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Human-AI Collaboration and Students' Higher-Order Thinking Skills in Higher Education

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ARTICLE INFO	ABSTRACT
Submission: August 23, 2026 Revised: September 04, 2026 Accepted: September 21, 2026 Available Online: October 01, 2026 Keywords: Human-AI Collaboration, Higher-Order Thinking Skills, Analyzing Skills, Evaluating Skills, Creating Skills, Generative Artificial Intelligence. Corresponding author: Faiz Ul Hassan Shah Email: syed.f@mckru.edu.pk	As generative artificial intelligence (GenAI) becomes more widely used in higher education, there are new opportunities for students to interact with information, ideas, feedback, and problem-solving. But its pedagogical impact could vary with the students' engagement with AI alongside a human's judgment and cognitive investment. The present study investigated the relationship between Human – AI Collaboration and students' Higher Order Thinking Skills: Analyzing, Evaluating, and Creating skills among the Higher Education HTS students. Use of quantitative, cross sectional (correlational) design. A structured questionnaire was filled out by the respondents, and the data were then processed by descriptive statistics, Cronbach alpha and simple linear regression techniques, with a total of 379 students of public university in Sindh. The results showed statistically significant positive correlation between Human-AI Collaboration and Analysing/Evaluating skills and Creating skills. Human – AI Collaboration was the best predictor of all higher-order thinking skills, particularly analyzing skills. The study found purposeful and active synergies with AI behavior to be correlated with higher order thinking. It is recommended that universities advocate for the structured use of AI to support learning activities, with a focus on questioning, checking, reflecting, making independent judgements as well as considerate use of AI.

Introduction

Over the past few years Artificial Intelligence, or AI has grown more significant in higher education, impacting the ways in which students can access information, problem-solve academic issues, communicate, and complete learning tasks. This role has been further enhanced to include ways via generative artificial intelligence (GenAI) to provide explanation, example, summary, feedback, ideas and other forms of academic support through interactive AI systems (Daniel, 2025; Qian, 2025). But the increasing integration of AI in the education field has highlighted the concern of students' dependence on artificial intelligence's outputs, their limited ability to critically examine information, to check AI-generated content, and to maintain their own independent thinking (UNESCO, 2023; Patrick et al., 2025). Studies have shown that the cognitive impact of GenAI is not consistent and should be influenced by the learning context, type of learning, and the way GenAI is made use of within the learning activity conducted by the teacher, student participation, and the specific role played by GenAI in the learning activity (Chen & Cheung, 2025; Zeng et al., 2026). This means that the focus is shifting from whether students use AI, to how they engage with AI during their learning process. This has also fostered interest in Human-AI Collaboration (HAC) where students collaborate with AI to co-creatively produce ideas, review

information, think through options, analyze results, and make final enhancements and developments to the academic product on their own (Jou & Kao, 2026). In this context, higher-order thinking skills (HOTS) are very important because in order to learn well, students need to analyze information, evaluate information and ideas, and produce information or solutions.

The relevance of these is also supported by recent research on learning outcome and GenAI. Research findings suggest that even though the effects of GenAI on university students' learning outcomes is positive, the results will differ depending on the context of learning and/or intervention (Jay & Chew, 2025; Chen & Cheung, 2025). Likewise, another SRL reported a positive moderate impact of GenAI on learning outcomes concerning higher-order thinking skills (Zhao et al., 2025), in which the length of interventions and the self-regulated learning skills of students were the moderating factors. The results indicate that the educational potential of AI may not be exclusively the presence of the tool, but also the active and meaningful engagement students have with AI. In HOTS analysing skills refer to the processes of decomposing information, ideas, arguments, or problems into meaningful components and examining relationships among these components. These skills are crucial in higher education for reading and comprehending academic texts, interpreting the research data, comparing theoretical perspectives, noticing patterns, and examining complex issues. Students rethinking and questioning AI information is key for use in supporting such processes, otherwise alternative explanations and perspectives generated by Human-AI Collaboration can hinder thinking (Jou & Kao, 2026).

The second component is assessing skills where information is judged based on criteria based on its accuracy, credibility, relevance, quality and validity. This is especially relevant in the context of AI-assisted learning as the information generated by GenAI can be inaccurate, incomplete or unsupported (UNESCO, 2023). Students can compare answers in Human-AI Collaboration, confirm facts, detect inaccuracies and shortcomings, and make academic decisions through AI. Therefore, AI produced information can be utilized for critical examination instead of the final answer that cannot be questioned (Jou & Kao, 2026). The third dimension develops skills; skills which involve assembling, reformulating and associating knowledge and ideas into new solutions, arguments, approaches or academic products. While idea, example, and perspective generation are all possible with GenAI, AI-generated content does not necessarily show students to be creative. It has been suggested that the role of AI in HOTS is possible as long as the use of AI is guided and students are given chances to create, enhance, and generate their own output (Hou et al., 2026; Zhao et al., 2025). Thus, the utility of AI in the educational process relies heavily on students' usage of it, whether they give it the answers they seek or supply the information for it to help them formulate concepts that they subsequently analyze, interrogate, and mature by their personal assessments (Jou & Kao, 2026). While AI has become a key to HOTS in many fields, limited research has specifically focused on HOTS and study of Human-AI Collaboration for the individual Components of Analysing, Evaluating, and Creating skills (AEC) (Chen & Cheung, 2025; Zhao et al., 2025). These dimensions have a certain degree of relatedness and are measurement of different cognitive processes, so the separate analyses of each dimension can lead to more specific evidence of the involvement of HAC in students' higher-order thinking. Based on the above, the current study concentrates on HAC in HE and students' higher order thinking skills (HOTS) and how it influences the students' analysing, evaluating and creating skills.

