The Role of Artificial Intelligence in Improving Literacy Education: A Study of Constructivism

Kamelia Zahra Ardiani* https://orcid.org/0009-0009-9685-605X
Sri Wahyuni https://orcid.org/0009-0007-0642-9923
Ervina Eka Saputri https://orcid.org/0009-0003-0680-2637
Kyla Jessica Veda https://orcid.org/0009-0004-8539-9969
Fauzi Annur https://orcid.org/0000-0002-6480-0766

Affiliation (Bachelor's Degree Program in Islamic Education, Faculty of Tarbiyah, Raden Mas Said State Islamic University Surakarta)

ABSTRACT

Literacy is not only about reading or writing skills, but also the ability to think critically and creatively. 21st century literacy is very important for the younger generation in facing various global challenges in the modern era. This study aims to identify how AI can contribute to improving the quality of 21st century literacy, facing challenges, and understanding the benefits of AI in education. The research method used is qualitative research with a library research approach, with data taken from several sources such as books, articles, and documents in the media. The results show that AI has brought significant changes to the world of education, especially in improving 21st-century digital literacy and the quality of learning in the current era. This can be seen from the way learning takes place in the classroom with digital learning, interactive applications, and adaptive and personalized learning systems. Thus, the use of AI in education can help improve 21st-century literacy, such as digital literacy, numeracy literacy, AI literacy, and communication literacy, by providing adaptive and personalized learning experiences for students. This literacy learning uses constructivism theory, which emphasizes learning from experience and being active so that students can think critically and understand technology well. This makes it easy for teachers to adjust the material according to the needs and learning styles of students, so that the learning process becomes more effective, enjoyable, and relevant to the times.

Keywords: 21st-Century Literacy, Artificial Intelligence in Education, Digital and AI Literacy

Introduction

In the era of the Industrial Revolution 4.0, technological advances are developing rapidly at an exponential rate. Artificial Intelligence is a major factor

* Corresponding author: kameliazahra19@gmail.com

that brings fundamental transformation in every aspect of life, including education. One of the main challenges in the world of education today is how to improve the quality of literacy in the 21st century. Literacy includes not only proficiency in reading and writing, but also the skills to think critically and creatively in an ever-evolving digital environment. 21st century literacy is essential for young people to face a wide range of global challenges in the modern era, including technological developments, changes in the order of life, and the flood of digital information. This era affects the younger generation to need to develop themselves in order to adapt and survive these changes. Due to exponential technological advances, the world of education is one of the most affected by the use of artificial intelligence (Kamaliah et al., 2025).

By reading one can open up the horizon of the world through seriousness in learning and understanding the meaning of the existing text. However, it is necessary to admit that the literacy level in Indonesia is still low. Based on the 2019 Program for International Student Assessment (PISA) survey published by the OECD, Indonesia is ranked 62nd out of 70 countries. These results show that many students still have difficulty understanding reading texts well. Some of the factors that cause the low literacy level in Indonesia include lack of interest in reading, limited access to quality books and learning resources, and lack of support from the surrounding environment in building good reading habits (Aziz & Nursikin, 2023).

In addition, the rapid development of digital technology also brings new challenges in the education sector. Students in this era grow up in a world full of information, but not all available information is trustworthy or beneficial to their development (Zalukhu et al., 2024). Therefore, in addition to basic literacy such as reading and writing, literacy such as digital literacy, numeracy literacy, AI literacy and communication literacy are also very important skills to master. This various literacy will involve the ability to operate technology, understand information critically, and use digital media ethically and responsibly.

AI can also help form a more personalized and adaptive learning system and as a more interactive learning facilitator, where each student can learn according to their own learning style. One of the biggest benefits of AI in the world of education is its ability to create a more adaptive and personalized learning system, AI is able to detect individual learning styles, provide good feedback, and create a more interactive and meaningful learning process (Diantama, 2023).

This article will further discuss the role of AI in improving the quality of literacy in the 21st century, using the theory of Constructivism. This approach is very much in line with AI, as it emphasizes learning that focuses on student activity, experience-based, and student-centered so that it is easy to apply in today's era, where AI also plays a role as an adaptive learning system and an inclusive learning partner, not just a tool. In addition, this article will also review the basics of constructivism, as well as the impact that may arise in the application of AI in education to optimally improve strategies in creating better education systems in the future.

