STUDENTS COGNITIVE DISCREPANCIES IN ARTIFICIAL INTELLIGENCES UTILIZATION: A CASE OF HIGHER LEARNING INSTITUTIONS

Shima Dawson Banele

College of Business Education, Tanzania
e-mail: shima.banele@cbe.ac.tz

ABSTRACT. The humanistic intellectual algorithmic nodes deployment on Artificial Intelligences (AIs) brought significance in undertaking socio-economic activities. Students in higher learning institutions utilized the AIs for education purposes leading to damage in the cognitive process. The phenomenography action research was purposively conducted to assess 113 higher-learning institution students' cognitive discrepancies due to AI utilization. The objectives undertaken were to: assess the attributes leading to students' differences in AI utilization and determine the student's cognitive discrepancies in performance resulting from the utilization of AI in the learning process. Data were collected through students' test-re-tested class activity worksheet observations and semi-structured interviews. The major findings showed that students were highly rated in the utilization of AI to save time, had cognitive worries and less authentic assurance. Also, the findings on students' cognitive discrepancies utilization were proved to be ascertained on indicators for cognitive processes, individual differences, feedback and interaction, motivation and engagement, creativity and imagination. The recommendation was made to students and instructors to appropriately utilize and blend AI utilization in the teaching and learning process for cognitive wealth to overwhelm shortfalls resulting from the overutilization of AIs.

Keywords: Artificial Intelligence; Cognitive; Discrepancies; Students

INTRODUCTION

Technology development brought about by the deployment of Artificial Intelligence (AI) and Machine Learning (ML) in higher learning institutions has significantly changed the utilization of human cognitive capacity (Dwivedi et al., 2022; Sharma, Lee-Cultura & Giannakos, 2022; Kadam & Vaidya, 2021)). Essentially, the innovativeness of AI is benchmarked on humans' intellectual algorithmic node's capabilities for content discovering, creation of descriptive meaning, enhanced reasoning performance, generalization as well as retrieval of the learnt information from past experience (Britannica, 2023, Dey, 2023). Nevertheless, the AI possessed reflective human-like cognition for interactive functionalities (Jokhan, Chand, Singh & Mamun, 2022). Significantly, the AIs are useful for increasing the performances of cultural and socio-economic activities (Sineviciene et al., 2021; Dey, 2023). For example, in health systems AI has become a functional tool for patients recording, diagnostic procedures and treatments (Wang & Ma, 2022), in environmental aspects are useful in the prediction and handling of floods (Tabbussum & Dar, 2021); arrangement of transportation logistics (Srinivas, Mahalaxmi, Vara-

prasad, Donald & Thippanna, 2022); in aerospace is capacitating the networks (Zhao, Zhao, Ai & Dong, 2022) and in military activities (Baigang & Yi, 2023).

However, despite the human brain being reflected within AI yet can't significantly work in full as the human-being cognition functional in teaching and learning processes (Jokhan et al., 2022; Anwar, Oganda, Santoso & Fabio, 2022). Certainly, was expressed by Yazdani-Asrami (2023) that in the education setting the AI practicalities is evidently in facilitating deep learning and handling big data manipulation. Furthermore, AI is apprehended in elucidating the sensory-driven educational activities (Sharma et al., 2022; Yan, de Lange & Richter, 2023); capacitating the language simulations, particularly in sound recognition, communication, translations and writing (Kliestik, Novak & Lăzăroiu, 2022; Liaw et al., 2023; Salvagno, Taccone & Gerli, 2023); accurately translating, generating and understanding the teaching and learning languages (Baidoo-Anu & Owusu Ansah, 2023); handling mathematical manipulations, analysis and presentation (Ivan, Chiru & Arcos, 2021). Significantly, despite the advantages of AI but the auscul-

tation of human intelligence displacement continued to be the focal point that embraced the realism of teaching, learning and research processes (Stone et al., 2022; Dwivedi et al., 2021; Yazdani-Asrami, 2023; Sharma et al., 2022). Superficially, the cognitive schema possessed human intelligence rationalities enhanced acquisition, processing, creation and accommodation of the new knowledge that pressed appropriate procedures in decision making, argumentations and making choices based on risen learning needs (Jokhan et al., 2022; Johnson, Bilovich & Tuckett, 2023).

