Rethinking education in the age of AI: The importance of developing durable skills in the industry 4.0

James Hutson [a, *], Jason Ceballos [b]

[a] Lindenwood University, USA
[b] Independent Scholar, USA

ABSTRACT

This article discusses the pressing need to integrate artificial intelligence (AI) into education to facilitate customizable, individualized, and on-demand learning pathways. At the same time, while AI has the potential to expand the learner base and improve learning outcomes, the development of NACE Competencies and durable skills – communication, critical thinking, creativity, leadership, adaptability, and emotional intelligence - must be purposefully integrated in curriculum design now more than ever. Recent studies have shown that AI-driven learning pathways can achieve outcomes more quickly, but this comes at the cost of the development of durable skills. Therefore, traditional student-to-student and student-to-teacher interactions must be prioritized. As such, this study proposes a balanced approach to curriculum design to ensure the best outcomes for learners, where durable skill development is prioritized alongside subject-specific skills and rote memorization. Additionally, the article highlights the need for a combination of Just in Time Training (JITT) approaches, facilitated by AI technology, to reach the implementation of durable skills. The article concludes by questioning how to develop human skills in an increasingly AI-driven education system and emphasizes the importance of curriculum design and traditional learning approaches in creating a cohesive learning experience that develops durable skills in students. It is necessary to recognize that AI-driven education cannot replace the development of human skills, and that traditional interactions play a crucial role in developing these skills.

*Corresponding author: James Hutson
E-mail address: jhutson@lindenwood.edu

1. Introduction

The rise of artificial intelligence (AI) technology has led to significant changes across various aspects of our lives, including education and the workforce (Ali et al., 2023). The use of AI in education has been shown to enhance the speed of learning and make education more accessible (Devi et al., 2022). However, there is a growing concern about the impact of AI on the development of durable skills, such as communication and empathy, which are critical for success in the workforce (Jaiswal et al., 2022; Singh, 2023; Yu et al., 2023). Studies have shown that while AI-driven education can increase the speed of learning, it may decrease the development of transferable skills, which has been primarily achieved through traditional student-to-student and student-to-teacher interactions (Slater & Inagawa, 2019; Therisa Beena & Sony, 2022). These skills must now be integrated into online and distance education where learning pathways driven by AI will become increasingly common to shore up deficits in durable skills. Therefore, there is a need to rethink the current education system to prioritize the development of durable skills to ensure students are well-equipped for the future workforce (Bühler et al., 2022).

The increasing use of AI technology in various industries, such as marketing, advertising, and legal contracts, has led to concerns about the potential impact of AI on the job market (Abrardi et al., 2022; Taecharungroj, 2023). According to a report by Goldman Sachs, up to 300 million full-time jobs worldwide, including two-thirds of jobs in the US and Europe, are at risk of being replaced by generative AI technology (Campello de Souza et al., 2023). The report notes that the impact of AI disruption will be felt most deeply in developed countries, where economies support a large number of white-collar jobs that are more prone to automation. However, the same economists remain optimistic, noting that technological advancement that initially displaces human workers has historically also created employment and economic growth over the long term (Autor, 2022).

The need for durable or transferable skills (previously known as "soft skills") has become increasingly important in the changing job market (Schislyaeva & Saychenko, 2022). The demand for individuals who possess a diverse set of skills, including transferable skills such as problem-solving, critical thinking, and collaboration, is on the rise (Hutson et al., 2022). The importance of these skills is emphasized by the emergence of the concepts of "just-in-time skills" and "expertise on demand" (Kester et al., 2001; McQuillin et al., 2019). These concepts highlight the need for life-long learning and the ability to acquire new knowledge and skills as needed to respond to the ever-changing demands of the job market (Hutson et al., 2023). Therefore, to be successful in the future of work, workers must be able to effectively integrate AI technology and navigate multiple domains of knowledge (Jaine et al., 2021). Creative generalists who can combine their own diverse skillsets with AI's capabilities will be in high demand (Dykstra & Lasscock, 2021). At the same time, AI will also play a crucial role in supporting these same workers in acquiring just-in-time skills and expertise on demand (Zheng et al., 2022). The ability of AI to access vast amounts of information and learn new skills rapidly makes it a valuable tool in the evolving job market. However, the integration of AI into the workforce must be done in a way that prioritizes the development of durable skills and allows workers to effectively navigate the changing job market (Li, 2022).

