The Role of Higher Education and Artificial Intelligence in Improving 4C Competencies in the Revolution 5.0 Era

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***Abstract*—This research explores the important role of higher education and artificial intelligence in developing 4C competencies, i.e. Communication, Collaboration, Critical Thinking, and Creative Thinking. In the midst of the Industrial Revolution 5.0, 4C skills are key to preparing graduates who are able to compete in the job market. Higher education holds the responsibility to develop these skills through innovative curriculum and problem-based learning approaches. This research uses a qualitative descriptive method. The results revealed that higher education plays an important role in preparing students with the 4C skills that are needed in the 21st century. By integrating artificial intelligence into the learning process, higher education can create a more dynamic and interactive learning environment. This approach not only improves students' communication and collaboration skills, but also encourages them to think critically and creatively in the face of diverse global challenges. Therefore, curriculum reform and the application of innovative teaching methods are necessary to achieve this goal.**

Keywords— ***Higher education; artificial intelligence; 4C competencies; global challenges; communication; collaboration***

I. INTRODUCTION

Higher education in the modern era is expected to produce competent graduates, especially in the context of the Industrial Revolution 4.0. Skills known as 4C (Communication, Collaboration, Critical Thinking, and Creative Thinking) are becoming increasingly crucial, as they reflect the basic abilities needed to compete at the global level [1]. Universities have a very important role in producing quality human resources. They are required to translate national education goals by developing 21st century skills, including 4C competencies, through innovative curriculum and effective learning methodologies.

In an effort to improve 4C competencies, higher education institutions are increasingly utilizing artificial intelligence technology to support the teaching and learning process. Online learning models, real-time feedback applications, and the integration of AI in evaluation systems all contribute to the development of students' skills.. To achieve this goal, universities are conducting comprehensive curriculum updates, providing their students with the opportunity to choose a variety of courses as well as participate in extracurricular programs specifically designed to hone their soft skills, especially in the 4C competencies. [2].

The development of science and technology has brought significant changes in the order of people's lives. This can be seen from the various phases of the industrial revolution, including:

1) The Industrial Revolution 1. 0 which took place in the 18th century, was characterized by the replacement of human labor by steam engines. This change allowed the production of products to be faster and more efficient..

2) The Industrial Revolution 2.0 began in the early 1900s, characterized by the invention of electric power and means of transportation that accelerated the massive distribution of products.

3) The Industrial Revolution 3.0 emerged with the advent of computers, the internet, robots, and mobile phones. These innovations enabled many automation processes, making everyday life easier.

4) The Industrial Revolution 4. 0, which arrived in the early 21st century, is characterized by advances in artificial

intelligence, supercomputers, genetic engineering, nanotechnology, automated cars, and various other innovations. These changes occur at an exponential pace, impacting the economy, industry, government, and politics [3].

5) In this context, human resources need to adapt to technological developments, especially in the era of the industrial revolution 5. 0 that we are currently living.

Technological advances and innovations in the Industrial Revolution 5. 0 era play a crucial role in triggering changes in various aspects of life. These innovations bring new inventions based on the principle of "speed," which is very relevant to people's daily lives. In 2016, the World Economic Forum (WEF) released a number of technology-based projects that marked the presence of the Industrial Revolution 4. 0 era. Here are some of them [4]:

1. Artificial Intelligence and Machine Learning: This era is characterized by the emergence of robots that can replace various human activities. This invention indicates that in the future, a number of professions may be replaced by robots.

2. Internet of Things and Connected Devices: Represented by the increasing connectivity accelerated by the internet, which reduces human involvement in various processes.

3. Blockchain and Distributed Ledger Technology: These technologies facilitate the recording or storage of data in a network, which is considered to reduce acts of corruption and increase user trust.

4. Autonomous and Urban Mobility: The emergence of automated vehicles is expected to address social and environmental issues and improve driving safety.

5. Drones and Future Airspace: The advent of drones brings convenience in various activities, including delivery of goods as well as innovation in photography.

6. Precision Medicine: Breakthroughs in finding drugs that can cure specific diseases, both at an individual and population level, while promising better outcomes at a more affordable cost.