Nevertheless, human cognitive intelligence being naturally made (De Garrido, 2022), is highly capacitated, able to independently perform innovation and development (Johnson et al., 2023). Certainly, despite the AI developments, still, human cognitive intelligence continued to work as an operative nucleus system fostering undertaking optimal reasonable operational activities towards goal achievements (Dey, 2023, Britannica, 2023); as well as guiding the selectivity of perceived sensory responses inputs (Yan et al., 2023; Arbuckle, Pruszynski & Diedrichsen, 2022). Furthermore, human cognitive intelligence enabled the utilization of algorithmic for proofing and solving the logic of the mathematical theorem flows (Poesia & Goodman, 2023); utilization of real-life educational game-plays in solving the practicable challenges (Li & Li, 2023); fostered synthesizing and summarizing of information, writing histories, stories, create arts and music (Chung, 2021; Renzulli, 2023).

Based on the mentioned stances, in teaching and learning processes the essentialities of students' cognitive capabilities had to be supported and not displaced by AI. Certainly, the support drawn from constructivism delineated learning being an individual process whereas students are articulated to construct their cognitive schema mind maps for their knowledge acquisition (Piaget, 1969). Further, during the learning processes, Happs (1985) disclosed that individual cognitive schema received, processed learnt contents and temporarily stored for use in the working short-term memory (CLT) and thereafter transferred, accommodated, stored and retrieved at the time required from Cognitive Learning Optimal (CLO) sometimes called the Long Term memory. Apparently, the paper was built on Cognitive Load Theory (CLT) and Cognitive Load Optimization (CLO) whereas the CLT measures individual cognitive learning schema within the spectrum of short memory while the counterfeit CLO pertains to attributes leading students to reaching the efficient schema optimal point in the long term memory due to appropriate utilization of instructional methods, approaches and teaching and learn-ing resources (Baidoo-Anu et al., 2023; Haryana, Warsono, Achjari & Nahartyo 2022; Maj, 2021).

Subsequently, two cognitive theories were apprehended as the lens for assessing cognitive functionalities, particularly on the discrepancies based on conditions of utilization and without AI in the performances of students' cognitive attributes. Outwardly, despite the use of AI being apprehended for bringing support in teaching and learning processes, there are doubtful in capacitating CLT and CLO realism based on students' cognitive attributes (Kasneci et al., 2023; Dwivedi et al., 2021). Certainly, the questionable vague continued on the learning aspects of the utilization of AI in the classroom being the friendly tool or rival (Sumakul, Hamied & Sukyadi 2022). The paper focused on responding to specific objectives that were to (1) Explore the attributes leading to students' differences in AI utilization for the learning process. (2) Determine the student's cognitive discrepancies in performance resulting from the utilization of AI in the learning process.

METHOD

The phenomenography action research design was deployed to undertake the qualitative study focused on the interpretation of the meaning obtained from the data. Subsequently, the sample size of 113 bachelor's degree students was purposively selected irrespective of the condition of undertaking the research methodology BAU7208 in Semester Two for the academic year 2022/23. Documentary review and semi-structured interviews were deployed for data collection. Moreover, documentary reviews were conducted in two phases: In phase one, take-home assignments comprised of simple calculations and explanations items to provide the responses from different sources without restrictions were administered to students. Certainly, after one day the same items were re-tested under restrictive supervision whereas students were not allowed to use digital and technology devices. Students' worksheets were thereafter collected and the researcher engaged in assessing the modalities students responded to on the same items with differences in treatments.

Furthermore, the interpretative discrepancies on cognitive processes attributes in individual differences, feedback and interaction, motivation and engagement, and creativity made by the students were carried out. Furthermore, 12 students with higher scores in the re-tested worksheets were purposively selected to be engaged in the semi-structured interview to explore the attributes leading to students' differences in AI utilization for the learning process. The data collected through the documentary review

were coded, edited, tabulated, and analyzed using Excel to get the frequency and percentages for cognitive attributes under conditions without the use of AI, use of AI and discrepancies in percentage levels. Thereafter, the findings were presented through Figures. Apparently, thematic content was deployed for analyzing semi-structured data, thereafter edited, and presented using simple summarised tables and case narratives.

RESULT AND DISCUSSION

Students' Attributes in AI Utilization

The findings on student attributes showed that out of 113 respondents, 78 (69%) selected to utilize AI to get the responses while those who were positively deliberated to the responses of the asked items without the use of AI were (35) 31% as exposed in Figure 1.