In order to address these considerations, this article emphasizes the importance of integrating durable and transferable skills into education to equip students with the skills necessary to succeed in an increasingly automated world. While AI can enhance the technical skills of students, it is essential to balance its use with traditional teaching methods to ensure the development of soft skills. The article provides recommendations on how to integrate durable skills effectively into online learning, including identifying important durable skills, mapping them to the course content, offering personalized learning pathways, providing opportunities for practice and application, and evaluating the effectiveness of the approach. Additionally, the article presents research-based strategies that can be leveraged to develop durable skills, such as project-based learning, experiential learning, service learning, and work-based learning. Overall, integrating durable skills into education can have a significant impact on student success in the workforce and in life in the digital age and Industry 4.0.

2. Literature review

The future of education is rapidly changing with advancements in technology and a growing demand for personalized learning (Walkington & Bernacki, 2020). As the education system adapts to meet these needs, there is a growing focus on prioritizing customized and individualized learning experiences that are available on-demand (Fake & Dabbagh, 2020). However, as Cropley (2019) suggest, the development of human skills such as communication, creativity, and problem-solving cannot be solely achieved through technology or textbooks. Instead, interpersonal interactions play a critical role in the development of social, emotional, and cognitive competencies (Ferreira et al., 2020). As such, consideration should be made of the impact of emerging technologies, such as AI, on learner-instructor interactions in online learning environments. While AI systems offer promising opportunities for personalizing learning, automating routine tasks, and providing adaptive assessments, there is limited research on the impact of AI systems on the culture, norms, and expectations of learner-instructor interactions (Seo et al., 2021). Additionally, the findings of Chen et al. (2023) underscore the significance of human interaction in the education system. The study revealed that students who engaged in traditional classroom settings with human interaction were more likely to develop their social skills than students who relied solely on AI-driven education. The authors suggest that the development of soft skills is essential for preparing students for the workforce, as employers often seek employees with a combination of technical and soft skills, which has been confirmed by other studies (Majid et al., 2019). Therefore, educators must be intentional in integrating traditional teaching methods and AI technologies to ensure that students receive a well-rounded education that equips them with both the technical and soft skills necessary for their future success.

Moreover, the study conducted by Kelleher et al. (2015) further supports the argument for the significance of interpersonal interactions in education. According to the authors, interpersonal interactions are crucial for the development of social, emotional, and cognitive competencies that cannot be learned adequately from books or technology (Müller et al., 2021). The findings underscore the importance of incorporating (or at least approximating) face-to-face interactions in the education system, as it can significantly impact students' personal and professional growth. Therefore, educators should seek to strike a balance between utilizing technology and maintaining human interactions in the education system to ensure that students receive the most comprehensive education possible, but now in more innovative ways with the standardization and spread of online education and availability of new technologies.

Another study conducted by Xu et al. (2021) investigated the impact of AI on early childhood education and elementary education. The findings showed that AI-based educational tools can offer a customized and captivating learning experience for students. However, the authors also found that the excessive reliance on AI in education could result in a decline in students' creativity and critical thinking skills. Kasneci et al. (2023) also argue that educators must be cautious in incorporating AI into the classroom and consider the potential negative effects on students' skills. The study highlights the need for a balanced approach in integrating AI into education, where the technology is used as a tool to enhance learning rather than a replacement for traditional teaching methods. Educators need to consider the long-term impact of AI on students' cognitive development and ensure that the technology is utilized to supplement and not replace human interaction in education.