Method

This research uses a qualitative method with a library research approach. Data collection is carried out from various sources such as books, journal articles, and documents relevant to the topics of Artificial Intelligence (AI), 21st century literacy, and constructivism theory. The data obtained was analyzed using content analysis with steps of reduction, classification, and drawing conclusions. By evaluating multiple sources of the literature, the researchers used source triangulation to maintain the validity of the data and ensure that the research findings were more accurate and reliable.

Results

In this fast-moving era, literacy is no longer limited to the ability to read and write. It has evolved into a much more complex, expansive, and profound life skill. We live in an era where every day we are treated to an abundance of information from screens, both educational and misleading. In the midst of this rapid flow of technology, digital literacy is present as an important bridge to 21st century life skills. In the past, just by being able to read and write, a person was considered literate. But today, these skills are no longer adequate. The digital world demands that we not only access information, but also understand it, filter it, and use it wisely. Digital literacy is a skill that everyone must have, in order to remain aware, critical, and responsible in a vast and infinite information landscape (Firmansyah, 2024).

Paul Gilster, who introduced the term *digital literacy*, described it as the skill of understanding and utilizing information in various forms through devices that can be accessed through computer devices (Tim, 2017). Then Syaripudin et al., (2017) added that digital literacy includes the ability to find, evaluate, create, and convey information using information and communication technology (ICT). It is a combination of our ability to skill and our thinking prowess. Thus, a person who is truly "digitally literate" is also those who are cognitively intellectually and ethically wise (Husna & Novita, 2022).

We cannot close our eyes that today's generation grew up in a very different world from previous generations. Our children are no strangers to touch screens, social media, and various digital platforms from a very young age. But the important question is: Have they been equipped with enough understanding to filter out what they see? Have they learned that not everything that goes viral is true, and not everything that is popular is worth believing?

In this context, digital literacy is present as a guardian of common sense. It teaches us not to be easily believed, to ask questions before sharing, and to pause before reacting. Digital literacy trains us to be active and responsible users of technology, not just passive connoisseurs.

Rulli Nasrullah likened digital literacy to a new fundamental skill, on a par with reading and arithmetic. It is not an addition, but an integral part of modern life. So it is not surprising that today's education, both formal and non-formal, must place digital literacy as the main pillar. Education at school, at home, and

even in society, needs to provide space to build healthy and critical digital awareness (Pradana, 2017).

Digital literacy is actually about how we socialize, learn, and shape ourselves in the digital space. The digital world is not only an information space, but also an interaction space. There, humans not only meet data, but also meet others with all their ideas, emotions, and diversity. So, digital literacy is about being a complete human being in cyberspace: still appreciative, still empathetic, keep thinking (Pradana, 2017). Ironically, many feel "enough" just by being able to operate a gadget. In fact, true digital literacy is when a person is able to choose consciously, weigh before acting, and use technology for positive and productive purposes. It's about awareness, not just skill.

21st century education can no longer be based on the old pattern. It must be able to adapt to the times, and provide provisions for the younger generation to be able to think and act intelligently in the midst of change. Schools are not enough to just teach subjects, but also need to teach how to deal with a world full of digital distractions that are simply understood.

By having strong digital literacy, a person will not only be more information-savvy, but also more emotionally and socially mature. He is not easily caught up in hoaxes, not easily provoked by emotions, and does not just share information. He becomes a more sensitive, caring, and responsible person both in the real and virtual worlds.

Finally, in the midst of this increasingly connected but increasingly complicated world, digital literacy is a small path that helps us walk more clearly. He does not make us perfect, but he makes us more vigilant. And perhaps, in today's information-filled age, vigilance is a new form of wisdom.

Discussion

The Basis of Constructivism in Improving Literacy in the 21st *Century*

Constructivism is a theory/learning process that has a constructive nature, both in terms of students' abilities and understanding during the learning process. Because of its constructive nature, it is hoped that students can be more active and their intelligence increases (Suparlan, 2019). According to Hill, constructivism is a stage of building aspects based on the knowledge that has been acquired. Constructivist learning encourages students to contribute to learning activities in the classroom. Constructivist learning theory considers that learning is not only an activity carried out by a person, but also a process by a person to form and develop the knowledge he obtains from his own experience (Lathifah et al., 2024). With this theory, students not only passively receive knowledge from the teacher, but also help students to build their own understanding through the intermediary of interaction and learning experiences.