Figure 1. Student's Levels on AI Utilizations
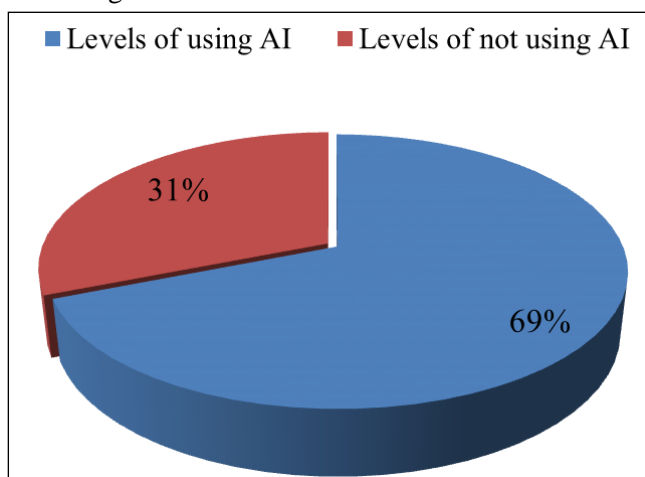
Certainly, the summary in Table 1 presented the main themes and sub-themes that emerged in responding to the main semi-structured interview item: *which significant attributes are leading students' differentiations in the utilization of AI for undertaking classroom learning activities.*

Apparently, the disclosures were made by the students that some are worried about the mindset distortion and less bothering to engage in cognitive activities as was expressed:

.....students just pose the question in the AI tab and then wait for the typed responses ...Most of the students are reluctant, and stagnated to use their brains... students are lazy, and are just copy-pasting the typed responses on the worksheet and collecting for marking. (Female respondent, Interview session).

Furthermore, the students were positively apprehending the responses provided by the AI on accuracy and speed in handling mathematical-related manipulations, calculation and analysis as was revealed:-

...Students face phobia in solving mathematical-related questions... AI brought independence as is doing everything neatly, but as the student the same question could be asked at the end of the Semester examination where digital devices are prohibited...... despite possession of well-performed continuous assessment, the same question when repeated will end up mass failure (Male respondent, Interview Session)

Table 1. Students' differentiations in AI utilization

Main Theme	Sub -Themes
Saves Time	Concentrating with other activities
	Difficult in arithmetic questions no need to undertake manipulation and calculation
	Enable accurately performing class activities to meet the deadline
Worries	Not sure of relevance information, lacked contextualization
	Mobs psychology among students
	Students became lazy and reluctant
	Plagiarism checking
Authentic	Reliability of the content derived
	Higher order grammatical language levels
	Smart Workout higher marks

Subsequently, students revealed that English being the second language brought the contextualization gaps henceforth, the use of AI has been assistive in working with the items of the assignments due to the provision of well grammatical paragraphs possessing unfamiliar vocabularies, and fluencies in sentences as was cited:-

...the English language administered by the AI is neat, smart without grammatical errors...Students will not replicate the same even with simple language when are restricted to use technologies....Content presentation using the English language continued to be an embarrassing venture in students learning. (Respondent 2, 6, and 10, Interviews Session)

Likewise, highly relying on AI to meet the lecturers' deadline directives had been experienced by the students. Also, some students feel prestige for scoring higher marks even though the machine learning work as was narrated:

Large groups of students are concentrated on other non-educational activities whereas much time is spent. In deadlines, are quickly tend to struggle to familiarize on AI usage to undertake the assignment.......are happy to score the highest coursework marks while not having ownership of the classroom assignment activities. (Respondents 7, 10, 12, Interviews Session).

Based on the findings, despite the first phase sit of the classroom activities students were not guided to utilize or not to utilize the AI, but a large percentage of students consciously decided to deploy the AI. Those findings implied, that large numbers of the students at higher learning institutions are familiar and relied highly on the use of various edu-

cational AI unconditionally. Moreover, the findings delineated the attributes pertained to saving time, worries and authenticity as bounded significances for students' engagement in AI utilization. Subsequently, the researcher's standpoint is on the gaps that have been envisaged in the learning contents authenticating drawn from AI. Apparently, the cognitivism processes required guidance on the learning content delivered to students through counterchecking for assurance of accuracy, validity, credibility and relevance. Furthermore, the attainment of realism of CLT and CLO in cognitivism emphasized learning as a chronological cognitive process needs ample time for the content to be captured and stored in short-term memory for immediate usage, later transferred for cognitive-schema optimization henceforth green-lined long-term memory content accommodation for retrieval at the required time. Likewise, Veale (2021) and Zemčík (2021) cautioned that the contents drawn from the AI are not all to be considered useful as other encompassed distortion elements hence affect cognition. Correspondingly, students are insisted on rechecking, critiquing and contextualization the contents picked from AI rather than consuming without relevance assurances.

