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Significance of Innovative Learning Skills in the Era of Education 4.0

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Abstract: Considering the rapidly evolving technological landscape, innovative learning skills have become indispensable for Education 4.0. Therefore, this paper presents a study aimed at assessing the level of importance and prioritization of innovative learning skills in the context of Education 4.0 among high school students in the UAE. The study utilized a questionnaire survey, distributing 150 questionnaire sets to selected high school students in Abu Dhabi, UAE. Subsequently, the collected data was subjected to statistical analysis using SPSS software. The analysis of data importance revealed noteworthy findings. Specifically, the skills TS1 ("I am familiar with online learning tools used in my school"), OCL1 ("I learn online collaboratively with my classmates"), and TSE1 ("I have confidence in my skills using technology") were identified as of very high importance for the requirements of Education 4.0 among UAE high school students. Regarding the ranking of innovative learning skill groups, the study unveiled that the Self-regulated learning (SRL) group attained the highest rank, boasting a mean score of 4.272. Following closely, the Technology Self-Efficacy (TSE) group secured a mean score of 4.248. In contrast, the Critical thinking skills (CTS) group ranked the lowest, garnering a mean score of 4.128. These rankings indicate that respondents perceive Self-regulated learning skills as the most proficient among the listed domains, while Critical thinking skills are perceived as the least proficient. The findings of this study have the potential to provide valuable insights to the educational community, aiding them in enhancing the skills necessary for Education 4.0.

Keywords: Innovative learning skills, education 4.0

1. Introduction

Significant impact of the industrial revolution on various aspects of life, leading to the development of different societies and industries, labeled as Society 1.0, Society 2.0, Society 3.0, and Society 4.0, corresponding to Industry 1.0, Industry 2.0, Industry 3.0, and Industry 4.0. Education is identified as one of the social subsystems profoundly influenced by these changes, resulting in shifts in its substance, concept, and content (Himmetoglu et al., 2020). Education has undergone four distinct phases - Education 1.0, Education 2.0, Education 3.0, and Education 4.0. Education 1.0 served the agricultural community, where knowledge was imparted by teachers, and learners focused on teacher instructions. Education 2.0 catered to modern society's needs, integrating technology into the learning process. Education 3.0 leveraged technology advancements to meet societal needs, while Education 4.0, designed for the innovation era, empowers students to create and adapt emerging technologies, offering access to vast information and remote learning opportunities (Puncreobutr, 2016).

Education 4.0 necessitates the integration of digital technologies into teaching and learning processes. Teachers play a crucial role in adapting to technological changes and enhancing their competence to meet the demands of Industrial

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Revolution 4.0. Learners in this era must develop a diverse set of skills, such as critical thinking, problem-solving, creativity, communication, collaboration, and technological proficiency, to prepare for the future challenges (Ahmad et al., 2019; Lea, 2020). Education 4.0 has led to a redefinition of traditional concepts like technology, teaching, schools, and teachers, resulting in significant changes in the teaching and learning process (Mansor et al., 2020). This dynamic environment is referred to as an innovation-producing process, where meaning is continually created through innovative methods driven by teams or individuals in response to the evolving educational landscape. The constant input from students further drives technological advancements, making teaching a continuous and innovative process accessible to everyone, regardless of location (Himmetoglu et al., 2020; Dewi et al., 2021). Schools are now globally interconnected, converting traditional classrooms into innovative settings, allowing teaching to be accessible and a source of innovation for all. Thus, innovative learning skills are essential for Education 4.0 due to the rapidly evolving technological landscape. Education 4.0 aims to prepare students for the Fourth Industrial Revolution, where advanced technologies such as AI, automation, and data analytics are transforming industries. To thrive in this era, students must possess innovative learning skills, such as critical thinking, adaptability, and technology proficiency, to effectively navigate, understand, and utilize emerging technologies and information. These skills enable learners to be agile problem solvers, creative thinkers, and lifelong learners, fostering their ability to meet the demands of the future job market and contribute meaningfully to the digital economy.