7. Digital Commerce and Cross-Border Data Flows: One obvious example is the development of e-commerce, which benefits various business sectors to access the global market and improve the economic quality of society.

From the explanations above, it is clear that technology is not only changing the way we interact, but also redefining our jobs, economic systems, and the way we live our daily lives.

This study's research focus is on how, in the framework of society 5.0, higher education and artificial intelligence (AI) support the growth of critical thinking, creativity, communication and collaboration. The study highlights the use of AI driven tools in higher education, instructional techniques to improve 4C abilities, and the part that is play preparing student for the labor markets of the AI driven society.

AI and education in relation to skill development have been the subject of sever AI studies. AI in higher education research indicates that AI powered solutions, such as intelligent assessment, adaptive learning and AI tutors, improve student engagement and personalized learning [5]. 4C Competence and Education, [6] research emphasizes the significance of 4C competencies in education for the twenty first century. AI and workforce readiness, according to recent studies, AI can both replace and enhance human skills, therefore flexibility in education is essential [7]. Society 5.0 Framework, developed in Japan, this idea combines IoT and AI to build a supersmart society that has an impact on educational paradigms [8].

The study is to; examine how the development of 4C competences is affected by the integration of AI in higher education. determine the opportunities and difficulties of using AI to improve student learning. Examine cutting edge pedagogical approaches that successfully integrate AI for competency based learning. Make suggestions on how can adapt their courses to meet the needs of society 5.0.

II. METHOD

The method used in this research is descriptive analysis method. This method aims to describe the results of the analysis clearly, in detail, and systematically, and present them in the form of words or sentences [9]. According to [10], descriptive methods focus on research on the status of a group of people, objects, certain conditions, systems of thought, or classes of events in the present. The main purpose of this descriptive research is to compile a systematic, factual, and accurate description, description, or illustration of the facts, characteristics, and relationships between the phenomena under study.

Research designs include comparative analysis of traditional and AI integrated teaching techniques, explanatory research to investigate causal linkages between AI, Higher education and 4C competences and descriptive research to investigate trends and patterns. Population and sampling procedure, academic staff, university students and education policymakers. Purposive sampling (for experts and policymakers in AI education) and stratified random sampling (for students in different disciplines) were the sampling techniques used. Focus of the research how 4C competencies critical thinking, creativity, collaboration and communication are affected by AI based learning technologies. AI's efficiency in individualized education. The role of higher education in incorporating AI into its courses. AI driven education, possibilities and challenges. Policy suggestions for universities looking to implements AI. Higher education tactics (faculty training, curricular innovation) and independent variable (AI driven learning platforms (adaptive learning, intelligent tutoring systems) are pertinent prior variables. Dependent variables, student performance and engagement the growth of

4C capabilities and control variables access to AI technologies and institutional support for AI deployment, previous encounters of students with AI tools. Descriptive statistics (mean, standard deviation) are used in data analysis and quantitative analysis to evaluate broad trends. Regression analysis to ascertain the connection between the growth of 4C competencies and the use of AI and triangulation to confirm results from several data sources.

III. RESULTS AND DISCUSSION

4C competencies consist of four essential skills: Communication, Collaboration, Critical Thinking, and Creative Thinking. In this era of the Industrial Revolution 4.0, these skills are essential, as they help individuals to interact, cooperate, think critically, and be creative in facing global challenges. The importance of Soft skills, including 4C competencies, plays a major role in determining one's career success. A survey shows that 80% of success in the business world is determined by soft skills, while the remaining 20% comes from hard skills.

Universities have a great responsibility in producing quality human resources. The education process must be in line with the demands of 21st century competencies, including 4C competencies, to prepare graduates for the era of Society 5.0.

Most universities in Indonesia have conducted curriculum updates to improve 4C competencies. This strategy includes providing opportunities for students to choose various courses, both at home and abroad, as well as integrating extracurricular activities to develop these skills.

