories, however, does not indicate a significant difference in responses, suggesting broadly similar perceptions regardless of gender.

Continuing the theme of reliance on generative AI, the next relationship examined involves the variables of dependence and concerns, corresponding to the statements "I rely on generative AI tools to complete my assignments" and "I am worried about plagiarism of my work more when I use generative AI tools."

The correlation between students' apprehension regarding plagiarism when using generative AI tools and their dependence on these tools for assignments reflects both the perceived risks and the degree of reliance associated with their

use. If students engage with these tools responsibly, treating the generated code as a reference rather than a definitive solution, they may benefit from enhanced efficiency and potentially improved grades (Chan and Hu, 2023). However, concerns about plagiarism can give rise to stress and anxiety, which may adversely affect academic performance. Moreover, should such concerns materialise into actual instances of plagiarism, this could carry serious consequences for students' learning experiences and academic trajectories.

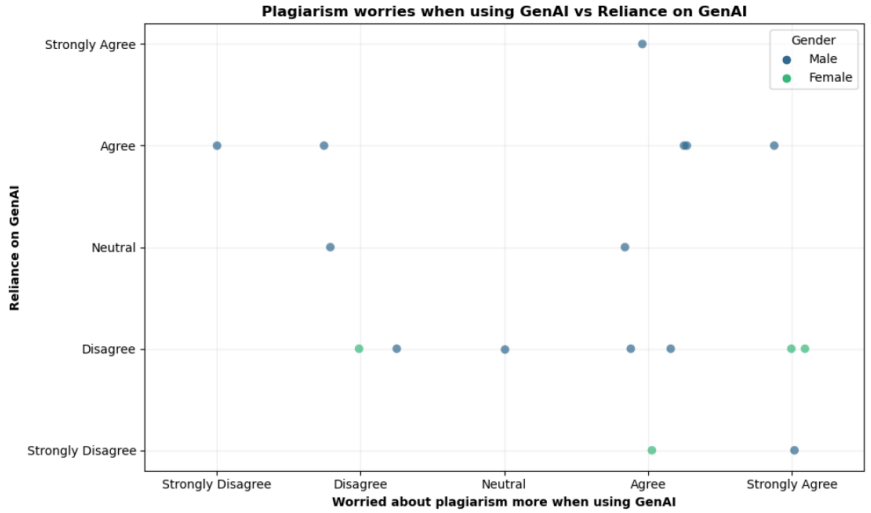

Figure 3 — Dependence and concerns variables

As shown in Figure 3, students' reliance on GenAI tools varies considerably across different levels of concern about plagiarism. Students generally exhibit a broad range of dependence on GenAI irrespective of their plagiarism-related apprehensions. Notably, those who agree or strongly agree with the concern about plagiarism appear to rely on GenAI tools to varying degrees, suggesting no direct correlation between heightened plagiarism concern and reduced reliance on GenAI. This indicates that although some students express concern about plagiarism, such apprehension does not necessarily discourage them from using GenAI tools extensively.

The final pair of variables examined within the student survey relates to help-seeking comfort and engagement, represented by the statements "I feel more comfortable to seek help from generative AI than from a peer, teaching assistant/ mentor or professor" and "I am more engaged in my studies when I use generative AI tools."

If students report greater engagement in their studies when using generative AI tools, this suggests that such tools are effectively stimulating their interest and involvement in the learning process (Zastudil et al., 2023). Conversely, if students feel more at ease seeking assistance from generative AI tools than from

human sources, this may indicate a preference for the anonymity, non-judgmental nature, and potentially the immediacy of feedback that these tools offer (Hou et al., 2024). The connection between these two variables lies in the enhanced learning experience that generative AI tools may facilitate. If a student is both more engaged in their studies when using these tools and feels comfortable seeking help from them, this can foster a positive learning environment that encourages sustained independent learning and exploration.