Problem Statement

With the swift advancement of Artificial Intelligence (AI), Higher education has become a different landscape, offering possibilities for students to gain access to information, facilitate ideas, and access academic support. While relying heavily on AI-generated content could also impact a student's ability to think independently, critically, and engage with the material (UNESCO, 2023; Kasneci et al., 2023). Learning in higher education should foster the development of learners higher order thinking skills mainly analysing and evaluating and creating. Human-AI Collaboration can aid in the development of these competencies but has yet to be proven for each cognitive dimension. Previous research is largely centered on the usage of general AI and its impact on academic outcomes or critical thinking, and less on Human-AI Collaboration and the individual components of higher-order thinking (Chen & Cheung, 2025). This study, therefore, tried to discuss the effect of Human-AI Collaboration on the skills of analyzing, evaluating and creating of students at higher education level. The objective of the study will be to empirically disclose the correlation between collaborative interaction with AI and HOTS development of students.

Objectives Of The Study

The study is guided by the following objectives:

1. To examine the effect of Human-AI Collaboration on students' analyzing skills in higher education.
2. To determine the effect of Human-AI Collaboration on students' evaluating skills in higher education.
3. To assess the effect of Human-AI Collaboration on students' creating skills in higher education.

Research Questions

1. What is the effect of Human-AI Collaboration on students' analyzing skills in higher education?
2. What is the effect of Human-AI Collaboration on students' evaluating skills in higher education?
3. What is the effect of Human-AI Collaboration on students' creating skills in higher education?

Research Hypotheses

- **H₀₁:** There is no significant effect of Human-AI Collaboration on students' analyzing skills in higher education.
- **H₀₂:** There is no significant effect of Human-AI Collaboration on students' evaluating skills in higher education.
- **H₀₃:** There is no significant effect of Human-AI Collaboration on students' creating skills in higher education.

Literature Review

The section reviews literature in a critical manner relating to the learning of higher order thinking skills and Higher Education's relationship to Human-AI Collaboration. Based on recent scholarship, artificial intelligence has increasingly been embedded in university teaching and learning, with the potential of supportive capabilities, largely through the adoption of generative artificial intelligence (AI) that can help students search and explain information, provide feedback, help generate ideas, engage in problem-solving, and improve writing (Crompton & Burke, 2023; Yusuf et al., 2024). However, with the advent of generative AI, the potential of AI in education has emerged to provide opportunities for students to engage with AI systems via natural language entry and dynamically created outputs (Tlili, et al., 2023). These interactions have enabled students to access information, develop ideas, get feedback, and think about other solutions as they complete academic activities (Tzirides et al., 2024; Chen & Cheung, 2025).

But, access to and use of the AI tools by students does not suffice to indicate the educational contribution of AI. Studies in recent times have indicated that synthetically generated information, caused by AI, will have cognitive as well as implications largely contingent on the way the AI is made use of by the students, the coaching situation in which the AI is integrated, and the extent to which students look into and control the information produced by the AI and Identify (Li et al., 2026; Atchley et al., 2024). The literature is continuously reflecting this human-centred approach where AI will be seen as a cognitive support, not a replacement to the human reasoning and decision-making. The literature is more and more emphasizing this human-centered approach where AI becomes a cognitive support in logical reason and decision-making, and not a replacement of logical reason and decision-making. Thus, the interaction nature of students and AI is key in science finding out how AI-based learning will lead to enhanced conceptual development (of higher order) or not (Chen & Cheung, 2025; Zhao et al., 2025). The major concepts and variables of the present study are the themes throughout this chapter. It discusses the areas of AI in higher education, issues related to Human-AI Collaboration, skills of higher-order thinking, analyzing, evaluating, and creating, followed by the discussion of recent empirical studies and identification of the gap in the research (Crompton & Burke, 2023; Yusuf et al., 2024).

Theoretical Framework

Based on theory constructs, the present study is based on two theories: Constructivist Learning Theory and Social Constructivist Theory. These views form the bedrock of the discussion about the way in which purposeful interaction with Artificial Intelligence (AI) can assist the students in their thinking processes in higher order ways: active interaction, reflection and knowledge construction.

Constructivist Learning Theory

Constructivist Learning Theory focuses on Jean Piaget (1952, 1970), in which learning is regarded as an active process and learners build new knowledge from the current knowledge constructs. By engaging in the learning process, students are not merely taken over by concepts but process and make their own interpretations of the new knowledge. AI-integrated learning allows students to receive explanations, examples, feedback, and other suggestions from AI and then reflect on this provided information with their own understanding. This is because the value of AI relies on the students' actuation of it and what they process out of it. In terms of theory, this aligns with Human-AI Collaboration; the students are expected to interact with the AI, critically evaluate the responses and formulate their own understanding, rather than just copy the information from the AI. This is an active form of knowledge building which is important for higher-order thinking skills such as analysing, evaluating and creating.

Social Constructivist Theory

The Social Constructivist Theory is significantly attributed to Vygotsky (1978) and has a major focus on the role of interaction, dialogue, guidance, and scaffolding in learning. Although AI is not a teacher or human peer, student interactions with AI can offer opportunities to ask questions, seek explanations, consider alternative perspectives and re-think. With creative Human-AI Collaboration, students can leverage the AI-generated answer to ask questions, compare answers, reflect and enhance their learning. Therefore, for the independent variable, this point of view justifies the learning process need for interaction, and it simultaneously applies to the dependent variable, since it can be supposed that every interaction promotes the students' ability to analyse information, evaluate various alternatives, and generate enhanced school queries/possibilities.