Apparently, was also found that the use of AI has been assistive to students with phobia in correctly writing contents in appropriate English grammar and sorting mathematical manipulations despite missing contextualization. The researcher insisted that, for students to achieve the higher English language skills order holding contextual examples and experiences had to engage in diverse reading, oral presentation practice and writing. Furthermore, reading and practice enable students to engage in different knowledge content comprised of complex vocabulary to be captured, accommodated and retrieved for usage. Similarly, Khasawneh (2021) asserted that new language competencies are developed through repetitive reading, writing, and pronunciation. Additionally, the implications are made to students that, too dependency on AI hindered cognitive schema capacity and challenges in building sentences, vocabulary, and paragraphs as well as stagnation in words pronunciations. Certainly, was insisted that the dependability of AI has been a considerable factor affecting new language development (Gayed, Carlon, Oriola & Cross, 2022; Chen, Zou, Xie & Cheng, 2021; Divekar et al., 2022). Moreover, the suggestions are made to students that, dependability on AI for language development hindered the CLT working memory displaced on personalized time spent in practising English in oral, written, critical reading, comprehension, and interpretation to become conversant

and confident for full utilization as the medium of instruction.

Consequently, was disclosed by the findings that students experienced dynamics to engage in learning practices and procedures instead are considering AI for granted as are rushing to acquire good grades and higher performances. The article in hand insisted on administering the holistic approaches and experiences through appropriate mediating and balance between technologies utilization blended with traditional pedagogical approaches for supporting the students' cognitivism processes in learning aspects. Besides, the appropriate guidance on AI useful is important to bring students sensory performances fostered by the traditional teaching and cognition learning approaches (Xue & Wang, 2022; Maj, 2021). Furthermore, the emphasis is made on the proper utilization of technology for interactivity and engaged creation in learning focused on building critical thinking competencies. Likewise, Zemčík (2021) and Kliestik et al. (2022) cemented the power of AI as learning platforms capacitating placement, disposition of digital simulations, and online resources for cognition process improvement. Further, suggestions are made to students that had to consider CLT and CLO as important aspects that need to be stimulated through engaging in human intellectual sensory than engaging in passive copy-pasting of the content retrieved by AI leading to the route learning. Furthermore, the researcher insisted on the integrative approaches for assessing cognitive capabilities including the continuous assessment that will make students to concentrates on stimulating and engaging in intellectual competencies.

## Students' Cognitive Discrepancies in Performance Due to AI Utilization

Test-retesting based on the time variation and treatment of controllable environment for the same assignment items administering was conducted to the sample of 113. The overall findings revealed that despite the students well performed in all cognitive-related attributes with the AI utilization supports, were significantly providing discrepancies levels to the same when were restricted to utilising AI. Superficially, cognitive attributes and individual differences measurements on the AI utilization were ranked 69% to 94% whilst the same attributes tested without AI showed a diminishing ranging from 30% to 6% with higher discrepancies levels as shown in Figure 2. Furthermore, a discrepancy in transferability of learning (62%) confirmed that the comprehended content by the students through AI was neither accommodate in neither short-term nor long-term memory due to less captivity although was fully supportive in repositioning.

Figure 2. Students' Cognition discrepancies
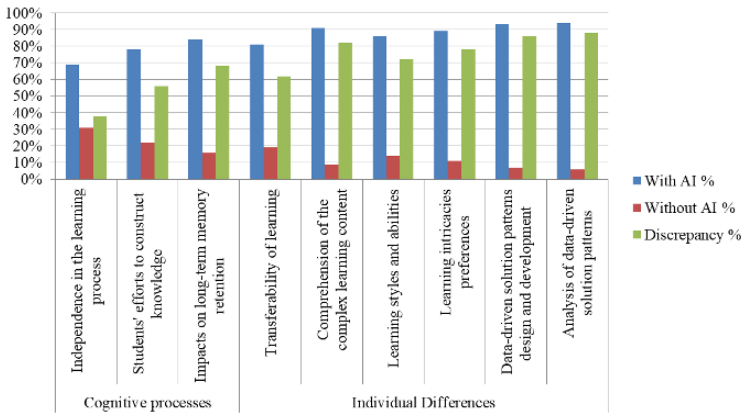
Additionally, despite learning being an independent activity that stimulates schemas to undertake the cognition process, the findings disclosed the presence of individualistic independency gaps on the learning sensory by 38%. Also, was revealed in the findings that students experienced discrepancies of 56% in knowledge construction during performing the same task under restrictiveness of not utilizing AI; implying that students' cognitive schema was negatively affected due to the engagement in route learning henceforth damaging the transferability, storage and retentions process to the long term memory for the same content by 68%.