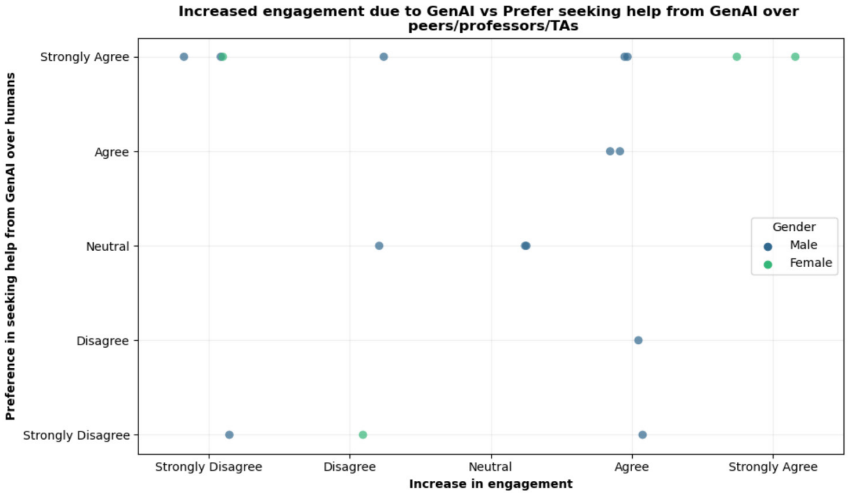

Figure 4 — Help-seeking comfort and engagement variables

Figure 4 presents this relationship in the form of a scatter plot. The data points are distributed across the graph, reflecting varied opinions among the students. It is worth noting, however, that a substantial proportion of students in the sample expressed a preference for seeking help from generative AI rather than from human educators or peers, as evidenced by the large number of data points clustered at the "Strongly Agree" position on the y-axis. Such a finding may indeed suggest that the immediacy of feedback, anonymity, and non-judgmental nature of the technology represent key advantages of GenAI tools relative to human assistants. Furthermore, a prominent cluster of data points in the upper-right quadrant of the plot indicates that a considerable number of participants agree or strongly agree with both statements, which may reflect the positive contribution that GenAI can make to the student learning experience.

Turning to the teaching assistant survey, the first variables analysed were dependence and confidence, corresponding to the statements "I have noticed a decrease in students' dependence on teaching assistants after the emergence of generative AI" and "Students seem more confident in their abilities since they started using generative AI tools."

By plotting these variables against one another, it becomes possible to ascertain

whether the reported decline in students' dependence on teaching assistants attributable to GenAI correlates with a perceived growth in student confidence. Independence from human educators' support may indeed foster greater confidence among students in their own abilities, given that they can address complex problems autonomously by consulting GenAI rather than seeking assistance from teaching assistants (Chan and Hu, 2023).

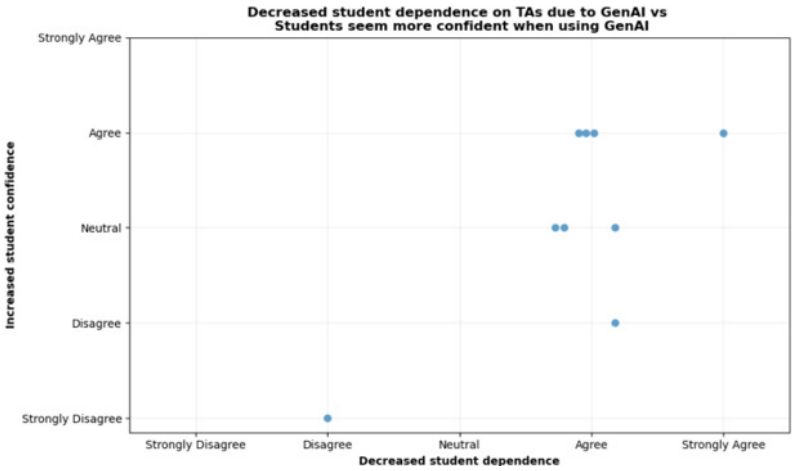

Figure 5 — Dependence and confidence variable

The first scatter plot of the teaching assistant survey analysis is presented in Figure 5. A positive correlation between decreased dependence on teaching assistants and increased student confidence is discernible from the plot. Nearly all data points are situated on the right-hand side of the graph, suggesting that the participating teaching assistants have indeed observed a reduction in students' reliance on their support. Moreover, a substantial proportion of the data points are located in the upper-right quadrant, indicating that respondents who have noticed decreased student dependence have also observed an increase in student confidence attributable to GenAI. It can therefore be inferred from the plot that as students become less dependent on teaching assistants, their confidence in their own abilities tends to increase. This suggests that GenAI is not only reducing the workload of teaching assistants but also cultivating a more self-reliant and confident learning environment for students, which may in turn positively influence their academic performance.