The Relationship of Constructivism with 21st Century Literacy

The theory of constructivism says that knowledge is built by students through their own experiences, thoughts, and interactions with others, not just conveyed by teachers. In the context of literacy, students not only learn to "read

and write", but also process information, think critically, and make meaning from various existing digital sources. Teachers play the role of a mentor, not an information center, and create an active learning atmosphere that involves cooperation. Students' abilities in digital literacy, numeracy, the use of AI, and communication stem from the way they build knowledge through data and personal experiences. (Fakhri, 2023)

The Role of AI to Improve the Quality of Literacy Education Using Constructivism Theory.

Education in the 19th - 21st Century

Education from the 19th century to the 21st century underwent enormous changes, especially in terms of objectives, teaching methods, technologies used, skills applied and evaluation. The following are the main differences between education in the 19th-20th century and the 21st century:

Table 1. the main differences between education in the 19th-20th century and the 21st century

Aspects	19th-20th Century	21st Century
Purpose	Prioritizing academic grades, basic knowledge.	Prioritizing Competence, creativity, life skills (Yuni et al., 2016).
Method	Active investigation, problem-solving, and decision-making.	Collaborative, interactive between teachers and students, project-based (Achzab & Budiyanto, 2018).
Technology	Books, chalkboards, chalk.	Internet, computers, digital devices.
Skills	Memorization, factual knowledge.	Critical thinking, collaboration, digital literacy.
Evaluation	Written tests, standardized exams.	Projects, portfolios, authentic appraisals.

Artificial Intelligence (AI) has had a significant impact on changes in the world of education, especially in improving the quality of literacy in the 21st century.

Artificial Intelligence

The term "artificial intelligence" (AI) comes from two words, namely *intelligence* which means intelligence, and *artificial* which means something made by humans. Artificial intelligence or AI is a collection of technologies that can improve human capabilities, such as through machine learning. These technologies can process and study raw data, as well as use deep learning to help make decisions. AI works with the help of intricate artificial neural networks.

In the world of computers, artificial intelligence (AI) is a branch of science that focuses on how to make machines or computers capable of thinking and acting like humans. According to John McCarthy, AI is a science and a way of making machines smart, especially by using computer programming (Bapenda, 2016). AI not only executes commands, but is also capable of learning, reasoning, and self-improvement. With AI, machines can mimic human intelligence, which opens up many opportunities to improve various areas of life, such as education and industry.

AI's ability to carry out tasks that could only be done by humans, such as understanding language, recognizing images, and making decisions in complex situations. Because AI's ability is not limited to mimicking human behavior biologically, but rather in imitating human thinking and logic abilities through computer programs. Herbert A. Simon also said that AI is a part of computer science that tries to make computers do things that normally only intelligent humans can do.

Marvin Minsky explained that AI is a science that tries to make machines able to perform tasks that require human intelligence. Arthur Samuel then added, AI is the study of how to make computers learn on their own without having to be given direct instructions (Redaksi Siberkreasi, 2024).

Elon Musk once called AI an extension of the human brain, where computers help us overcome the limitations of our natural abilities. According to Rich and Knight (1991), AI is the study of teaching computers to perform tasks that are currently better performed by humans, so AI tries to imitate the way humans think and turn them into computer programs (Bapenda, 2016).

Pratikno then also explained AI as a technology that can help humans by working like robots, even though it is only in the form of a computer program (Hamdani, 2017). Gaskin said AI is intelligence created by humans and integrated into computer programs so that machines can mimic human behavior. According to McLeod and Schell, AI is an activity that allows machines like computers to behave like humans and do jobs that require human intelligence (Pasla, 2024).

Artificial Intelligence (AI) is a collection of technologies that can improve human capabilities, such as through machine learning. These technologies can process and study raw data, and use deep learning to help make decisions. and in a variety of literatures, AI includes machine learning, neural networks, and decision trees (Habibi & Haryati, 2021).

Michael Henlein and Andreas Kaplan also added that AI is the ability of a system to understand data from the surrounding environment and help complete tasks in a more flexible way (BINUS (Binus University), 2024). In short, AI is a technology that allows machines to learn information from data, identify patterns, and make their own decisions, so that machines can mimic the way humans think and act in various situations.