Figure 3. Feedback, Motivation and Creativity Discrepancies
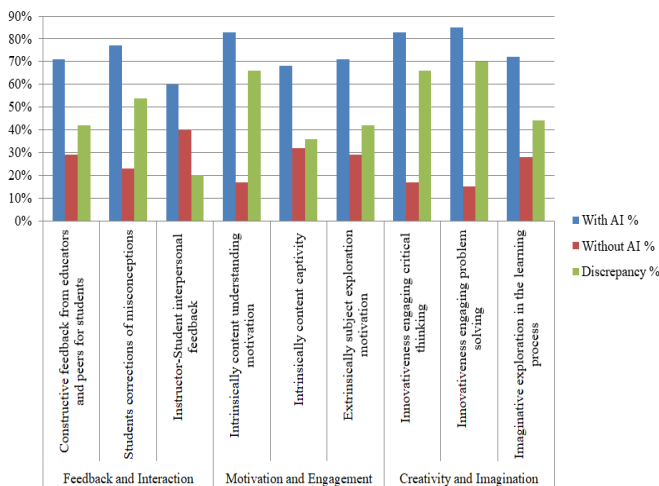
Certainly, for the attainability of CLT, students had to depend on constructive feedback and interaction, motivation and engagement, creativity and imagination. These attributes are essential in assessing different supportive intrinsic and extrinsic competencies and motives simulated intellectual sensual support for CLO accommodation.

Seemingly, the discrepancies levels in the utilization of AI on the measured attributes proved to be higher ranging from 60% to 85% compared to being

relatively low in the context of not using AI ranging from 15% to 40% as displayed in Figure 3. Subsequently, the finding decree that AI is assistive to students in developing independence as well as providing comprehension debating language on the complex content (91%) but in the same vein was against cognitivism theories as the same standalone students were not capable to replicate the same activities leading discrepancies (82%) when required to repeat without utilization of AI.

The cognitive theory emphasized that the mental process attributed to learning had to engage short and long-term memory to engage in critical thinking and problem-solving. Certainly was revealed in the findings on the cognitive learning processes presented stagnation and decreased learning efforts among students due to over-dependency in AI utilization. However, created cognitive-related gaps were described by Gyll and Hayes (2021) that students possessed individual learning differences, and discrepancies in engagement capabilities fostering diligence exploration, systematic investigation, and cognitive schema decision-making relative to selecting the learnt contents to accommodate. Afterwards, the researcher insisted on the importance of accelerating knowledge transferability and independent comprehension of the learnt contents as are important indicators supporting interactivity of the learning processes and sensory integration for building individual differences.

Apparently, human intelligence continued to be important for realism in teaching, learning and research processes (Sharma et al., 2022; Stone et al., 2022; Yazdani-Asrami, 2023; Dwivedi et al., 2021). Also, was added by Baidoo-Anu et al. (2023) and Haryana et al. (2022) that the appropriateness of utilization of instructional methods and approaches is keen in supporting resources of teaching and learning whereas AI are inclusive. Certainly, the paper in hand observed that individual students' cognitive maps pertaining to CLT and CLO are attributed to the appropriate blended learning styles and capabilities, intricacies preferences, designing, developing and analyzing data solutions and patterns involving schemas. The views provided by the researcher are based on guiding and preparing classroom activities portrayed into hands-on activities to stimulate other cognitive senses for bridging the active schemata mental process during the learning process.

Farther, despite the findings proving that the AIs' integration shed lighted positivity in undertaking various learning traits, particularly in driving solutions and undertaking analysis of the problem but the negative repercussion is stagnation to the student's learning experiences attributed to stimulating and engaging the cognitive mind-maps as machine learning created everything on their behalf (Kadam

& Vaidya, 2021). The paper apprehended that, despite the 21st-century competencies and skills requirements front-lined deployment and utilization of 4IR digital and technologies but in the learning context special attention had to be considered to overcome CLT and CLO distortions. The alerts were made by Selwyn (2022) and Sumakul et al. (2022) that the AI product's utilization in education is the agenda that need discussion, particularly for the engagement of learning activities.