The statements "Students seem to understand complex concepts better when they use generative AI" and "Generative AI tools help students apply their knowledge more effectively" correspond to the learning and application variables. A positive correlation between these two variables would suggest that students who demonstrate better understanding of complex concepts through GenAI use also apply their knowledge more effectively.

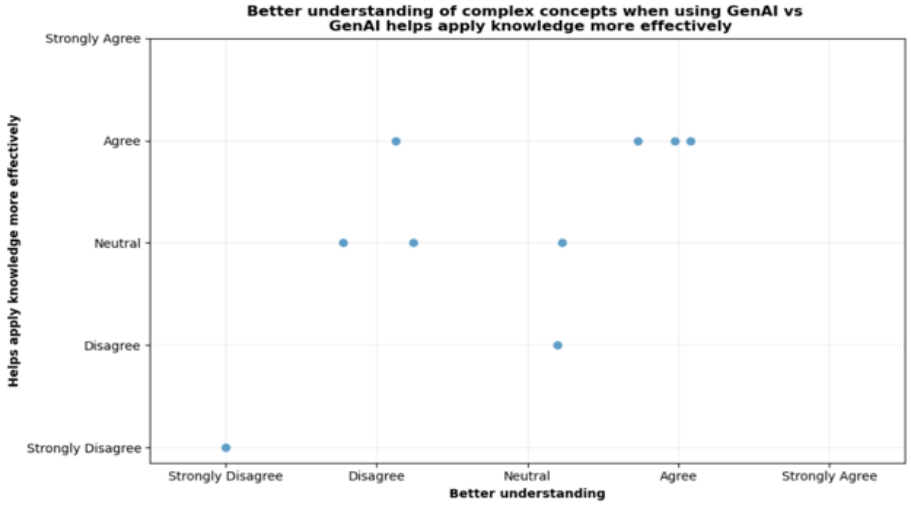

Figure 6 — Learning and application variables

As illustrated in Figure 6, 33% of respondents expressed agreement with both statements, while one respondent strongly disagreed with both and another responded neutrally to both. This pattern tentatively suggests a positive correlation between the variables. Nevertheless, it is difficult to characterise this correlation as robust given the limited number of data points. Despite the constraints of the sample size, the teaching assistants' responses and perceptions regarding these statements provide evidence of the potential for generative AI tools to exert a positive influence on students in computer science education.

The final variable analysis within the teaching assistant survey concerns grading efficiency and grade improvements, corresponding to the statements "Generative AI tools have made grading assignments more efficient" and "I have noticed an improvement in students' grades since the introduction of generative AI tools." A positive correlation between these variables would suggest that as GenAI tools enhance grading efficiency, students' grades also improve. Such an improvement could be attributable to more timely and detailed feedback from teaching assistants utilising GenAI tools, enabling students to learn from their errors and enhance their performance through the receipt of prompt feedback.