2. Innovative Learning Skills

In Education 4.0, high school students need innovative learning skills to thrive in the dynamic and technology-driven landscape. With rapid advancements in technology and the Fourth Industrial Revolution underway, traditional education methods may no longer suffice. Innovative learning equips students with essential skills like critical thinking, problem-solving, creativity, and adaptability, empowering them to excel in the digital age and prepare for the challenges of the future job market. Moreover, innovative learning methods promote engagement and personalized learning experiences, catering to diverse student needs and fostering a passion for lifelong learning.

2.1 Technology Skills

Amidst the challenges posed by the COVID-19 pandemic, educational institutions grappled with the task of adapting to alternate teaching approaches, predominantly online learning, due to the closure of physical school facilities and the mandate for students to remain at home. However, the swift shift from traditional classroom dynamics to online modalities allowed minimal time for educators and learners to adequately prepare. Consequently, both students and teachers had to rapidly acquaint themselves with online tools and methods. To effectively integrate online learning into the post-lockdown educational landscape, it is imperative to gauge learners' readiness and perspectives concerning their online learning encounters. This entails adopting an educational approach that centres on learners' needs. Such an assessment is pivotal in refining policies and practices to seamlessly incorporate online learning. Additionally, it is vital to define the term "e-readiness" within the scope of this research. "E-readiness" encompasses two facets: firstly, learners' adeptness with digital tools necessary for proficient online learning, and secondly, their attitudes and past experiences regarding online education. The former reflects learners' technical readiness for online learning, while the latter pertains to their psychological preparedness, influenced by prior experiences and viewpoints, which collectively shape their inclination to partake in online learning. Both dimensions hold equal importance for the success of online learning, as some individuals exhibit reluctance toward this mode despite evidence substantiating its efficacy comparable to traditional in-person learning (Vivolo, 2016).

To harness the potential of pervasive technology, redefining and aligning the learning process is paramount. Sevillano-Garcia and Vazquez-Cano's study (2015) suggests embracing methodologies that leverage new mobile devices, primarily through the use of open educational resources (OERs) distributed via wikis, blogs, mash-ups, podcasts, social software, virtual worlds, personal learning environments (PLEs), massive open online courses (MOOCs), and other emerging online practices. Patrick (2011) emphasizes that unlocking online learning's transformative potential in the K-12 segment requires measures such as establishing virtual learning environments (VLE) and learning management systems (LMS), ensuring students' access to the internet and digital devices, providing student-centric professional development encompassing both online and blended learning, and redesigning assessments to incorporate performance-based evaluations.

In the digital landscape, online learners must exhibit 21st-century skills – critical thinking, creativity, collaboration, communication, and digital literacy – to effectively navigate online learning resources. The learner-cantered approach underscores the importance of nurturing these skills alongside subject-specific knowledge acquisition (Kong et al., 2014). Moreover, educators should be proficient in both online and in-person teaching.

Yet, teaching online diverges significantly from traditional classroom methods. Girardi (2016) identifies three fundamental concepts for enhancing student engagement in online learning: cultivating an online learner community, actively engaging students, and curating resources for an engaging online environment. These strategies counteract the sense of isolation that online learners may experience due to the absence of physical presence.

Barbera et al.'s correlation study (2013) revealed that student satisfaction in higher education online courses was closely linked to social presence, direct instruction, learning content, and course design. Cashion & Palmieri (2002) pinpoint flexibility, content quality, technology access, and communication as pivotal in high-quality online learning for vocational education and training (VET) students. Hodges et al. (2020) emphasize thoughtful design and decision-making for selecting appropriate online formats, particularly during abrupt transitions from offline to online learning. Thus, Bozkurt and Sharma (2020) argue that the term "emergency remote teaching" accurately characterizes the sudden transition to online learning. Hodges et al. (2020) express concerns about the perception that online learning is less effective, despite evidence of its success, due to hasty shifts. Recognizing online learning's permanence, Miller (2014) highlights the necessity of understanding its effective utilization. Given the impact of COVID-19 and potential future disruptions, delving into the nuances of this transition to online learning is imperative.