Consequently, the researcher insisted that students are not supposed to align too much in AI utilization for undertaking every classroom activity to evacuate and rescue the decreasing cognitive schema efforts fostering the receiving, processing, transferring and accommodations situated from CLT to CLO. Consequently, the paper insisted on feedback and interaction being essential cognitive processes attributes that enabled the acquisition of critiques that are assistive in the rectification of the wrongly learnt content passiveness, capacitates defending competencies henceforward well-shaping mind. Likewise, Han and Xu (2021) elicited that student's feedbacks are an enabler in construction and stabilizing the optimal cognitive capacity. Furthermore, Britannica (2023) insisted on human cognitive intelligence in fostering the reasonable operationalization of learning goals and achievements.

Apparently, cautionary suggestions are made to instructors and students on the utilization of AI as education-supportive tools by ensuring that attributes for feedback and interactions, motivation and engagement, creativity and imagination continue to be apprehended as comprised with potential attributes supporting CLT and CTO responsiveness. The additional attributes were proposed by Johnson et al. (2023). That the well-capacitated human cognitive intelligence had to undertake innovation and development activities. Certainly, the emphasizing recommendations are made to students to engage in an active learning process for reaching realism in knowledge construction.

Similarly, the students' full overdependence and engagement in AI implied the development of emptied knowledge vacuum cognitive not capacitated to undertake various socio-economic activities as future human capitals. Moreover, today's students' cognitive processes continued to be distorted by the overutilization of AI implied future workforce stagnated in undertaking activities related to creativity, imaginary development and construction of models, processes and procedures for realism problem-solving. Certainly, cognition practices had to be focused on cultivating higher students thinking talents levels based on the concepts of CLO that are fostered by intrinsic motivation, problem-solving and critical thinking (Pan et al., 2023). Likewise, schol-

ars insisted on engaging human cognitive schema for the acquisition, processing, creation and accommodation of new knowledge that is reflective for assisting in undertaking decision-making, argumentations and making choices based on learning needs (Jokhan et al., 2022; Johnson et al., 2023).

Yet, the paper made the suggestions to the students to engage in exploration and higher order innovative capabilities levels nurturing alignment of cognitive nodes maps for critical thinking processes. Furthermore, the emphasis is made on the provision of intrinsic and extrinsic motivations found through interactions with different elements in the learning process as are the build blocks for valuable knowledge creation based on students' differentiated learning needs. Also, Qureshi et al. (2023) insisted on the nature and frequencies of interaction with peers and instructors significantly affecting the students' motivation towards learning performance. Superficially, despite learning being an inert process, interpersonal interaction for feedback provision among instructors, peers and students articulated on learnt content correction and displacement of misconception attributed into improvements for cognitive growth rational encouragement.

CONCLUSION

The AI has brought alert shed lighted the dismantling of pedagogical practices supports pertained the realism of the CLT and CLO. Moreover, CLT and CLO as the core functional of cognitivism processes elucidated the sensitization rationality and provision of appropriate guidance to higher learning students on appropriate utilization of AI without outwardly the traditional learning approaches. However, the findings alarmed the administering of the take-home continuous assessments such as individual assignments whereas the students utilized AI for responses exaggeration implying the low utilization of cognitive schema and learning continued being inert. Furthermore, the utilization of blending, engaging, participatory and technology inclusiveness approaches are essential for the betterment of students in accommodating the CLT and CLO.

The learning process as the central activity that stimulates the cognitive mind map construction had to be well balanced with the integration of AI for active cognition processes supports. The gaps brought by students through the deployment of AI on content responses relevance, peer pressure, plagiarism, and learning laziness need to be appropriately sorted out. Moreover, the role of module instructors has been increased towards appropriately guiding students to balance approaches focused on encouraging critical thinking, authentic engagement, and responsible digital resource utilization.

Further, alarming brought by the uncontrolled utilization of AI in the learning processes has implications on the distortion of students' capabilities towards engaging in CLT and CLO henceforth continued to be with deteriorated cognitively. Certainly, the future depending on today's students had to be assigned learning tasks that fostered the aspects of memory retention, transferability, constructive independent comprehension, critical thinking, interpersonal and content interaction, and problem-solving for effective learning outcomes. All in all, the balance in AI utilization, and active engaging pedagogies that influence all elements of the learning process are crucial for the realism attainability of CLT and CLO. Additionally, the suggestions are made for future research in the areas of:-

1. Powered AI tools integrative strategies for cognitive engagement, critical thinking, and problem-solving.
2. Effects of long-term AI integration on students' critical cognitive processes for skills and retention developments.