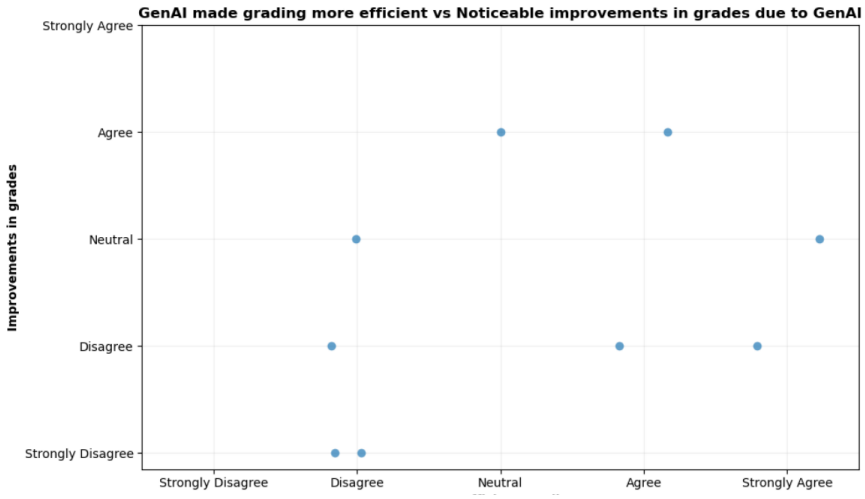

Figure 7 — Grading efficiency and grade improvements variables

The plot in Figure 7 reveals a varied distribution of responses. The figure shows responses distributed across different levels of agreement and disagreement for both statements. Some teaching assistants strongly agree that generative AI has rendered grading more efficient and have observed improvements in student grades, while others disagree or remain neutral on both counts. This spread indicates mixed perceptions among teaching assistants, with no strong consensus regarding the effectiveness of generative AI tools in enhancing grading efficiency or improving grades. Overall, the data suggest that while some teaching assistants perceive tangible benefits, opinions remain divided, reflecting the complexity of GenAI's impact.

This subsection, in contrast to the preceding one, compares matched statements from the student and teaching assistant surveys in order to identify similarities and differences in their respective perceptions of generative AI and its impact on students.

The first overarching theme drawn from both surveys is "Confidence." The student survey statement reads: "I feel more confident in my abilities when I use generative AI tools," while the corresponding teaching assistant survey statement is: "Students seem more confident in their abilities since they started using generative AI tools."

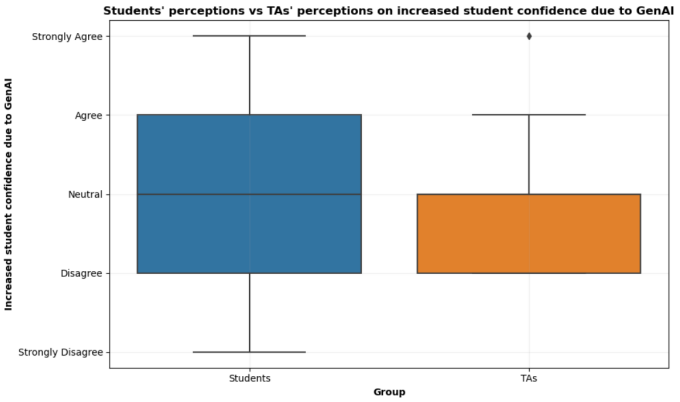

Figure 8 — Confidence variable in both surveys

As shown in the box plot in Figure 8, both students and teaching assistants exhibit a median response in the "Neutral" category, suggesting that the central perception for both groups is neither clearly positive nor negative regarding whether GenAI enhances student confidence. However, the distribution of responses indicates that students hold a wider range of perceptions compared to teaching assistants. The interquartile range (IQR) for students extends from "Disagree" to "Agree," whereas for teaching assistants it is narrower, spanning from "Disagree" to "Neutral." This suggests that students' opinions on GenAI's influence on their confidence are more varied and that, on average, students may feel somewhat more confident as a result of GenAI use than teaching assistants perceive or observe.

The next variable featuring matched statements from both surveys is "Grade Improvements." The corresponding statements are "I believe my grades have improved because of generative AI tools" (Students) and "I have noticed an improvement in students' grades since the introduction of generative AI tools" (TAs).

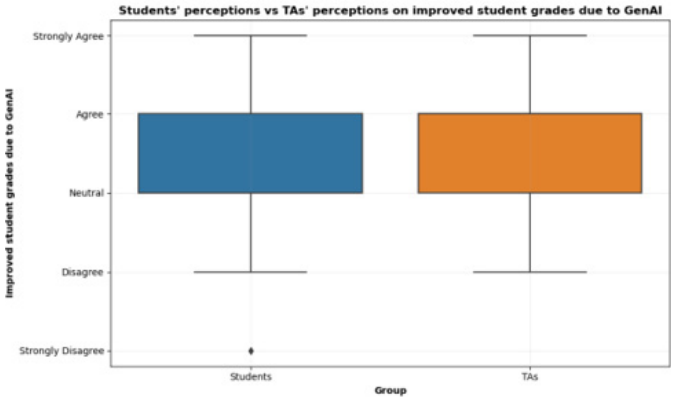

Figure 9 — Grades improvements variable in both surveys

From Figure 9, it can be inferred that the median response for both students and teaching assistants is "Agree," suggesting that the majority of both groups believe that generative AI has contributed to improved student grades. While there is a general consensus between students and teaching assistants that generative AI has had a positive effect on grades, the student responses display a wider range of opinions. The presence of an outlier in the student data indicates that some students may strongly disagree with the prevailing view. This divergence could constitute an interesting area for further investigation.