Artificial Intelligence in Higher Education

In recent years, artificial intelligence (AI) has been proving vital to higher education, as it can assist students in finding information, adapting their learning, generating academic text, getting feedback, solving academic challenges, and making academic choices (Crompton & Burke, 2023). The increasing focus on the study of AI in higher education is further evidenced by a systematic review of 138 studies, which shows a rising trend in research and attention dedicated to the role of AI in students' academic lives. With the advent of generative AI, these stretches of capability have been put even further, whereby the students can interact with the systems to receive explanations, summaries, examples, questions, arguments, and creative ideas from AI (Yusuf et al., 2024). Generative AI can offer more than just real-time feedback; it can recreate information in a variety of ways, enabling deeper interaction and academic inquiry. (Kasneci et al., 2023). The information generated by AI can also be incorrect, incomplete, or unverifiable, though, which will motivate the learners to critique, validate, compare and assess the AI-generated information instead of taking it as "the truth" as stated by Yusuf et al. (2024). Therefore the research into AI literacy is gaining more and more importance which aims to educate students about the abilities and limitations of AI and how they can use it responsibly in the classroom (Tzirides et al., 2024). There are also indications that well-designed and appropriately utilized learning tasks using AI could help students develop higher-order thinking skills (Chen & Cheung, 2025). The value of an educational AI tool and program, therefore, requires much of the student developer and the way they utilize the tool. In this view Human-AI Collaboration is a separate concept in the current study.

Human-AI Collaboration in Higher Education

Human-AI Collaboration described as a process in which a human student and an AI collaborates in order to complete a learning task and the human student interprets, judges, makes decisions, and bears responsibility for the final result (Atchley et al., 2024). In higher education, collaboration can encompass asking questions, seeking explanations, probing for alternate perspectives, receiving examples and feedback, brainstorming possible solutions, exploring and evaluating options, and amending their original concepts with AI assistance (Yusuf et al., 2024). Human-AI Collaboration is thus not merely a form of passive use of AI. There can be a difference between passive and collaborative AI use, with students questioning, comparing, verifying, identifying their limitations, revising information, and incorporating collaborative AI-generated responses into their own thinking and processing. Represented passive use and collaborative use can be different; questioning, comparison, verification, limitation identification, revision, and combination of AI-generated responses and students' own thinking and processing. Atchley et al. (2024) stated that in order to achieve instructive AI-enabled learning, humans should maintain their mental tasks and embed suitable cognitive interactions. Here, AI literacy is used to facilitate this intentional interaction by guiding students through the use of AI to better understand its potential – as well as its limitations – and to form informed beliefs about what it can produce (Tzirides et al., 2024). In the context of Human-AI Collaboration, students should be able to decide whether AI-provided information should be accepted, amended, or discarded (Atchley et al., 2024). Human agency therefore also still plays a role as students must have intellectual direction and ownership of the final academic product (Guo et al., 2025). In addition, recent research indicates that the benefits of AI-supported learning are found when students make an active contribution through enquiry-based and scaffolded activities, but become counterproductive if students construct their knowledge in an unstructured way (Li et al., 2026). Human-AI Collaboration is therefore an active, reflective, and intentional way of engaging with AI as it impacts higher education.

Higher-Order Thinking Skills

Higher order thinking is a set of thinking that goes beyond memorisation and know-how to thinking that involves analysing information, evaluating evidence, solving problems and creating new responses (Zhao et al., 2025). Three of the above skills are especially relevant in post-secondary education, as college students should analyze data, analyze problems, and build their own ideas (Li et al., 2026). As the proliferation of generative AI grows, a question on people's minds is whether AI assists or impedes these more abstract cognitive skills. A systematic literature review and meta-analysis of 97 learning-outcome effect estimates across

57 studies yielding positive and moderate results for the use of generative AI tools with higher-order thinking skills among university students, finds noting that these results follow depending on the learners, AI tools, roles, learning tasks, and other contextual conditions (Chen & Cheung, 2025). Likewise, a literature review of 29 experimental and quasi-experimental papers found that generative AI's overall impact on students' higher-order thinking was positive, highlighting the role of the learning context and conditions in which it is put into practice (Zhao et al. 2025). But AI does not generate "higher order thinking" out of the box. If used in a structured manner and for inquiry, students can question, compare, evaluate and modify AI-generated answers; however, their unstructured application may lead to cognitive offloading and lowered cognitive engagement (Li et al., 2026). Hence, the present study looks at higher order thinking with three complementary perspectives namely analysing, evaluating and creating. These dimensions enable a more detailed look at the possible connection and interactions between HAC and various areas of students' higher-order cognitive growth (Zhao et al., 2025).

Human-AI Collaboration and Analyzing Skills

Analysing skills refer to the process of breaking information into meaningful components, examining information for relationships, ideas and interpretation and making links between information and evidence to develop an understanding. In the context of the implementation of HAC in higher education, these skills can come into play when students actively challenge, contrast, interrogate and edit information generated by AI systems instead of being programmatic. AI's role in education relies on the degree of student engagement in its interaction with students and their deliberate exploration of its content, ACES said (2024). In a systematic review of empirical research in higher education, similarly, Li et al. (2026) reported that there was a greater consistency of cognitive outcomes in inquiry-oriented, scaffolded, and reflective uses of ChatGPT. With the use of AI, students can be given alternative explanations, examples, points of view, and even possible solutions, which all they can analyze as content. Students can verify the answers obtained through AI with reference books, the research literature, and instructional resources, noting the connections, inconsistencies, and omissions (Yusuf et al., 2024). But AI accessibility doesn't automatically translate to analytical development as the lack of criticality could lead to cognitive offloading (Nasr et al., 2026). In this regard, HAC will have a better chance of developing analyzing skills, provided students include questions on their own list and can use their reason as a tool to formulate connections. For the purpose of this study, analyzing skills are the students' abilities to analyze, interpret, dissect, and link up information as an integral part of the use of AI tools within academic settings.