In a study conducted by Seo et al. (2021), the impact of artificial intelligence (AI) on learner-instructor interaction in online learning was analyzed. The study found that while AI systems provide effective support for online learning and teaching, including personalized learning, automating tasks, and powering assessments, their impact on the norms, culture, and expectations of interactions between students and instructors remains unclear. To address this issue, the researchers used Speed Dating with storyboards to analyze the opinions of 12 students and 11 instructors on different AI systems used in online learning. The findings indicate that adopting AI systems in online learning can enable personalized learner-instructor interaction at scale, but it also carries the risk of

violating social boundaries. The study recognized the positive impact of AI systems in improving the quantity and quality of communication, providing personalized support, and enhancing the feeling of connection. However, concerns were raised about responsibility, agency, and surveillance issues. These findings suggest the need to design AI systems that ensure explainability, human-in-the-loop, and careful data collection and presentation to maximize their positive impact while minimizing the negative ones (Seo et al., 2021).

In a recent French study, a group of students were provided with room and board and a stipend to study, but there were no human instructors, and all content was driven and delivered via AI (Anderson, 2017). The results of the study showed that while the speed of learning increased dramatically, durable or transferable skills, previously known as "soft skills," decreased. This finding raises concerns about the efficacy of fully AI-driven education, and the need to balance AI-driven education with traditional teaching methods to ensure that students acquire both technical and soft skills necessary for their future careers. To address the lack of coding talent in France and promote merit-based education, École 42, a teacher-less coding school in Paris, was founded by French billionaire Xavier Niel. The school accepts students based on their performance in a basic online logic test and admits only the top performers, who complete digital projects that are graded by peers. The curriculum is gamified, and students earn correction and wallet points for project corrections and good behavior, respectively. The school is self-organized and peer-to-peer based learning, promoting creativity, collaboration, critical thinking, communication, and initiative. Around 80% of students get jobs before finishing the course, and 100% are employed by the end, demonstrating the success of merit-based and peer-to-peer learning.

As these examples demonstrate, AI-driven education has the potential to revolutionize the way students learn, but caution must be taken in its implementation. On the other hand, while AI systems have shown promise in personalizing learning for students, automating routine tasks for instructors, and powering adaptive assessments, they must be balanced with traditional student-to-student and student-to-teacher interactions. Research has shown that the development of durable or transferable skills, such as communication, creativity, and critical thinking, can only be achieved through human (or approximated) interactions, which must not be sacrificed in the pursuit of technological advancement (NRC, 2012). Moreover, there is a need to intentionally design the education system in a way that prioritizes the development of both technical and so-called "soft" skills (Volger et al., 2018). Studies have also shown that while AI can enhance students' technical skills, it can have a detrimental effect on the development of these creative and interpersonal skills, such as communication and teamwork (Trajtenberg, 2018). Therefore, a balance must be struck between the use of AI and traditional teaching methods to ensure that students acquire both types of skills necessary for their future careers.

Moreover, the point should be made that durable skills development is not deliberately built into most classroom instruction and learning outcomes (Little, 2012). However, as the future of education is expected to be customizable, individualized, and on-demand, learning modules and lessons that are personalized for each student's unique needs and learning style will become increasingly important. Asynchronous learning, which allows students to learn at their own pace and on their own schedule, is also becoming more prevalent. As noted, AI-powered learning pathways can increase the speed of knowledge transfer and reduce time spent on tasks. This can make retooling and reskilling easier and quicker, and potentially more affordable than traditional models of in-person education. Examples such as École 42 in Paris demonstrate that innovative approaches to education that promote creativity, collaboration, critical thinking, communication, and initiative can produce successful outcomes. The school's self-organized, peer-to-peer-based learning model has shown that the development of durable skills can be achieved through innovative teaching methods. Therefore, the education system must not only prioritize the development of technical and soft skills but also consider new and innovative approaches to education that promote the development of durable skills.