Turning to the "Learning" variable, which also comprised similar statements across both surveys, the corresponding items are "The generative AI tools help me understand complex programming concepts better" (Students) and "Students seem to understand complex concepts better when they use generative AI" (TAs).

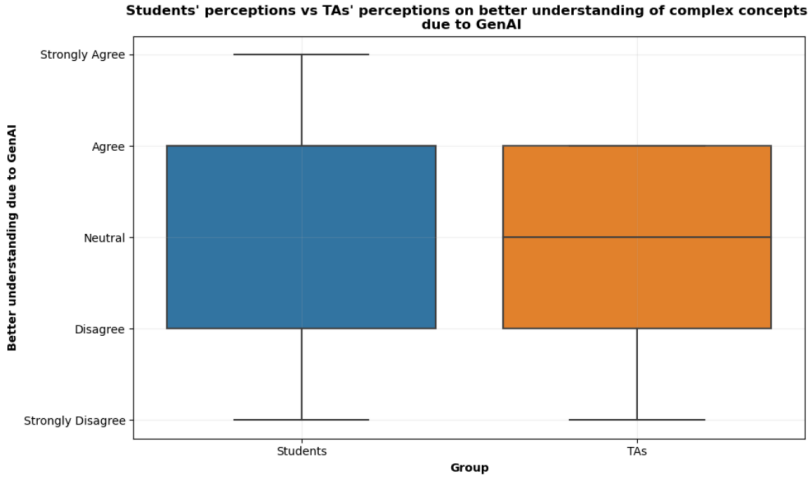

Figure 10 — Learning variable in both surveys

Figure 10 shows that the students' responses span from "Strongly Disagree" to "Strongly Agree," while the teaching assistants' responses range from "Strongly Disagree" to "Agree," indicating a variety of opinions on the effectiveness of generative AI in facilitating the understanding of complex programming concepts. The median response for both groups falls within the "Neutral" category, suggesting a relatively balanced view on the impact of generative AI tools. The interquartile range for both groups extends from "Disagree" to "Agree," indicating that the central 50% of responses reflect moderate disagreement to agreement on the respective statements.