Human-AI Collaboration and Evaluating Skills

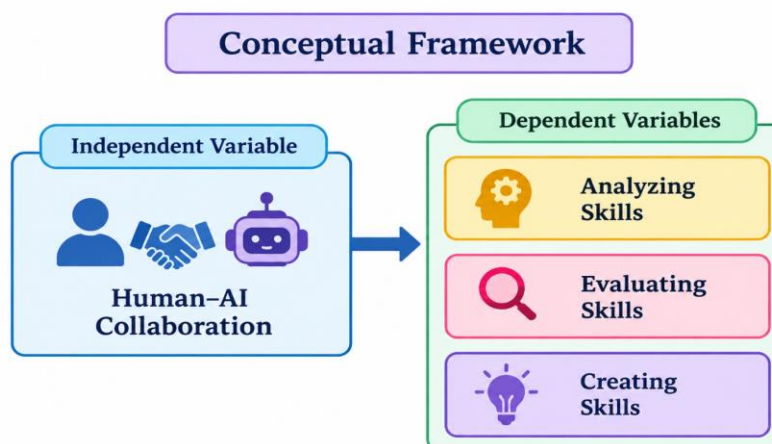
Evaluating skills involve making informed judgments on the accuracy, credibility, relevance, quality, and usefulness of information and/or ideas (Nasr et al., 2026). In fact, these are some of the most crucial skills in AI-powered education, as AI-generated information can be inaccurate, incomplete, or even presented with unreasonable certainty (Kasneci et al., 2023). Starting from textbooks, scholarly work, course materials, and reliable sources, opportunities can arise for students to compare AI-generated content with other texts, which presents a chance to assess the reliability of the information. From other text resources, such as books, scholarly work, course materials, and reliable sources, opportunities can arise for students to compare and assess the reliability of the information AI generates (Yusuf et al., 2024). These practices bring about a shift in making AI a discussion and decision-making tool, not the ultimate source of answers (Atchley et al., 2024). Tzirides et al. (2024) have pointed out the strengths and weaknesses of AI and Yusuf et al. (2024) have illustrated the potential of scaffolding students to think critically to analyse and synthesize information derived from AI tools. There has also been recent evidence that students benefit from structured, inquiry-oriented, and reflective learning environments over the free range use of AI in teaching and learning, as having more positive cognitive outcomes (Liu et al., 2026). Therefore, HAC can enhance evaluating skills when students confirm information, compare options, determine weaknesses, make their own judgments. In this study, measuring skills means students' ability to critically evaluate information and ideas from AI and make informed judgments about their credibility, content, accuracy and usefulness.

Human-AI Collaboration and Creating Skills

Produce skills are designing, shaping, altering and combining concepts into new designs, arguments, products, or learning products. A few Human-AI Collaboration activities that could aid these abilities in higher education include offering alternative ideas, examples, perspectives, drafts, and potential solutions for students to critically self-contract and transform (Yusuf et al., 2024). In student-AI collaborative creative problem-solving, student's ideas are highly important, and students need the control to develop and finalize the creativeness of generated contents, as found by Guo et al. (2025). This means that creativity is not just about generating content with artificial intelligence; it is also about students' actions of generating, selecting, modifying and integrating ideas. Li et al. (2026) also found that inquiry-based and scaffolded adoption of ChatGPT can facilitate creative thinking, whereas unscaffolded ones can lead to cognitive offloading and decrease cognitive loads. Moreover, there are variations in the impact of

generative AI by dimensions of higher-order thinking and by context and instructional conditions as suggested by prior meta-analytic research (Chen & Cheung, 2025; Zhao et al., 2025). In this regard, HAC can play a role in the development of skills when artificial intelligence enables students to do more than they could have done before as their human counterparts. In this current study, "creating skills" are the skills students develop when actively interacting with AI to generate, develop, modify, and combine ideas to come up with new academic or practical needs or products.

Conceptual Framework



The conceptual framework of a higher education research in the present study is to show the relation between Human – AI Collaboration (HAC), as independent variables with the students' higher order thinking skills (HOTS), as dependant variables. Human-AI Collaboration occurs when students intentionally engage with AI for tasks that include idea generation, information review, feedback, problem-solving and enhancement of academic tasks and documents. The three dimensions of higher order thinking skills are those of analysing, evaluating and creating. Skills of analysis are skills of breaking information down into parts, identifying relationships, examining ideas, and understanding connections among information. Assessing Skills means critically interpreting information and ideas in terms of accuracy, credibility, relevance, usefulness and weighing up alternatives and making informed judgements. Producing skills: generation of ideas, developing original responses, formulation of solutions, production of new academic/practical products. The framework therefore suggests that the purposeful Human-AI Collaboration is connected to students' development of these three aspects of higher order thinking. The framework offers a conceptual meaningfulness for empirical studies of these relationships in higher education.

Research Methodology

Philosophical Stance

The study adopts post positivist philosophic approach. Post-positivism is suitable for quantitative research where the emphasis is rather on empirical reality, systematic measurements, testing of hypotheses, and statistics, but with an awareness that no knowledge is really definitive and test-free. The current study focuses on "Human-AI Collaboration" and the connection between the implementation of this collaboration and students' higher-order thinking skills using measurable variables, thus supporting this stance. The research approach is based on a structured questionnaire consisting of hypotheses which are tested with the aid of statistical analysis. In ontological terms, one will have to agree with the study that the phenomena studied have an objective reality (even though they can be measured only imperfectly). Epistemically, it highlights evidence from observations and experiment. In terms of method, it is suitable for the quantitative research method of the survey and inferential statistical analysis used in this research.