The Role of AI in Improving the Quality of Literacy Education

Artificial Intelligence (AI) originated from developments in the era of Industry 4.0 and Society 5.0. AI is a combination of computer programs, machine learning, and hardware and software. AI is very helpful in the learning process in the classroom, both for teachers and students, because it can adjust the subject matter according to the abilities and learning methods of each student (Dinata et al., 2024).

Students can benefit from a more personalized and responsive learning experience thanks to AI's ability to facilitate more interactive and adaptive learning. One of the important contributions of AI in the world of education is its ability to create a more adaptive and personalized learning system, AI is able to

detect a person's learning style, provide good feedback, and create a more effective and engaging learning experience (Pebrian & Farhat, 2023).

With the utilization of this technology, each student can learn according to their own style and dexterity. AI can analyze students' learning patterns and provide material recommendations tailored to the needs of each individual. For example, AI-based learning platforms like *Khan Academy* or *Duolingo* have implemented this technology to provide a more interactive learning experience.

AI is able to adjust the difficulty level of the questions based on students understanding, so they don't feel overwhelmed or too easy to learn (Maulana, 2024). AI allows learning to become more personalized and no longer generalized to everyone. By adapting the material and delivery methods to the needs and interests of each student, AI creates a more engaging and relevant learning experience. This makes the process of reading and understanding the material easier and more enjoyable, thus increasing the motivation to learn. With higher motivation and the right materials, learning effectiveness increases, helping students achieve better results.

AI strongly supports distance learning and e-learning by providing an adaptive and personalized online platform. With this technology, students can access subject matter from anywhere without being limited by location, including remote areas, so that education becomes more equitable and easy to reach (Anas & Zakir, 2024). Each student gets lessons that match his or her own way and speed of learning. Because the material can be accessed online, so students don't have to come to class physically and can learn from anywhere. This makes education more equitable, especially for people who live in remote or hard-to-reach areas. With the help of AI, good learning opportunities are no longer limited by place or time.

In addition, AI also plays a role in expanding access to education for students with special needs (disabilities). Technologies such as *speech-to-text* and *text-to-speech* allow a person with a physical disability or learning impairment to still get an equal education. These features make it easier for them to master the subject matter better, so that education becomes more inclusive. Not only that, AI also supports automatic translation which makes it easier for people from various language backgrounds to understand the material more effectively (Ashshidiqi & Wijiastuti, 2020).

With AI, students from various regions or even countries with language differences are no longer hampered in accessing higher quality learning resources. This contributes to the creation of a wider learning environment, where one can interact with peers from different nationalities, cultures and traditions which will broaden their horizons. AI not only helps students, but also teachers. With AI, teachers can more easily find out the problems faced by students directly, so that they can provide timely guidance or teaching and focus more on learning, not just administrative matters.

In the education sector, AI also has the ability to analyze academic data and provide more comprehensive insights for teachers in identifying learning obstacles that may be being experienced by their students. With AI-based systems, teachers can access real-time student performance data and adjust their

teaching methods to be more effective. Thus, learning becomes more directed and can be adjusted to each individual's needs.

In addition, AI will also ease the administrative burden on teachers, such as automated grading systems and academic report generation, so that teachers can concentrate more on guiding and building better interactions with students. AI's ability to conduct data analysis can also assist schools in making policies that are data- and fact-based critically to improve the quality of their education (Herak, 2025).

Artificial intelligence also plays an important role in increasing students' creativity by offering a variety of tools such as generator tools, stories, poems, and word games. AI-based storytelling tools assist students in developing narratives and plots by providing ideas, suggestions, or even dialogues based on specific keywords or themes. Meanwhile, AI in poetry creation will understand structure, rhythm, and rhyme so that it can produce poems that match the given theme or emotion, even adapt the style of famous poets or create something unique.

AI-based wordplay also helps enrich students' vocabulary, diction and understanding of the meaning of words that are complex enough to be understood interactively that will result in critical and creative thinking for a person (Hindra et al., 2024). By utilizing this technology, one will be able to more easily express ideas and improve the quality of their literacy in the 21st century.

Artificial Intelligence also plays an important role when helping a person improve their literacy skills in a way that is more conducive to their willingness and personality. AI can recommend books or articles based on each person's interests, habits, and level of understanding, similar to how a music or movie platform suggests content we like within its platform (Devara et al., 2021). With reading that matches interests, a person will become more motivated and engaged in activities when reading. In addition, AI is also capable of adjusting the difficulty level of reading materials, such as simplifying texts that are too complicated or providing a more challenging and complicated reading for a person. This method will make the impression of reading more fun and effective, because everyone can learn in a rhythm and in the way that is most appropriate for them.