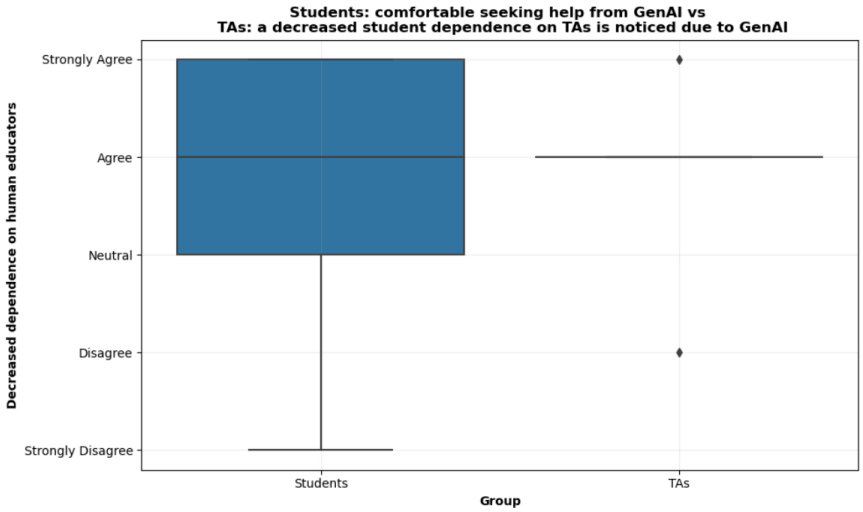

Figure 11 — Help-seeking preference and dependence on Tas

The final box plot, presented in Figure 11, displays the responses to the statements "I feel more comfortable to seek help from generative AI than from a peer, teaching assistant/mentor or professor" and "I have noticed a decrease in students' dependence on teaching assistants after the emergence of generative AI." The box plot indicates that students are increasingly comfortable seeking assistance from generative AI, with responses ranging from "Neutral" to "Strongly Agree." Concurrently, teaching assistants have observed a decline in students' reliance on their support, with nearly all responses falling at the "Agree" level. This suggests a shift in educational reliance from human tutors towards AI, potentially driven by factors such as students' comfort with AI, the efficiency of these tools, or their increasing prevalence in educational settings (Zastudil et al., 2023).

Discussion. The central objective of this research was to examine the impact of generative AI on students' academic performance within computer science education. This section summarises and interprets the findings derived from the student and teaching assistant surveys, situates them within the broader research objectives, and considers their wider implications. Additionally, the limitations of the study are addressed and directions for future research are proposed.

The survey analysis revealed that students' engagement and perceived grade improvements are associated with the use of generative AI tools, although individual experiences varied considerably. The study also identified a substantial proportion of students utilising these tools both for comprehending complex programming concepts and for completing assignments, indicating that generative AI serves a dual function as both a learning aid and a potential source of over-reliance.

Despite apprehensions regarding plagiarism, such concerns do not appear to discourage the extensive use of AI tools, underscoring the need for strategies aimed

at preserving academic integrity. A considerable number of students expressed a preference for AI-based assistance over support from peers or instructors, citing the anonymity and non-judgmental nature of these tools, which was found to be associated with increased engagement and the promotion of independent learning and problem-solving.

From the perspective of teaching assistants, the survey revealed a perceived decline in student dependence on teaching assistants alongside an increase in student confidence. This was reflected in the positive correlation observed between these variables, suggesting that generative AI tools may foster a more self-reliant and confident approach to learning. Furthermore, teaching assistants noted that students who engaged with generative AI tools tended to demonstrate improved understanding of complex concepts and more effective application of their knowledge, albeit with some variation in perceptions.

The comparative analysis of student and teaching assistant perceptions indicated that both groups held broadly similar views regarding the impact of generative AI. For instance, both students and teaching assistants generally agreed that generative AI tools contribute to improved grades and enhanced comprehension of complex concepts. Nevertheless, students exhibited a wider spectrum of opinions, reflecting more diverse individual experiences. Teaching assistants, by contrast, demonstrated greater consistency in their perceptions, particularly in reporting increased student confidence and decreased reliance on their support. A notable difference was observed with respect to perceived confidence levels attributable to GenAI. The median perception for both groups was neutral regarding whether GenAI enhances student confidence; however, students' opinions were more varied than those of teaching assistants, suggesting that while some students may feel somewhat more confident when using GenAI, this perception is not uniformly held.

The positive association between engagement and grade improvements suggests that generative AI tools have the potential to enhance academic performance by rendering the learning process more interactive and engaging. This may be particularly advantageous in a discipline such as computer science, where the comprehension of complex concepts is of paramount importance.

However, the reliance on generative AI tools for completing assignments raises concerns regarding the development of independent problem-solving competencies. While these tools can substantially support learning, it is essential to encourage students to employ them as supplementary resources rather than as primary sources of solutions. Achieving this balance is critical to ensuring that students develop the requisite skills to succeed autonomously.

The varied perceptions surrounding plagiarism concerns highlight the complexity inherent in integrating generative AI into educational practice. Institutions must establish clear guidelines and develop educational programs to support students in using AI tools responsibly, thereby mitigating the risks associated with academic dishonesty.

The observed shift towards seeking assistance from AI rather than human educators points to the need for a seamless integration of AI within educational frameworks. While AI can provide immediate and non-judgmental support, human educators continue to play an indispensable role in offering personalised guidance and mentorship. A blended approach that draws upon the strengths of both AI and human support has the potential to create an optimal learning environment.