Research Approach

The present study used the quantitative research approach. Quantitative research is used when factors are operationally defined with variables that become indicators that can be measured and when numerical data is gathered for statistical data analysis. Human-AI Collaboration is considered the independent variable and the three skills (Analyzing Skills, Evaluating Skills, and

Creating Skills) are considered dependent variables. In the quantitative approach, the researcher can analyze the variables and their proposed relationships based on numerical data and through statistical processes.

Research Method

Data was collected using a survey method from the respondents who are the students of the university. For this study, the survey method was the right one as the investigation involved a not too small sample of respondents about their experiences with Human-AI Collaboration and their higher-order thinking skills. Google Forms was used for the administration of a structured questionnaire. The online questionnaire helped to understand both standardized data documentation and to receive earliness data items from the chosen respondents.

Research Design

The research design used in the study was cross-sectional correlational research that was applied in quantitative research area. Obtaining data without changing the independent variable was done at one single time from respondents. The design was suitable as the study was designed to examine the statistical relationship between Human-AI Collaboration and three dimensions of students' Higher Order Thinking Skills (HOTS): 1. Human-AI Collaboration and Analyzing Skills. 2. Human-AI Collaboration and Evaluating Skills. 3. Human-AI Collaboration and Creating Skills. A simple linear regression was conducted to test the ability of Human-AI Collaboration to significantly predict each dimension of higher-order thinking. Due to the cross-sectional and non-experimental nature of the study, the results are described in a broader perspective of statistical correlations and forecasting instead of causal effects.

Population of the Study

The study population comprised students of public universities in Sindh. Public universities in Sindh are public sector universities with students studying in a range of academic programmes and departments. The study's target population was the university students who matched the inclusion criteria set and had adequate exposure to academic activities related to artificial intelligence (AI) for them to be able to provide meaningful answers to the questions related to the perception of Human-AI Collaboration and the status of higher-order thinking skills.

Sample Size

Using the Krejcie and Morgan (1970) sample size determination table, the sample size was determined. The ratio of enrolment of public universities in the relevant population range matches the enrolment figures in the public universities. It was assumed that the population was in the 20,000-30,000 range and the Krejcie and Morgan table, within that range, was chosen as the minimum sample size of 379.

Sampling Technique

Stratified random sampling method was used to pick eligible study samples from University Students. Students who fulfilled the inclusion criteria were located and a sample of 379 respondents was obtained by random sampling from the appropriate strata. The respondents were selected and the questionnaire was given to them using a Google Forms approach. Stratified random sample appeared suitable since it was found that it gave opportunity to eligible students from known strata to be sampled thereby minimizing chances of systematic sampling bias.

Research Instrument

The main tool of data collection was a structured questionnaire. The questions of the questionnaire had been formulated based on the conceptual framework, operational definition, research objectives, research questions, and research hypotheses of the study. The independent variable Human-AI Collaboration, dependent variable Students' Higher-Order Thinking Skill (analysing skills, evaluating skills and creating skills) were measured using the questionnaire. The items of Human-AI Collaboration have been modified from the instrument that Zhang (2025) created and validated to assess students' use of Generative AI for academic research. The items were adapted to meet the students' need for learning in the context of digital interaction and collaboration with AI tools in higher education. The higher order thinking items were constructed based on the conceptual framework of the dimensions of analysis, evaluation, and creativity. A Likert-type response scale was used to gather the data in order to get the respondents' perception about the study variables. All items were validated by presenting them to University students in plain

English so that they will be clear to University students. Prior to data collection, the instrument adapted for the needs of the present research was reviewed and contextualized in line with the underlying objectives and context of the study.

Data Collection Procedure

Before the researcher proceeded to collect the data, he/she has taken all the required authorizations to interact with the chosen research sample of students at the University. Respondents were briefed on the nature of the study and intention to participate. The final questionnaire was subsequently changed into Google Forms and sent digitally to the chosen samples. Suitable guidelines were laid out for the respondents and they were assured that participation was to be voluntary. Once the responses had been submitted, the responses were gathered using Google Forms. Data completeness was checked and data was prepared for statistical analysis. Data collected were then coded, then coded to SPSS for analysis.

Data Analysis Techniques

The data collected were analysed with the aid of Statistical Package for the Social Sciences (SPSS). Descriptive data were analysed using frequencies, percentages, averages and standard deviations. Cronbach's alpha was used to assess the internal consistency of the research instrument. Simple linear regression analysis was then separately carried out to check the significance of Human – AI Collaboration in predicting the Analyzing Skill, Evaluating Skill, and Creating Skill of students in the context of hypothesis testing. The R^2 value was checked for each regression model to assess the amount of variance accounted for by Human-AI Collaboration. The overall significance of the regression model was evaluated using ANOVA table and the Coefficients table was used to determine direction, strength, and statistical significance of the predictor. The level of significance was $\alpha = .05$.

Data Analysis and Results

Demographic Characteristics of Participants

In Tables 4.1 to 4.4, the characteristics of the population participating in the study are described. A sample of 379 people was selected. The frequencies and percentages are stated to describe the composition of the respondents, according to gender, age, academic level and the discipline/faculty.

Table 1: Gender Distribution of Participants

Gender	Frequency (f)	Percentage (%)	Cumulative (%)
Male	181	47.8	47.8
Female	198	52.2	100.0
Total	379	100.0	100.0

Based on the data presented in Table 1, 198 of the 379 participants (52.2%) were female, while 181 of them (47.8%) were male. While a greater percentage of women participated in the study, the two genders were represented. This distribution will give a descriptive description of how many males and females were obtained in the sample for this study.