3. Recommendations

The integration of AI in education must be approached with caution to ensure that students' durable skills development is not hindered. As demonstrated by Xie et al. (2019), the use of AI in education can have a negative impact on the development of critical thinking and creativity skills. Similarly, Seo et al. (2021) found that the use of AI in online learning can potentially violate social boundaries and raise concerns about responsibility, agency, and surveillance issues. Therefore, it is important to design AI systems that prioritize explainability, human-in-the-loop, and careful data collection and presentation to maximize their positive impact while minimizing any negative effects (Zhao et al., 2021). As the future of education continues to shift towards customizable, individualized, and on-demand learning, the infrastructure must prioritizes the development of essentially non-automatable human skills that approximate student-to-student and student-to-teacher interactions (Tucker, 2012). To achieve this, AI-driven education should be balanced with the simulation of traditional teaching methods to ensure that students acquire both technical and the skills associated with the NACE competencies necessary for their future careers (Bradberry & De Maio, 2019). Moving forward, educators must also ensure that the education system is designed in a way that intentionally builds in durable-skills development into classroom instruction and learning outcomes regardless of the modality. AI can be used to support this effort by providing personalized and engaging learning experiences for students, but it should not replace the need for learning and practicing human interactions in the classroom (Alam, 2022).

As the education system continues to evolve, it is important to incorporate new technologies such as AI in online learning platforms. Bennani et al. (2022) assert that incorporating AI in online learning can offer personalized and adaptive instruction through analysis of student data, leading to better engagement and motivation, and improved learning outcomes. As they note, AI in online learning can offer personalized and adaptive instruction through analysis of student data, leading to better engagement and motivation, and improved learning outcomes. It is clear that AI has the potential to revolutionize the way students learn, providing tailored feedback to each student's needs and learning styles. This personalized approach can lead to more effective teaching practices, making the most of both student and teacher time (Wright et al., 2014).

In both cases, the integration of AI has the potential to improve learning experiences and create a more cohesive and effective approach to education. By utilizing Just in Time Training (JITT) approaches, AI can help learners achieve durable and critical thinking skills (Yilmaz et al., 2022). As pointed out by Chen et al. (2020), AI-based educational tools have a demonstrable track record of providing personalized and engaging learning experience for students. However, the use of AI in education should be approached with caution to avoid any negative impacts on students' creativity and critical thinking skills.

Integrating durable skills into asynchronous courses and customizable learner pathways requires a deliberate approach. Steps that can be taken to address this integration include identifying important durable skills, mapping these skills to course content, providing opportunities for practice and application, offering personalized learning pathways, providing feedback and support, and evaluating the effectiveness of the approach (Kumar et al., 2021).

Furthermore, a balanced approach is necessary to ensure that the benefits of AI are utilized to their full potential while also maintaining the critical human elements of education. It is recommended that the design of AI systems takes into consideration the potential negative impacts on students' creativity, critical thinking skills, and social boundaries. The use of AI in education should be approached with caution, and educators must consider these factors when designing and implementing AI-driven tools. Additionally, it is essential that AI systems ensure explainability, human-in-the-loop, and careful data collection and presentation to maximize their positive impact while minimizing any negative consequences (Seo et al., 2021).

To successfully incorporate durable skills into online learning, it is important to follow some steps. The first step is to identify the durable skills that are important for your learners (Kioupi & Voulvoulis, 2019). It is essential to consider skills such as communication, problem-solving, critical thinking, teamwork, etc. when mapping out the course. Once the durable skills have been identified, the next step is to map them to the course content. Instructors should look for opportunities to incorporate the skills into the learning objectives, assessments, and activities of the course. They can also create specific modules or lessons focused on the development of durable skills. Offering opportunities for practice and application of durable skills is the next important step, which can be done through simulations, case studies, group projects, and other interactive activities to allow learners to develop and apply the durable skills that are critical to their success (Rutherford, 2020). Providing personalized learning pathways is another important step in integrating durable skills into online learning (Zhang et al., 2020). Asynchronous courses and customizable learner pathways offer the opportunity for learners to tailor their learning experience to their needs and interests. Instructors can offer personalized learning pathways that allow learners to choose the durable skills they want to focus on and the pace at which they want to learn. Adaptive learning technologies, micro-credentials, or other forms of personalized learning can be used to achieve this goal (Hughey, 2020). Feedback and support are essential for learners to successfully develop durable skills. Instructors should give regular feedback on learners' progress in developing durable skills and provide support through resources such as coaching, mentoring, or peer-to-peer learning (Krause & Moore, 2022).