The overall impact of generative AI on students' academic performance in computer science education is multifaceted. Generative AI tools enhance the learning experience by rendering complex concepts more accessible and delivering personalised support, which may contribute to improved academic outcomes. Students benefit from heightened engagement and confidence, both of which are positively associated with performance. However, the integration of these tools also necessitates addressing challenges such as over-reliance and threats to academic integrity. To maximise the benefits of generative AI, educational institutions should develop strategies that incorporate these tools as complements to traditional pedagogical methods, ensuring that students build robust foundational skills while capitalizing on the advantages afforded by advanced AI technologies.

This study is subject to several limitations that should be taken into account when interpreting the findings. The rapid pace of development in generative AI technology means that the landscape is in a state of continual evolution, which may affect the applicability and relevance of the findings over time. Furthermore, the temporal constraints of this research limited the depth of analysis and precluded an examination of long-term impacts.

Additionally, the sample size was relatively modest and not fully representative of the broader student population. Nonetheless, it yielded valuable insights into individual perspectives, which are essential for understanding the nuanced effects of emerging technologies in education. Future research should endeavor to recruit a larger and more diverse sample in order to enhance the generalizability of the findings.

Measuring the impact of generative AI on academic performance is inherently challenging given the multifaceted nature of education and learning processes. Future studies could benefit from adopting a mixed-methods approach, integrating quantitative data with qualitative insights to provide a more comprehensive understanding. Additionally, incorporating the perceptions of academic staff regarding GenAI in computer science education would further enrich the evidence base.

Conclusion. In summary, this research has demonstrated that generative AI tools hold considerable potential to enhance computer science education by fostering greater student engagement and improving academic performance. The findings suggest that while GenAI tools facilitate the comprehension of complex programming concepts, there exists a tangible risk of students developing an excessive dependence on such tools, which may in turn compromise the cultivation of independent problem-solving competencies. The diversity of perceptions

surrounding plagiarism further highlights the necessity for establishing clear institutional guidelines and educational programs to promote the responsible use of AI tools. Future research should seek to address the limitations identified in this study by incorporating larger and more demographically diverse samples and adopting a mixed-methods approach to yield a more holistic understanding of generative AI's impact on education. Ultimately, a balanced integration of AI tools alongside human educators has the potential to foster an optimal learning environment—one that harnesses the respective strengths of both to support student success in computer science education.

References

Chan C.K.Y., and Hu W. (2023) Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. International Journal of Educational Technology in Higher Education, 20(1). — 43 p. https://doi.org/10.1186/s41239-023-00411-8 (in English)

Crawford J., Cowling M., and Allen K.-A. (2023) Leadership is needed for ethical ChatGPT: Character, assessment, and learning using artificial intelligence (AI). Journal of University Teaching and Learning Practice, 20(3), 02. https://doi.org/10.53761/1.20.3.02 (in English)

Dickey E., and Bejarano A. (2023) A model for integrating generative AI into course content development. arXiv preprint arXiv:2308.12276. https://doi.org/10.48550/arXiv.2308.12276 (in English)

Eynon R., and Young E. (2021) Methodology, legend, and rhetoric: The constructions of AI by academia, industry, and policy groups for lifelong learning. Science, Technology, and Human Values, 46(1). — P. 166–191. https://doi.org/10.1177/0162243920906475 (in English)

Ghimire A., Prather J., and Edwards J. (2024) Generative AI in education: A study of educators' awareness, sentiments, and influencing factors. arXiv preprint arXiv:2403.15586. https://doi.org/10.48550/arXiv.2403.15586 (in English)

Hou I., Metille S., Li Z., Man O., Zastudil C., and MacNeil S. (2024) The effects of generative AI on computing students' help-seeking preferences. In Proceedings of the 26th Australasian Computing Education Conference. — P. 39–48. https://doi.org/10.1145/3636243.3636248 (in English)

Hughes J. L., Camden A. A., Yangchen T., Smith G. P., Rodríguez M. M. D., Rouse S. V., McDonald C. P., and Lopez S. (2022) Guidance for researchers when using inclusive demographic questions for surveys: Improved and updated questions. Psi Chi Journal of Psychological Research, 27(4). — P. 232–255. https://doi.org/10.24839/2325-7342.JN27.4.232 (in English)