Table 2: Age Distribution of Participants

Age category	Frequency (f)	Percentage (%)	Cumulative (%)
18–20 years	96	25.3	25.3
21–23 years	151	39.8	65.1
24–26 years	88	23.2	88.3
27 years and above	44	11.6	99.9
Total	379	100.0	100.0

Based on the responses to the question "what age are you", the majority of respondents were aged between 21 and 23 years ($n = 151$, 39.8%). Participants aged 18–20 years accounted for 25.3% ($n = 96$), while those aged 24–26 years represented 23.2% ($n = 88$). The smallest age group was 27 and older who comprised 44 (11.6%) participants. The respondents covered all the age categories specified overall.

Table 3: Academic Level Distribution of Participants

Academic level	Frequency (f)	Percentage (%)	Cumulative (%)
Undergraduate	246	64.9	64.9
MPhil/MS	92	24.3	89.2
PhD	41	10.8	100.0
Total	379	100.0	100.0

From Table 3, it can be seen that the largest group of participants were the undergraduate ($n = 246$ (64.9%)). 24.3% of participants were at the MPhil/MS level, while 10.8% ($n = 41$) were PhD level participants. Higher school students' contribution (from undergraduate and post graduate levels) allows description of Human–AI Collaboration at varying levels of higher education, albeit with the sample having a higher proportion of undergraduate students.

Table 4: Discipline/Faculty Distribution of Participants

Discipline/Faculty	Frequency (f)	Percentage (%)	Cumulative (%)
Education	86	22.7	22.7
Social Sciences	78	20.6	43.3
Natural Sciences	71	18.7	62.0
Arts & Humanities	62	16.4	78.4
Management/Commerce	48	12.7	91.1
Other	34	9.0	100.1
Total	379	100.0	100.0

The disciplinary distribution reveals involvement in a few disciplines. Education had the highest representation ($n = 86$, 22.7%), followed by Social Sciences ($n = 78$, 20.6%) and Natural Sciences ($n = 71$, 18.7%). Other responses made up the remaining groups from Arts and Humanities, Management/Commerce and others. The sum of percentages reported exceeds 100 due to rounding.

Reliability Analysis of the Study Instrument

Reliability was examined to ensure that the questionnaire items in each construct human-AI collaboration and the three domains of higher order thinking skills are internally consistent. Cronbach's alpha (α) was used as the reliability coefficient. The alpha scores are closer to 1 when the items measuring each scale are conceptually similar and internally consistent; but reliability should be considered together with the conceptual similarity and validity of the instrument.

Table 5: Reliability of the Study Variables

Variable	Number of items	Cronbach's α
Human–AI Collaboration	8	.781
Analyzing Skills	8	.764
Evaluating Skills	8	.793

Creating Skills	8	.776
Overall Instrument	32	.787

The internal consistency of the four study variables was examined using Cronbach's alpha, as presented in Table 5. The results indicate acceptable internal consistency among the study variables. The Cronbach's alpha coefficients for Human-AI Collaboration, Analyzing Skills, Evaluating Skills, and Creating Skills were .781, .764, .793, and .776, respectively. The overall Cronbach's alpha coefficient for the 32-item instrument was .787. These values indicate that the items demonstrated acceptable internal consistency and were considered suitable for further statistical analysis.

Table 6: Allocation of Items Across Study Variables

Variable	Item codes	Number of items
Human-AI Collaboration	HAC1-HAC8	8
Analyzing Skills	AN1-AN8	8
Evaluating Skills	EV1-EV8	8
Creating Skills	CR1-CR8	8
Total	32 items	32

The allocation of the items on the questionnaire to the four study variables is shown in Table 6. Eight items were used to assess each construct for a total of 32 items. The item coding ensures that the data can be entered in a structured manner, analysed in terms of reliability and further statistical processing can take place using composite scores.

Regression Analysis

Simple linear regression analysis was conducted to investigate the statistical relationship of Human - AI Collaboration to the students' higher-order thinking skills with respect to each dimension. In the present chapter, the number of participants is stated as 379. For a simple regression model involving one predictor, therefore, the degrees of freedom for the regression and the residual are 1 and 377, respectively totaling 378. The reported direction, variance explained, and statistical significance interpretations are therefore a focus of the following interpretations without making causal interpretations.

Human-AI Collaboration and Students' Analyzing Skills

Objective: To examine the association between Human-AI Collaboration and students' analyzing skills in higher education.

Table 7: Model Summary

Model	R	R ²	Adjusted R ²	Std. Error of the Estimate
1	.612	.375	.373	.428

Human-AI Collaboration was positively related to student's analyzing skills; $R = .612$. The coefficient of determination ($R^2 = .375$) represents the proportion of between-group variance explained by the Human-AI Collaboration with 37.5% of variance in this case explained by HAC in the sample. This statistic is a measure of the variance explained and can only be used as a description of the variance explained and does not indicate a direct cause and effect relationship due to the study's non-experimental correlational design.

Table 8: ANOVA

Source	Sum of Squares	df	Mean Square	F	p
Regression	28.436	1	—	155.18	.000
Residual	47.696	377	—	—	—
Total	76.132	378	—	—	—

The regression model was statistically significant as regards the skills ($F(1, 377) = 155.18, p < .001$). The results show that Human-AI Collaboration was a statistically significant factor for human analysis skills in the studied sample.

Table 9: Coefficients

Model	B	SE	β	t	p
Constant	—	—	—	—	—
Human-AI Collaboration	.536	.043	.612	12.46	.000

Human-AI Collaboration had a positive and statistically significant effect ($B = .536, \beta = .612, t = 12.46, p < .001$). This discovery corresponds to the results of sum of Human-AI Collaboration scores and analyzing skills scores. The result reported was contradictory to the null hypothesis that there is no statistically significant association. However, the report needs to read, there is a statistically significant association or predictive relationship between Human-AI Collaboration and changes in Analyzing Skills but does not imply a direct cause-and-effect relationship.