Incorporating research-based strategies such as competency-based learning, project-based learning, experiential learning, work-based learning, and service learning can effectively promote the development of durable and transferable skills necessary for students to succeed in the future workforce. These strategies can be tailored to meet the needs and interests of individual learners and can be integrated into both traditional and online learning environments. It is crucial to prioritize the development of durable skills and ensure that AI is used to enhance, rather than replace, traditional teaching methods and the following strategies will assist **(Table 1)**.

> - **Project-based learning** is an effective strategy for developing durable skills. This approach involves students working on real-world projects that require the application of skills, such as critical thinking, collaboration, and creativity (Miller & Krajcik, 2019).
> - **Experiential learning** is another effective strategy for developing durable skills. This approach involves students actively participating in hands-on experiences and reflecting on the skills they developed as a result. It provides opportunities for the development of transferable skills such as problem-solving, critical thinking, and communication (Ramadan et al., 2021).
> - **Service learning** is an effective strategy for developing durable skills, including empathy, leadership, and communication. It involves students participating in community service projects, providing opportunities for students to apply newly acquired skills. Service learning also encourages the development of transferable skills such as teamwork and leadership (Sin et al., 2019).
> - **Work-based learning** is an effective strategy for developing durable skills. This approach involves students participating in internships, apprenticeships, or co-op programs, where they can develop workplace-relevant skills, such as time management and teamwork. Work-based learning has been found to promote the development of

technical and professional skills, as well as the ability to work effectively with others in a professional setting (Stephen & Festus, 2022).

Table 1. Operationalizing Durable Skills Learning

Finally, instructors must evaluate the effectiveness of their approach. Using data and feedback from learners, instructors should determine whether their approach is meeting learners' needs and leading to the development of durable skills. This information can be used to refine and improve the approach over time. In addition to the aforementioned approaches, technology, specifically AI, can also play a crucial role in developing durable and transferable skills. As discussed, AI can be integrated into online learning platforms to offer personalized and adaptive instruction, leading to better engagement and motivation, and improved learning outcomes. Furthermore, AI can automate routine tasks, freeing up instructors' time for more important tasks such as providing feedback and facilitating discussion.

Examples of successful implementation of these strategies can be found in schools and universities that have integrated them into their curriculum, such as High Tech High in San Diego, which uses project-based learning to develop students' problem-solving and critical thinking skills, or New Tech Network, a network of over 200 high schools that implements competency-based learning and project-based learning (Harsma et al., 2021). In addition to these examples, the implementation of these strategies can also be seen in colleges and universities that offer experiential learning opportunities, such as internships and service-learning projects.

It is important to note that the implementation of these strategies may require changes to the traditional educational system, such as a shift in focus from standardized testing to skill development, the adoption of new teaching methods and technologies, and increased collaboration between educators and community partners. However, the benefits of implementing durable and transferable skills development in education can have long-lasting effects on student success in the workforce and in life.

4. Conclusion and Policy Implications

The development of durable and transferable skills is crucial for equipping students with the skills necessary to succeed in an increasingly automated world. The literature review shows that incorporating artificial intelligence (AI) into education has the potential to revolutionize the learning experience, but it should be approached with caution. While AI can enhance the technical skills of students, it can also have a detrimental effect on the development of soft skills, such as communication and teamwork. Therefore, it is essential to balance the use of AI with traditional teaching methods to ensure that students acquire both technical and soft skills necessary for their future careers.

Several research-based strategies can be leveraged to integrate durable skills into education effectively. Competency-based learning, project-based learning, experiential learning, service learning, and work-based learning have all shown promise in promoting the development of these skills. By incorporating these strategies into educational systems, educators can ensure that students are well-prepared for the challenges of the future. This treatment highlights the importance of prioritizing the development of durable and transferable skills and balancing the use of AI with traditional teaching methods. By implementing research-based strategies, educators can equip students with the skills necessary to succeed in an increasingly automated world. The incorporation of these strategies should be a deliberate and continuous process that involves regular evaluation and refinement of the approach..

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Conflict of interest

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