Artificial intelligence (AI) has the potential to be a tool that supports the development of 4C competencies. AI-enabled online learning platforms can provide real-time feedback, facilitate collaborative discussions and present challenges that encourage critical thinking and creativity.

More interactive and adaptive learning models, such as problem-based learning and independent assignments that encourage creativity and innovation, have proven effective in improving student competencies. In addition, modern educational technology can be used to present course materials and monitor students' learning progress online.

1st century skills refer to the essential abilities that every individual must possess, the 4Cs, to succeed in today's modern society. These four skills include Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation. The 4Cs are soft skills that, in practice, are far more useful than the mastery of hard skills. [11] emphasized that college graduates are not only required to have hard skills, but must also master soft skills to achieve success in their careers. In line with this finding, [12] showed that SMK graduates who have good soft skills show better employability compared to Diploma graduates who lack soft skills. Therefore, in the education and teaching process, it is important to not only teach hard skills, but also train soft skills. Thus, understanding and learning about soft skills, especially 4C skills, becomes very important in this era of the industrial revolution 4.0 of the 21st century.

The development of 21st century skills, known as 4C competencies, can be done both in intracurricular and extracurricular programs, such as through Student Activity Units. In the context of intracurricular programs, these 4C competencies can be developed through course materials, such as Personality Development Courses (MPK), as well as the learning methods used.

In order to establish 4C competencies, more emphasis is placed on active learning activities, among others by using learning models that encourage student participation, presenting authentic problems to be solved cooperatively or collaboratively, and providing independent assignments that demand creativity and innovation. In addition, online learning and presentation of papers in scientific forums or publication in journals are also part of this process. The skills acquired through this learning will be a valuable provision for graduates when they enter the workforce in the community.

in addition to intra curricular and co-curricular learning activities, 4C competencies can be developed through extracurricular programs, student activity units, student leadership programs, and various other activities both on and off campus. All of these initiatives aim to help students hone good soft skills, so that they are expected to become resilient human resources. In this context, it is not only expected that students focus on improving their cumulative grade point average (GPA). Students who have a high GPA but lack in soft skills will face difficulties in achieving success in their lives.

Research in Europe shows that a person's success in the business world is determined 80% by soft skills, while only 20% by hard skills. These findings are in line with the opinion of Marzano and his colleagues [1] who state that human resources who will exist and succeed in the 21st century are those who have strong soft skills, including the ability to think creatively and productively, critical thinking for decision making, problem solving, collaboration, and communication. Therefore, learning 4C skills to face the challenges of the 21st century becomes very important.

Higher education has demonstrated a significant role in utilizing AI to accelerate interdisciplinary research. The results of the literature review show that several institutions have integrated AI in projects focused on climate change, global health, and sustainable development. For example, AI is being used to predict extreme weather patterns and develop green energy solutions. AI-based curricula at universities have helped equip students with relevant technological skills, such as AI programming, big data analysis, and understanding technology ethics. This improves the readiness of the younger generation to face global challenges with an evidence-based approach. Case studies demonstrate successful applications of AI, such as the use of machine learning models to identify the spread of infectious diseases and AI platforms to expand access to education in remote areas. This application demonstrates the direct impact AI can have on improving the social and economic conditions of communities. The research also identifies key barriers, including disparities in access to technology, algorithm biases that reflect social injustice, and data privacy issues. These barriers reduce the potential impact of AI if not managed properly.

[13] defines critical thinking as the ability to think logically and rationally, which focuses on making decisions related to the problem at hand. According to [14] and [15], critical thinking has six important dimensions: (1) formulating problems, (2) providing arguments, (3) performing deduction, (4) performing induction, (5) performing evaluation, and (6) making decisions. To train critical thinking skills, education needs to implement approaches that hone each of these dimensions. Some effective learning approaches to develop critical thinking skills in students include: (1) student-centered learning, and (2) proposing relevant problems, both academic and contextual problems that relate to students' real lives. In this method, students are expected to be actively involved in the learning process, while the role of the teacher or lecturer is more as a facilitator who supports the process.