REFERENCES

Anwar, M.R., Oganda, F.P., Santoso, N.P.L. & Fabio, M., (2022). Artificial Intelligence that Exists in the Human Mind. *International Transactions on Artificial Intelligence*, *1*(1), 28-42.

Arbuckle, S. A., Pruszynski, J. A., & Diedrichsen, J. (2022). Mapping the integration of sensory information across fingers in human sensorimotor cortex. *Journal of Neuroscience*, *42*(26), 5173-5185.

Baidoo-Anu, D., & Owusu Ansah, L. (2023). Education in the era of generative artificial intelligence (AI): Understanding the potential benefits of ChatGPT in promoting teaching and learning. *Available at SSRN 4337484*.

Baigang, M., & Yi, F. (2023). A review: development of named entity recognition (NER) technology for aeronautical information intelligence. *Artificial Intelligence Review*, *56*(2), 1515-1542.

Britannica (23 February 2023). Artificial İntelligence. https://www.britannica.com/technology/artificial-intelligence

Chen, X., Zou, D., Xie, H., & Cheng, G. (2021). Twenty years of personalized language learning. *Educational Technology & Society*, *24*(1), 205-222.

Chung, N. C. (2021). Human in the loop for machine creativity. *arXiv preprint arXiv:2110.03569*.

De Garrido, L. (2022). Conceptual design of a creative artificial intelligence system based on the neurocognitive bases of human creativity in the brain. *Creativity Research Journal*, *34*(3), 273-294.

Dey, N. (Ed.). (2023). *Applied Genetic Algorithm and Its Variants: Case Studies and New Developments*. Springer Nature.

Divekar, R. R., Drozdal, J., Chabot, S., Zhou, Y., Su, H., Chen, Y., ... & Braasch, J. (2022). Foreign language acquisition via artificial intelligence and extended reality: design and evaluation. *Computer Assisted Language Learning*, *35*(9), 2332-2360.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., ... & Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management*, *57*, 101994.

Gayed, J. M., Carlon, M. K. J., Oriola, A. M., & Cross, J. S. (2022). Exploring an AI-based writing Assistant's impact on English language learners. *Computers and Education: Artificial Intelligence*, *3*, 100055.

Gyll, S. P., & Hayes, H. (2021). Learning and individual differences in skilled competency-based performance: Using a course planning and learning tool as an indicator for student success. *The Journal of Competency-Based Education*, *6*(3), e1259.

Han, Y., & Xu, Y. (2021). Student feedback literacy and engagement with feedback: A case study of Chinese undergraduate students. *Teaching in Higher Education*, *26*(2), 181-196.

Happs, J. C. (1985). Cognitive learning theory and classroom complexity. Research in Science and Technology Education, 3, 159-174. https://doi.org/10.1080/0263514850030109a

Haryana, M. R. A., Warsono, S., Achjari, D., & Nahartyo, E. (2022). Virtual reality learning media with innovative learning materials to enhance individual learning outcomes based on cognitive load theory. *The International Journal of Management Education*, *20*(3), 100657.

Ivan, C., Chiru, I., & Arcos, R. (2021). A whole of society intelligence approach: critical reassessment of the tools and means used to counter information warfare in the digital age. *Intelligence and National Security*, *36*(4), 495-511.

Johnson, S. G., Bilovich, A., & Tuckett, D. (2023). Conviction narrative theory: A theory of choice under radical uncertainty. *Behavioral and Brain Sciences*, *46*, e82.

Jokhan, A., Chand, A. A., Singh, V., & Mamun, K. A. (2022). Increased digital resource consumption in higher educational institutions and the artificial intelligence role in informing decisions related to student performance. *Sustainability*, *14*(4), 2377.

Kadam, S., & Vaidya, V. (2021). Cognitive evaluation of machine learning agents. *Cognitive Systems Research*, *66*, 100-121.

Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. Learning and Individual Differences, 103, 102274.

Khasawneh, M. A. S. (2021). Teacher perspective on language competences relation to learning difficulties in English learning. *Journal Educational Verkenning*, *2*(1), 29-37.

Kliestik, T., Novak, A., & Lăzăroiu, G. (2022). Live shopping in the metaverse: Visual and spatial analytics, cognitive artificial intelligence techniques and algorithms, and immersive digital simulations. *Linguistic and Philosophical Investigations*, *21*, 187-202.