Fred D. Davis (1989) put forward two main factors that influence education in the level of use of (digital) technology: first, the absorption of usability and second, the ease of use. These two factors play an important role in improving digital literacy, because without an understanding that technology can provide benefits and convenience directly, it can cause users to not want to learn and use the latest technology (Wikipedia, 2025). So, in order for someone to be smarter and more accustomed to using technology (digital literacy), it is important to ensure that technology is useful and easy to use, starting from small habits that are done daily.

AI provides educators with access to a wide range of interactive applications, simulations, and digital learning materials that can enrich their pedagogical approaches. Teachers can also utilize AI in designing curriculum and developing teaching materials by increasing the attractiveness of learning and helping teachers stay relevant in teaching the latest learning concepts that can be accepted more easily by students (Arisanti et al., 2024). This makes the teaching

and learning process more lively and interactive, so that students are more motivated to learn.

AI helps teachers stay up-to-date with the latest science and technology developments. With AI, teachers can update subject matter according to trends and needs of the times, so that the concepts taught are easier for students to understand. In addition, AI reduces the administrative burden on teachers, so they can focus more on teaching and interacting with students. With the support of AI, learning becomes more effective, engaging, and relevant in the digital age.

In addition to improving the quality of learning, AI also has an important role in detecting and reducing plagiarism in the academic world, especially in universities. AI technology is able to analyze and compare texts with extensive databases to ensure the authenticity of a work. Platforms like *Turnitin* and *Grammarly* have leveraged this technology to assist students and academics in producing more original and quality writing. With AI, the quality of research and academic writing can be better maintained, while instilling the values of intellectual honesty in the world of Education(The Case HQ, 2025).

AI can also help students improve their writing skills by providing grammar corrections, sentence structure, and recommendations for better vocabulary use. This makes it very possible for students to produce papers that are in accordance with the authorship system in accordance with good academic standards. As generative AI tools like ChatGPT, Gemini, and Claude become more accessible to access, concerns about plagiarism and errors in the presentation of academic work are more worrying than ever.

This can lead to an increase in demand and demand for technology that can protect the honesty of academics and encourage responsible learning habits. With all the advantages of AI, the future of education in Indonesia can become better, inclusive, and relevant to the needs of the times. However, challenges remain, so the use of AI must be done wisely and responsibly.

AI and Constructivism: Creating a More Personalized and Dynamic Learning Environment

AI plays an important role in building a more personalized and interactive learning atmosphere, where students can learn according to their own needs and rhythm, while developing understanding actively and collaboratively. The following are some of the ways AI supports the principles of constructivism in education(Astsaniah et al., 2024) :

1. AI as an Adaptive Learning Facilitator

   With AI, learning can be more in line with the needs of each student. Platforms like Khan Academy and Duolingo tailor the material to students' learning styles, allowing them to learn at a pace that's right for them. This is in accordance with the principle of constructivism which says that students build their own understanding according to their abilities.
2. AI as a Reflective Feedback Giver

   AI provides immediate feedback on students' answers, helping them correct mistakes and understand concepts more deeply. This process also trains students to do self-reflection, which is important in constructivistic learning.

3. AI as a Collaboration Liaison.

   AI can facilitate discussion and collaboration between students. With AI applications, students can share ideas, discuss, and develop mutual understanding, which supports Vygotsky's theory of social learning.
4. AI as a Digital Literacy Guide.

   AI also helps students to be smarter in using information in the digital world. AI trains them to assess credible sources, avoid hoaxes, and write with digital ethics, so they can think critically and ethically in the digital age.
5. AI as a Creative Medium.

   With AI tools like ChatGPT or story generators, students can be creative and experiment. These activities support creative literacy and digital communication, as well as encourage exploration and personal experiences that are in line with the principles of constructivism.

The Impact of Using AI on Students and Teachers in Education

With all the advantages of AI, the future of education in Indonesia can become better, inclusive, and relevant to the needs of the times. However, its implementation also faces some important challenges. One of them is the unequal access to technology, especially in the 3T areas (disadvantaged, frontier, and outermost) which often lack facilities such as internet networks and computer devices. This makes the use of AI difficult and has the potential to widen the education gap.