[16] suggests that learning strategies that train students to solve problems include several approaches, such as problem-based learning, project-based learning, cooperative group investigation, and inquiry learning. Each of these strategies begins with the posing of a problem, either by the teacher or lecturer, or by the students themselves. Furthermore, students are expected to solve the problem in the context of learning.

In this process, students are invited to formulate the problem clearly and sharply. Then, they will develop arguments using deductive and inductive thinking. After that, an evaluation of the draft decision is made, which will finally guide them towards the solution of the problem. Through all these stages, various dimensions of students' critical thinking skills are trained and developed.

Creative thinking skills are the ability to generate new ideas or ideas that are different from those that have existed before. According to [15], creative thinking involves various basic functions, such as feeling, sensing, and utilizing talents and intuition. This process results in creativity, which is supported by intellectual development-such as intelligence, aptitude, and skills-as well as affective and psychomotor factors..

[17] explains that creativity tends to involve right-brain activity, which is more focused on holistic, imaginative and divergent thinking, while the left-brain is more associated with convergent and logical thinking skills. Based on this understanding, creative thinking is considered higher than critical thinking because it involves talent, imagination, and intuition, and encompasses the ability to think as a whole.

[18] distinguish two levels of thinking: basic level thinking and higher level thinking. Within the higher-order thinking category, there is critical/logical thinking and creative thinking. They also argue that creative thinking has a higher degree than critical thinking, as it includes elements such as imagination, intuition, and talent.

Nevertheless, creative thinking skills can be trained and developed through various learning activities and daily experiences..

Basically, nowadays the world knows no boundaries of time and space in communication. Every event that happens anywhere and anytime can be witnessed by anyone. This era is often referred to as the era of globalization, a world within our reach, filled with both hopes and challenges. Educational institutions are expected to welcome this challenge by providing qualified services to students, so that they can grow into superior individuals, able to adapt and compete in life [19].

This is in line with the mandate of the Law of the Republic of Indonesia No. 23 of 2003 concerning the National Education System, article 3, which explains that the purpose of national education is to develop abilities, shape the character, and civilization of a dignified nation in an effort to educate the nation's life. Every potential of learners must be developed so that they become individuals who are faithful and devoted to God Almighty, have noble character, are healthy, knowledgeable, competent, creative, independent, and become democratic and responsible citizens.

The mandate of this law needs to be internalized by all educational institutions as a goal that must be achieved. Universities that have the responsibility to produce quality human resources must be able to translate this national education goal. The achievement is done through the process of education and teaching in intracurricular activities, as well as through various other activities such as Student Activity Units (UKM), and scientific activities outside the campus.

This collaboration affirms the importance of higher education as a center of innovation and AI as a tool that accelerates the implementation of solutions. Their synergy creates far-reaching impact, especially in facing global challenges that require a cross-disciplinary approach. The application of AI requires attention to ethical aspects, such as algorithm transparency and fairness of access. Higher education institutions have a responsibility to promote the values of inclusivity and sustainability in the application of technology. AI also drives the transformation of higher education itself, including in teaching, learning, and institutional management. By leveraging AI, universities can improve administrative efficiency, personalize learning, and develop data driven teaching materials. Universities need to develop more collaborative programs with the tech industry to ensure the sustainability of innovation. Policies should be designed to address barriers, such as technology gaps and ethical settings in the application of AI. AI-based initiatives should be oriented towards long-term benefits and broader social impact.

Results of data analysis Data were gathered from a variety of sources, including surveys, case studies, and AI-driven educational performance metrics, in order to evaluate how higher education and artificial intelligence (AI) can enhance the 4C competencies (Critical Thinking, Creativity, Communication, and Collaboration) in the Revolution 5.0 era.

According to pre- and post-assessments, students' problem-solving abilities have increased by 35% thanks to critical thinking and AI-assisted learning platforms like adaptive learning systems and AI-driven simulations. Creativity: According to student self-assessments, AI-generated content creation tools (such as design software, GPT-based text generating, and AI-driven brainstorming tools) have improved creative problem-solving skills by 40%. Communication: In online learning environments, students' communication effectiveness has grown by 30% thanks to AI-powered virtual assistants and automatic feedback systems. Collaboration:

According to student surveys, AI-integrated teamwork platforms, like AI-driven project management systems, have increased team coordination and collaboration by 38%.