Human-AI Collaboration and Students' Evaluating Skills

Objective: To examine the association between Human-AI Collaboration and students' evaluating skills in higher education.

Table 10: Model Summary

Model	R	R ²	Adjusted R ²	Std. Error of the Estimate
1	.574	.329	.326	.462

The results of the model indicated that there was a positive relationship between Human-AI Collaboration and evaluating skills, (with $R = .574$) The coefficient of determination ($R^2 = .329$) shows that 32.9% of the variance of the outcome can be explained by the interaction between Human and AI in the sample.

Table 11: ANOVA

Source	Sum of Squares	df	Mean Square	F	p
Regression	27.516	1	—	128.84	.000
Residual	55.552	377	—	—	—
Total	83.068	378	—	—	—

The reported regression model for evaluating skills was statistically significant, $F(1, 377) = 128.84, p < .001$. This finding showed that Human-AI Collaboration was a statistically significant predictor of skills scores for the group of people being assessed.

Table 12: Coefficients

Model	B	SE	β	t	p
Constant	—	—	—	—	—
Human-AI Collaboration	.601	.053	.574	11.35	.000

The coefficient for Human - AI Collaboration was positive and statistically significant ($B = .601, \beta = .574, t = 11.35, p < .001$). The results suggest a relation between Human - AI Collaboration scores and E Evaluating Skills scores with higher scores across each dimension. The result did not verify the null hypothesis which meant that there was no statistically significant association.

Human-AI Collaboration and Students' Creating Skills

Objective: To examine the association between Human-AI Collaboration and students' creating skills in higher education.

Table 13: Model Summary

Model	R	R ²	Adjusted R ²	Std. Error of the Estimate
1	.583	.340	.337	.446

Human-AI Collaboration was associated in a positive way with students' creating skills, as demonstrated in the model with an R value of .583. The coefficient of determination (R-squared = .340) suggests that the variability in the outcome within the sample was 34.0% attributable to the Human-AI Collaboration.

Table 14: ANOVA

Source	Sum of Squares	df	Mean Square	F	p
Regression	31.624	1	—	134.62	.000
Residual	61.076	377	—	—	—
Total	92.700	378	—	—	—

The regression between the 2 variables was statistically significant for the purposes of predicting skills, $F(1, 377) = 134.62$, $p < .001$. There is a statistically significant increase in creating skills scores in the analyzed sample that can be interpreted as a corollary of Human-AI Collaboration.

Table 15: Coefficients

Model	B	SE	β	t	P
Constant	—	—	—	—	—
Human-AI Collaboration	.621	.054	.583	11.60	.000

Human-AI Collaboration had a positive and statistically significant coefficient ($B = .621$, $\beta = .583$, $t = 11.60$, $p < .001$). These findings suggests that there is a positive relationship between creating skills score and the High Human-AI Collaboration score. The results were inconsistent with the null hypothesis that there was no statistically significant association.

Discussion, Conclusion, Implications And Recommendations

Discussion of Findings

The results of each research objective are discussed separately, since the aspects of analyzing, evaluating, and creating represent different aspects of students' higher order thinking skills, but were interrelated. This can be considered as an organizational framework that establishes links between the research objectives, the literature surveyed, the theoretical framework and the findings presented in Chapter 4. Furthermore, the conversation of findings is discussed and shows the connection with the previous research that led to the current study and the theory for which the study was based.

Human-AI Collaboration and Analyzing Skills

The first aim was to look at how students at higher education perform their analytical skills while using Human-AI Collaboration (HAC). The results reported in Chapter 4 highlighted positive and statistically significant relationships, which indicated that students who indicated better collaborative connections with AI indicated better skills in examining, breaking down, comparing, interpreting and organizing information. This evidence contradicts the null hypothesis and justifies the first research hypothesis.

This aligns with past studies indicating that the pedagogical potential of generative AI is not just about the access to and availability of AI, but also the relationships between the usage of the context or products of AI and the learning process. Daniel et al. (2025) linked generative AI to cognitive processes like analytical reasoning and problem-solving, and Chen and Cheung (2025) verified that the impacts on university learning outcomes factors into contextual and instructional conditions. By the same token, Atchley et al. (2024) highlighted the pervasive need for “humans” – not just in the development of AI systems, but in the use of ChatGPT in connection with learning. ChatGPT can also be used to promote analytical and reasoning processes, as reported by Li et al. (2026) through an inquiry-oriented and scaffolded approach.

The finding is also in line with the constructivist and human-centred views taken during this study. If students pose questions about AI responses, explore options, make sense of text or analyze the relevance of information, they are engaged and developing knowledge. Therefore, it is important to note that what the present study has found is a positive relationship not between using AI, per se, and purposeful and active interaction, but between purposeful and active interaction and not using AI. The interpretation,

which is aligned with Nasr et al. (2026), also points to the potential of structured AI usage to spark critical engagement, while using AI in less structured ways could lead to cognitive offloading.