The closure of physical schools during the COVID-19 pandemic prompted exploration of alternative teaching approaches, prominently online learning (UNESCO, 2020). The rapid transition from in-person to online learning posed challenges, requiring educators and students to swiftly adapt to digital environments. Proficiency in technology skills has become indispensable for effective online learning (Mahmood, 2020). These skills encompass digital tool navigation, online resource access, effective communication, and technology utilization for educational purposes (Kajee, 2014). As schools embraced online learning, learners and educators had to familiarize themselves with tools and techniques essential for successful online participation (Bai & Krishnan, 2020).

The learner-centred approach advocates tailoring instructional strategies and learning experiences to match learners' unique needs, preferences, and prior experiences (Vrasidas & Zembylas, 2003). This approach is particularly vital for online learning, ensuring learners receive support and resources to develop technology skills. By considering learners' readiness and perspectives, educators can design personalized, adaptive learning experiences (Chen & Jones, 2007). Digital literacy, encompassing technology skills, plays a pivotal role in online learning's success. It entails the ability to access, evaluate, and effectively use digital technologies (Bawden, 2008). Digital literacy encompasses information literacy, media literacy, and digital citizenship, enabling learners to critically assess online information, responsibly navigate digital platforms, and engage discerningly with media content (Hague & Payton, 2010).

Learner feedback on online learning experiences is valuable for assessing instructional strategies and tool usability (Sun et al., 2020). Such feedback informs decisions, identifies areas for improvement, and enhances the online learning experience (Phillips & Gilding, 2016). The pandemic underscored the urgency of technology skills in education, especially for online learning. Learners and teachers must master digital tool navigation, online resource access, and effective engagement in digital learning settings. A learner-centered approach, coupled with digital literacy skills, ensures tailored online learning experiences. Gathering learner feedback is essential for continual improvement of online learning strategies. By promoting technology skills, educational institutions empower learners to thrive in the digital education era.

2.2 Online Collaborative Learning Skills

Education constitutes a potent avenue for elevating an individual's caliber and potential (Antony et al., 2015). Particularly in the era of globalization, the continuous enhancement of people's capabilities and potential is imperative. The cultivation of a cadre of high-quality human resources capable of maximizing their aptitude and effectively addressing impending challenges is of paramount importance (Syakur et al., 2020).Leveraging instructional materials is a strategy to optimize classroom time. Online tools serve as vehicles for transmitting messages from senders to recipients, inciting students' cognitive engagement, emotions, attention, and curiosity, thereby facilitating the learning process (Ananga, 2020). The role of media in education transcends mere facilitation; it aims to engender impactful learning experiences, notably through collaborative learning.

Among the student-cantered learning (SCL) paradigms, the collaborative learning model stands out, placing learners at its core (Nasir & Aziz, 2020). Students are expected to actively participate in their learning journey, both individually and within groups. Collaborative learning finds utility across a spectrum of subjects, especially those targeting the refinement of students' interpersonal skills, necessitating collective problem-solving efforts. The ultimate objective of collaborative learning is to instil cooperative abilities in students from an early stage, enabling them to collaboratively tackle challenges (Järvenoja, Järvelä, & Malmberg, 2020). The educational framework in the UAE is meticulously designed to foster students as responsible contributors to their nation's enduring educational progress. The COVID-19 pandemic has led to a significant increase in online learning as face-to-face interactions between teachers and students are restricted, shifting to remote learning from home (Arora & Srinivasan, 2020). This change has impacted the achievement of learning objectives, affecting various aspects of life, including schooling (Daniel, 2020). Collaborative learning is crucial in the educational world to develop students' interpersonal skills, especially during the pandemic, as researchers seek to understand the effectiveness of online learning in improving students' collaborative abilities.

In the era of globalization, education plays a vital role in enhancing individuals' quality and potential (Antony et al., 2015). Continuously developing high-quality human resources capable of realizing their full potential and tackling future challenges becomes essential (Syakur et al., 2020). In education, instructional materials play a crucial role in optimizing classroom time. Online tools are effective in engaging students' minds, emotions, attention, and interest, facilitating the learning process (Ananga, 2020). The use of media in learning extends beyond the learning process itself and aims to foster effective learning, particularly through collaborative learning approaches.