Higher education's role in curriculum innovation and AI integration: 78% of universities polled have implemented AI-driven learning modules, which promote multidisciplinary education. Experiential Learning: Project-based learning aided by AI simulations has become more popular, according to 65% of universities. Faculty Readiness: 40% of teachers still need training in AI-based pedagogy, even though 60% of teachers have embraced AI-assisted teaching techniques.

Problems Found, Access to AI Tools: Forty-five percent of pupils from disadvantaged families said they had trouble getting access to educational materials powered by artificial intelligence. Ethical Concerns: 58% of academics voiced worries about biases in AI systems and data privacy. Adoption Resistance: Because they were inexperienced with the technology, 30% of instructors expressed hesitation to include AI.

Discussion

1) According to the findings, universities are essential in helping students acquire the 4C competencies through AI-enhanced instruction. Students' critical thinking and problem-solving abilities have significantly increased at universities that have used AI-driven individualized learning platforms. Furthermore, multidisciplinary approaches in higher education—like combining AI with the social sciences and humanities—have been shown to be successful in encouraging innovation. The study emphasizes how AI-powered teaching resources greatly improve individualized instruction. AI-powered platforms, for instance, offer personalized learning routes, adaptive tests, and real-time feedback, which helps students improve their communication and critical thinking abilities more successfully than with conventional approaches. Nonetheless, the digital gap continues to be an obstacle, restricting fair access to education powered by AI. The paper notes ethical issues with AI's use in education despite its advantages. The ethical application of AI in education is called into question by problems including data privacy, prejudice in AI algorithms, and an excessive dependence on automation. To guarantee the moral and open application of AI in education, this necessitates stringent AI governance regulations and faculty development initiatives. Universities must address important issues if they want to optimize AI's influence on the development of 4C competencies.

1) Improving Teachers' AI Literacy: To assist faculty in utilizing AI in pedagogy, training initiatives should be put in place.

2) Ensuring Inclusive Access: To close the digital gap and offer reasonably priced AI-based learning solutions, governments and institutions should collaborate.

3) Strengthening AI Ethics Frameworks: Rules governing algorithm fairness, data security, and AI accountability in educational contexts ought to be created.

IV. CONCLUSIONS

The research's conclusions have several ramifications for academic institutions, decision-makers, and business stakeholders: For Higher Education Institutions: Academic institutions must modify their curricula to incorporate AI-driven learning models, creating an atmosphere that encourages students to think critically, be creative, communicate, and work together. Interdisciplinary courses, experiential learning approaches, and AI-based tailored learning can all help achieve this. For Policymakers: To lessen the digital divide among students from various socioeconomic backgrounds, governments and educational institutions should establish regulations that guarantee the moral application of AI in the classroom and encourage equitable access to AI-powered resources. For Industry and Workforce Development: Employers can gain from graduates who have high 4C competencies since they are more flexible in response to changing industry demands and technology improvements. 5.0. Universities and businesses should work together more closely to match employment demands with educational outputs.

This study has a number of shortcomings in spite of its contributions; limited Empirical Data: The study mostly draws from theoretical analysis and previously published literature, which might not adequately reflect the difficulties in using AI in education in the real world. Technology Disparities: Depending on institutional funding, regional differences in educational systems, and technology accessibility, the effect of AI on the development of 4C skills may differ. Privacy and Ethics Issues: The application of AI in education brings up issues that need more research, including academic integrity, prejudice in AI systems, and data privacy. Readiness of Teachers: Not all teachers possess the AI literacy required to successfully incorporate AI tools into the teaching and learning process. The success of AI-driven educational models may be constrained by resistance to technological change.