Li, B., & Li, W. (2023). Developing Students' Game Competence: Situated Game Teaching through Set Plays. *Strategies*, *36*(1), 31-39.

Liaw, S. Y., Tan, J. Z., Lim, S., Zhou, W., Yap, J., Ratan, R., ... & Chua, W. L. (2023). Artificial intelligence in virtual reality simulation for interprofessional communication training: Mixed method study. *Nurse Education Today*, *122*, 105718.

Maj, S. P. (2021). Benchmarking educational quality–an analysis and alternative practical learning theory and technology. *ASCILITE Publications*, 308-312.

Pan, Q., Zhou, J., Yang, D., Shi, D., Wang, D., Chen, X., & Liu, J. (2023). Mapping Knowledge Domain Analysis in Deep Learning Research of Global Education. *Sustainability*, *15*(4), 3097.

Poesia, G., & Goodman, N. D. (2023). Peano: learning formal mathematical reasoning. *Philosophical Transactions of the Royal Society A*, *381*(2251), 20220044.

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engage-ment. *Interactive Learning Environments*, *31*(4), 2371-2391.

Renzulli, J. (2023). *The multiple menu model: A practical guide for developing differentiated curriculum*. Taylor & Francis.

Salvagno, M., Taccone, F. S., & Gerli, A. G. (2023). Can artificial intelligence help for scientific writing?. *Critical care*, *27*(1), 1-5.

Selwyn, N. (2022). The future of AI and education: Some cautionary notes. *European Journal of Education*, *57*(4), 620-631.

Sharma, K., Lee-Cultura, S., & Giannakos, M. (2022). Keep calm and do not carry-forward: Toward sensor-data driven AI agent to enhance human learning. *Frontiers in Artificial Intelligence*, *4*, 713176.

Sineviciene, L., Hens, L., Kubatko, O., Melnyk, L., Dehtyarova, I., & Fedyna, S. (2021). Socio-economic and cultural effects of disruptive industrial technologies for sustainable development. *International Journal of Global Energy Issues*, *43*(2-3), 284-305.

Srinivas, T., Mahalaxmi, G., Varaprasad, R., Donald, A. D., & Thippanna, G. (2022). AI in Transportation: Current and Promising Applications. *IUP Journal of Telecommunications*, *14*(4).

Stone, P., Brooks, R., Brynjolfsson, E., Calo, R., Etzioni, O., Hager, G., ... & Teller, A. (2022). Artificial intelligence and life in 2030: the one hundred year study on artificial intelligence. *arXiv preprint arXiv:2211.06318*.

Sumakul, D. T., Hamied, F. A., & Sukyadi, D. (2022). Artificial intelligence in EFL classrooms: Friend or foe? LEARN Journal: Language Education and Acquisition Research Network, 15(1), 232-256.

Tabbussum, R., & Dar, A. Q. (2021). Performance evaluation of artificial intelligence paradigms—artificial neural networks, fuzzy logic, and adaptive neuro-fuzzy inference system for flood prediction. *Environmental Science and Pollution Research*, *28*(20), 25265-25282.

Veale, M., & Zuiderveen Borgesius, F. (2021). Demystifying the Draft EU Artificial Intelligence Act—Analysing the good, the bad, and the unclear elements of the proposed approach. *Computer Law Review International*, *22*(4), 97-112.

Wang, H., & Ma, S. (2022). Preventing crimes against public health with artificial intelligence and machine learning capabilities. *Socio-Economic Planning Sciences*, *80*, 101043.

Xue, Y., & Wang, Y. (2022). Artificial intelligence for education and teaching. *Wireless Communications and Mobile Computing*, *2022*, 1-10.

Yan, C., de Lange, F. P., & Richter, D. (2023). Conceptual associations generate sensory predictions. *Journal of Neuroscience*, *43*(20), 3733-3742.

Yazdani-Asrami, M. (2023). Artificial intelligence, machine learning, deep learning, and big data techniques for the advancements of superconducting technology: a road to smarter and intelligent superconductivity. *Superconductor Science and Technology*, *36*(8), 084001.

Zemčík, T. (2021). Failure of chatbot Tay was evil, ugliness and uselessness in its nature or do we judge it through cognitive shortcuts and biases?. *AI & SOCIETY*, *36*, 361-367.

Zhao, Y., Zhao, H., Ai, J., & Dong, Y. (2022). Robust data-driven fault detection: An application to aircraft air data sensors. *International Journal of Aerospace Engineering*, *2022*.