Karpouzis K., Pantazatos D., Taouki J., and Meli K. (2024) Tailoring education with GenAI: A new horizon in lesson planning. arXiv preprint arXiv:2403.12071. https://doi.org/10.48550/arXiv.2403.12071 (in English)

Kotsiovos J., Chicone R., and Doyle S. (2025) Optimizing student success: The impact of artificial intelligence in teaching and learning. International Journal for Educational Media and Technology, 18(2). (in English)

Lo C. K. (2023) What is the impact of ChatGPT on education? A rapid review of the literature. Education Sciences, 13(4), 410. https://doi.org/10.3390/educsci13040410 (in English)

Martin Sanz N., Rodrigo I., Izquierdo García C., and Ajenjo Pastrana P. (2017) Exploring academic performance: Looking beyond numerical grades. Universal Journal of Educational Research, 5(7). — P. 1105–1112. https://doi.org/10.13189/ujer.2017.050703 (in English)

McLeod S. (2023) Likert scale questionnaire: Examples and analysis. Simply Psychology. (in English)

Parikh N. A. (2023) Empowering business transformation: The positive impact and ethical considerations of generative AI in software product management — A systematic literature review. In Transformational Interventions for Business, Technology, and Healthcare. — P. 269–293. IGI Global. (in English)

Pedro F., Subosa M., Rivas A., and Valverde P. (2019) Artificial intelligence in education: Challenges and opportunities for sustainable development. UNESCO. (in English)

Poropat A. E. (2009) A meta-analysis of the five-factor model of personality and academic performance. Psychological Bulletin, 135(2). — P. 322–338. https://doi.org/10.1037/a0014996 (in English)

Prather J., Denny P., Leinonen J., Becker B. A., Albluwi I., Craig M., Keuning H., Kiesler N., Kohn T., and Luxton-Reilly A. (2023) The robots are here: Navigating the generative AI revolution in computing education. In Proceedings of the 2023 Working Group Reports on Innovation and Technology in Computer Science Education. — P. 108–159. https://doi.org/10.1145/3623762.3633499 (in English)

Raihan N., Siddiq M. L., Santos J. C. S., and Zampieri M. (2025) Large language models in computer science education: A systematic literature review. In Proceedings of the 56th ACM Technical Symposium on Computer Science Education V. 1 (SIGCSE TS 2025). https://doi.org/10.1145/3641554.3701863 (in English)

Vafadar M., and Amani A. M. (2024) Academic education in the era of generative artificial intelligence. Journal of Electronics and Electrical Engineering, 3(2). — P. 110–124. https://doi.org/10.37256/jeee.3220245443 (in English)

Yilmaz R., and Yilmaz F. G. K. (2023) The effect of generative artificial intelligence (AI)-based tool use on students' computational thinking skills, programming self-efficacy and motivation. Computers and Education: Artificial Intelligence, 4, 100147. https://doi.org/10.1016/j.caeai.2023.100147 (in English)

Zastudil C., Rogalska M., Kapp C., Vaughn J., and MacNeil S. (2023) Generative AI in computing education: Perspectives of students and instructors. In 2023 IEEE Frontiers in Education Conference (FIE). — P. 1–9. https://doi.org/10.1109/FIE58773.2023.10342898 (in English)

Publication Ethics and Publication Malpractice in the journals of the Central Asian Academic Research Center LLP

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the journals of the Central Asian Academic Research CenterLLP implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier. com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The Central Asian Academic Research Center LLP follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http:// publicationethics. org/files/ u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/ or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the Central Asian Academic Research Center LLP.

The Editorial Board of the Central Asian Academic Research Center LLP will monitor and safeguard publishing ethics.

Requirements for articles design for publication in the journal are available on the websites:

www: nauka-nanrk.kz
ISSN 2518–1467 (Online),
ISSN 1991–3494 (Print)
http://www.bulletin–science.kz/index.php/en

Managing Editor: A.Shormakova
Editors: D.S. Alenov, M.Konyrbekov
Computer layout: G.D. Zhadyranova

Signed for print: August 31, 2026
Format: 70×90 1/16. 48.0 printed sheets. Order No. 4

«Central Asian Academic Research Center» LLP
Almaty, Shevchenko Street, 28