In addition, many teachers are not familiar or do not have adequate skills to use AI effectively. They need training to be able to use this technology effectively in learning activities. Without sufficient support, AI can actually become a burden, not a solution. The issue of cost is also an obstacle, because the application of AI requires considerable costs for the procurement of devices and training for their use. Schools with limited budgets have difficulty adopting this technology thoroughly. Therefore, support from the government and the private sector is essential so that AI can be accessed equally.

The use of AI involving the collection of students' personal data poses additional challenges related to security and privacy, which must be handled with extreme care to prevent data leaks (Oktavia & Suseno, 2024). AI collects a lot of students' personal information in order to provide appropriate and effective learning. However, if this data is not properly protected, it can be misused or leaked to irresponsible parties. Therefore, data protection must be carried out strictly, for example through sophisticated security systems and clear rules about who can access the data. By maintaining the privacy and security of student data, the use of AI in education can run safely and comfortably. This will make teachers, students, and parents feel confident and calm when utilizing AI technology.

Additionally, an over-reliance on artificial intelligence (AI) technology can hinder students' critical and independent thinking abilities as well as their ability to participate in group discussions. Al can also lead to a lack of creativity and intuition so that it cannot capture the nuances that may be needed in the discussion process. Likewise, the risk of spreading misinformation as a result of Technology Dependence. If not monitored carefully. Al's limitations and errors

can result in inaccurate or potentially misleading content (Mahendra et al., 2024). In addition, there is a risk of a digital divide between learners who have access to the latest technology and those who do not. This can exacerbate educational inequality because disadvantaged students do not get the opportunity to learn with the latest technology. The application of AI in the curriculum is also not an easy thing and requires considerable adjustments. AI can also have an impact on children's mental health and emotional dependence, although AI provides ease in learning, excessive use can have a psychological impact on students. Reliance on AI systems such as tutor chatbots, learning assistants, or automated learning applications can reduce social interaction between learners and decrease empathy skills. Students who interact too often with AI-based systems tend to be more socially passive, less confident when communicating with peers, and at risk of digital isolation. (Kaur & Kovalchuk,S, 2024)

Creating an AI system that can adapt to Indonesia's diverse languages and cultures is a complex and time-consuming task. Therefore, to overcome this problem, careful planning and proper methods are needed. With the right strategy, these challenges can be overcome so that AI can be used optimally to improve the quality of education evenly throughout Indonesia.

Conclusion

In the 21st century, literacy is no longer just about being able to read and write, but about how a person is able to think critically, wisely, and responsibly in using technology. Digital literacy is an important provision so that we are not only users of information, but also creators of useful knowledge.

Through the constructivist approach, the learning process is no longer focused on the teacher, but rather gives students the opportunity to build their own understanding through experience and interaction. In this way, students learn not only "what to know," but also "how to learn and think."

The presence of artificial intelligence (AI) brings a breath of fresh air in the world of education. AI helps make learning more engaging, accessible, and tailored to each student's needs. Teachers are also helped in understanding students' difficulties, designing materials, and assessing learning outcomes more effectively. However, behind this convenience, there are challenges that need to be watched out for such as technology access gaps, data security, the potential for over-reliance on machines, and other negative things.

Therefore, AI should be used wisely as an aid, not a substitute for humans. When digital literacy, constructivistic learning, and AI technology are combined in a balanced manner, education will be able to produce a generation that is intelligent, critical, creative, and ethical in the real world and the digital world.

Acknowledgements

The authors would like to express their deepest gratitude to Raden Mas Said State Islamic University Surakarta, especially the Faculty of Tarbiyah, for their continuous support and academic guidance throughout this research. Our sincere appreciation also goes to the lecturers of the Islamic Education Study Program,

who provided valuable insights and constructive feedback that significantly contributed to the completion of this paper.

We are also indebted to all librarians, digital resource managers, and academic staff who assisted us in collecting references and data for this study. Special thanks are extended to our peers and reviewers who provided thoughtful comments and encouragement during the preparation and revision of this manuscript.

Lastly, we would like to acknowledge the inspiration and moral support from our families and friends, whose motivation has been invaluable during the research and writing process. Their patience and understanding have allowed us to focus and complete this academic work successfully.

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