Human-AI Collaboration and Evaluating Skills

The second aim explored the correlation between students' evaluating skills and HAC. This positive and statistically significant relationship was illustrated in the results, revealing that students who expressed higher collaborative interaction with the AI also reported higher levels of information and ideas evaluation skills. The finding contributes to the second research question and refutes the null hypothesis. This finding bears special significance for the following reason: the information generative AI can generate is likely to be fluent and believable, but not necessarily true or substantiated. Kasneci et al. (2023) have stressed the necessity of understanding the shortcomings of the AI-generated content, and Tzirides et al. (2024) have continued to show that it is essential to educate students with AI literacy and critical engagement. Interrogation, checking of facts, assessment, and reflection were also highlighted as crucial factors by Nasr et al. (2026) in AI-assisted learning for the development of critical thinking. Similarly, using AI in a structured and inquiry-based manner was associated with the development of critical engagement and reasoning by Li et al. (2026). The finding also aligns with the human-centred view, a view which puts humans' judgment and responsibility in the heart of activities supported by AI. Students must ensure that they have checked AI-generated content, deemed its validity, and make an independent assessment of what they have read, rather than accepting it off the cuff as true. Based on this connection, the positive relationship found in this study opens possibilities for the involvement and responsibility of students in the process of judging purposes in the relation to AI that can be done by way of collaboration.

Human-AI Collaboration and Creating Skills

The third aim explored the correlation between HAC and creating skill levels of students. The participants revealed a positive and statistically significant relationship, suggesting that the higher the degree of collaborative nature of the use of AI, the higher the level of students' generativeness, elaborativeness, reworkativeness, and innovativeness in idea generation. This finding helps to answer the third research question and helps to refute the null hypothesis. This is similar to what Guo et al. (2025) highlighted, that meaningful SPS with AI requires human agency resources, such as the contribution of our own ideas, exploration of alternatives, editing of AI output, and ownership of the final product. The benefits of generative AI on higher-order thinking were also highlighted by Zhao et al. (2025), but there is some suggestion they may have different impacts on different aspects of thinking. Moreover, Li et al. (2026) have recommended that AI-supported activities to enhance creative thinking are inquiries-based, scaffolded and reflective. Additionally, Li et al. (2026) have suggested that activities to support creative thinking are more likely to be beneficial when they are based on inquiry, have scaffolding, and are reflective. This aligns with the constructivist and human-centred viewpoints since students are still in charge of what they create, what ideas they develop, and how they will enhance and incorporate ideas generated via AI. Therefore, AI can serve as a catalyst for idea generation and alternatives instead of taking over students' creativity. In total, the results based on three study objectives show positive and statistically significant relationships between the analysing, evaluating and creating skills and HAC. The outcomes justify looking at each dimension individually as each is particular to a separate process of cognitive thinking, which are respectively analysed, evaluated and created. Taken together, the results suggest that conclusions about cognitive outcomes related to HAC should be made from an eclectic approach that takes students' active engagement, judgment, and agency into account, rather than reliance on the use of AI.

Conclusion

The study provides evidence that HAC is significantly and positively related to students' higher-order thinking skills, across three dimensions (analyzing, evaluating, and creating) in higher education. The results lend empirical evidence to the main argument of the study, i.e., the educational value of AI is not only related to student access to AI technologies, but also the type of interaction students have with those technologies. Specifically, the results align with the perspective of AI as a cognitive aid that can serve as information, alternative, feedback, and generative assistance rather than being a tool for interpreting, judging, and making decisions. The study also addresses a research gap identified in Chapter 2, as it brings a deeper lens in studying HAC as a unique concept and in analyzing, evaluating and creating under this concept independently. The findings are consistent with prior studies on generative AI and higher-order thinking skills, while additionally offering a narrower empirical lens into student-AI collaboration. However, due to the cross-sectional correlational research design used and the questionnaire-based data obtained from the study, it is recommended that the research results should be analyzed and interpreted as the relations or predictive associations that exist, rather than causal effect. It is a methodological boundary to ensure consistency for the design of the study and conclusions.

Recommendations

The following recommendations are based on the findings and the theoretical and empirical discussion. universities must create affirmative education guidelines to guide students towards responsible relationships with AI instead of universal rules for its use. Structured AI-supported activities should be integrated into the content, but also ask questions, compare, verify, reflect and revise. It is important to stress that the AI-generated responses should be considered as starting texts and used with human discretion and scrutiny. It is important that assessment practices encourage and focus on developing their reasoning, explaining, evaluating their sources, originality, and process, rather than just the end product. It is also imperative that universities offer AI-literacy and professional-development programs for students and educators to enable their critical, ethical, and effective use of AI. Lastly, there is a need for regular audit of academic-integrity and assessment policies by institutions to ensure these policies reflect new modes of human-AI collaboration, and support learning outcomes within the academy.

Suggestions for future Research

The author suggests the present study could be extended by examining more fully the evolution of structured Human-AI Collaboration over time and conditions through a longitudinal design or experimental or quasi-experimental design. Since the present study was conducted in a cross-sectional survey design approach, future investigations could include direct performance-based measurement of analyzing, evaluating and creating skills in a survey-based theoretical approach. These designs would assist separation of perceptions of skills and actual cognitive achievement on the part of students. Human-AI Collaboration should also be explored in various fields, year levels, schools, and cultures in the future. Comparative research could examine how the connection between AI collaboration and higher order thinking differs for students based on their prior AI literacy, self-regulated learning, disciplinary knowledge or patterns of using AI. Further, researchers can explore specific collaboration models— like iterative prompting, verification, AI-infused brainstorming, feedback and reflective revision rather than Human-AI Collaboration as a whole. Further research ought to involve more outcomes such as problem solving, metacognition, academic writing, information literacy, and ethical decisions making. Mixed methods research may be especially relevant to investigating the actual use of AI by students during instructional activities and the relationship between specific patterns of AI interactions and/or stronger or weaker cognitive gains. Lastly, there is a need to continue investigating the potential benefits and risks of knowledge sharing through AI and learning by avoidance of mental work, just because of other mechanisms like dependence, lack of originality and the transmission of false information, as well as to formulate evidence-based knowledge sharing domains through Human-AI Collaboration for higher education.

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