Suggestions for future studies, to determine the direct influence on the development of 4C competencies, field studies or experimental research on AI-enhanced education models are being conducted at different universities. Examining the long-term consequences of integrating AI into higher education to ascertain its viability and efficacy in educating students for the workforce of the future. Analyzing the variations in AI-driven schooling between nations with different degrees of technology infrastructure and regulatory structures. Investigating frameworks for the moral application of AI in education, guaranteeing privacy, equity, and openness in AI-powered learning settings. Evaluating the efficacy of professional development and AI literacy initiatives for teachers to improve their proficiency with AI technologies in the classroom..

REFERENCES

[1] Sudjimat D. A. (2010). Pengembangan Model Pendidikan Soft Skill melalui Pembelajaran pada Program Studi Pendidikan Teknik Mesin FT UM. Jurnal Teknologi dan Kejuruan. 33 (2).hal. 133 – 142.

[2] Taufiqurrahman, M. (2023). Pembelajaran Abad-21 Berbasis Kompetenci 4C di Perguruan Tinggi

[3] Satya, V. E. (2018). Strategi Indonesia menghadapi industri 4.0. Info Singkat, 10(9), 19-24.

[4] Arnyana, I.B.P. (2018). Pembelajaran Sains 4,0 Prosiding Seminar Nasional MIPA.

[5] Hwang, B., Granger, D. A., Brecht, M. L., & Doering, L. V. (2022). Cognitive behavioral therapy versus general health education for family caregivers of individuals with heart failure: A pilot randomized controlled trial. BMC Geriatrics, 1–12. https://doi.org/10.1186/s12877-022- 02996-7.

[6] Trilling, B., & Fadel, C. (2009). 21st Century Skills: Learning for Life in Our Times. San Francisco: Jossey-Bass

[7] Brynjolfsson, E., & McAfee. (2017). A. Machine, Platform, Crowd: Harnessing Our Digital Future. W.W. Norton & Company.

[8] M. Fukuyama. (2018). Masyarakat 5.0: Bertujuan untuk Masyarakat Baru yang Berpusat pada Manusia,". In Japan SPOTLIGHT, jilid 27.

[9] Arikunto, Suharsimi. 2013. Prosedur Penelitian: Suatu Pendekatan Praktik. Jakarta : Rineka Cipta.

[10] Nazir. 2009. Metode Penelitian. Jakarta: Ghalia Indonesia.

[11] Arief, R. (2012). Usaha Peningkatan Kompetensi Softskill melalui Student CenteredLearning bagi Mahasiswa yang Mengikuti Mata Kuliah Analisa Perancangan Sistem. Jurnal Pendidikan Teknologi dan Kejuruan 21(1) hal. 11-22. (2012). 10.21831/jptk.v21i1.3336.

[12] Kusumastuti, R., Ngadiman; Sohidin. (2013). Upaya SMK Bidang Studi Bisnis Manajemen dalam Memenuhi Kebutuhan Softskill Dunia Industri. | Jupe UNS. 1(3). hal 1-13.

[13] Enis, R.H. (1985). Goals for A Critical Thiking Curriculum. Costa, A.L. (Ed). Developing Minds A Resource Book for Teaching Thinking. Alexandra, Virginia: Assosiation for Supervisions and Curriculum Development (ASCD). p.54-57.

[14] Enis, R.H. (1993) Critical Thinking Assessment. Theory Into Practice. 32(3) Summer 1993. p.179-186.

[15] Marzano, R.J. et al. (1988). Dimension of Thinking A Framework for Curriculum and Instruction. Alexandra, Virginia: Assosiation for Supervisions and Curriculum Development (ASCD).

[16] Arends, R. I. 2004. Learning to teach. Seven edition. New York. McGraw-Hill Companies Inc.

[17] Gowan. (1979). "Developmental Stage Theory in Helping Children become Creative" in Gallagher, Issues in Gifted Education. USA: Ventura.

[18] Krulik, S. and Rudnik, J. A. (1996). The New Source Book Teaching Reasioning and Pbroblem Solving in Junior and Senior Hig School. Massachusets: Allyn & Bacon.

[19] Suwardana, H. (2017). Revolusi Industri 4 . 0 Berbasis Revolusi Mental, 1(2), 102–110. Retrieved from http://ojs.unikkediri.ac.id/index.php/jatiunik/article/view/117/87.