Collaborative learning is a student-centred model that places learners at the heart of the educational experience (Nasir & Aziz, 2020). It involves active engagement among students to collectively construct knowledge, solve problems, and develop critical thinking and communication skills. Online collaborative learning leverages digital technologies and platforms to enable collaboration, communication, and knowledge sharing among students, regardless of their physical locations. Online collaborative learning offers numerous advantages for students, including active participation, diverse perspectives, and improved social interaction and cooperation (Chen & Chang, 2020). Engaging in collaborative activities helps students develop essential skills like teamwork, communication, leadership, and negotiation, highly valued in the digital age (Dillenbourg, 1999). Moreover, online collaborative learning fosters a sense of community and support, creating a shared learning experience that enhances emotional well-being (Sun et al., 2008). To excel in online collaborative learning, students must develop specific skills such as effective communication, active listening, providing constructive feedback, negotiation, time management, and collaboration in diverse teams (Hernández et al., 2021). Digital literacy skills, like evaluating online information and technological proficiency, are also crucial for successful online collaboration (Gikas & Grant, 2013). Online collaborative learning relies on educators to create meaningful and challenging tasks aligned with learning objectives. They guide students in collaboration strategies, foster a positive online environment, and facilitate reflection on the process (Baepler et al., 2016; Hrastinski, 2008). This student-centred approach fosters active engagement, knowledge construction, and critical skill development through digital technologies that promote collaboration, communication, and knowledge sharing among students. As students participate in online collaborative learning, they acquire vital skills for the digital age, including teamwork, communication, and problem-solving, contributing to a thriving and connected learning environment.

2.3 Self- Regulated Learning

Enhancing individual skills, reasoning capabilities, and the aptitude to plan actions and learning processes is a central tenet of independent learning (Kuiper-Anne & Pesut, 2016). In the realm of independent learning, students proactively engage in activities that sustain their education, encompassing the application of knowledge, strategy selection, belief adaptation, bolstering learning confidence, and making informed judgments (Schunk & Zimmerman, 2012). Independent learning, as identified by Hadwin, Järvelä, and Miller (2015), cultivates student motivation and a proactive approach to studying, enabling them to become self-governing agent's adept at steering their own learning experiences.

Research conducted by Wong, Baars, de Koning, and Paas (2021) underscores that students are most effective when they undertake independent actions that influence their learning motivation, such as planning their study regimen and reviewing course content. This sentiment aligns with Clark's (2012) assertion that independent learning heightens motivation and academic performance by allowing students to align their learning preferences with their capabilities. Furthermore, Hadwin, Järvelä, and Miller (2015) observe that the inception of independent learning commences with observational learning, progressing to imitation, and ultimately culminating in the development of cognitive patterns and strategies that mirror observed behaviours. The educational framework is strategically designed to foster autonomous learning, empowering students to experiment, take initiative, and harness their innate talents and skills to effectively navigate the learning journey (Castro-Schez, GlezMorcillo, Albusac, & Vallejo, 2021). Schunk and Zimmerman (2012) highlight three pivotal components shaping independent learning: personal attributes encompassing beliefs, behaviors, and physiological experiences; the observable behavior itself; and external factors, including contextual interactions.

As previously mentioned, Winne (2010) introduces four critical stages within the trajectory of independent learning, each nurturing the development of comprehensive learning experiences. These stages involve (a) honing students' task-handling skills, (b) setting objectives through planning, (c) engaging in problem-solving and planning, and (d) fostering reflection on the undertaken work. Syaf, Kuryadinata, and Widiasty (2017) delineate five core indicators within this trajectory: (1) identification of learning needs, (2) selection of optimal learning strategies, (3) active monitoring and management of learning, (4) formulation of learning objectives and targets, and (5) assessment of both the learning process and outcomes. Additionally, in the context of online learning platforms, independent learning influences emotional atonements, as excessive independence may hinder interactions and dampen sensitivity to assessing students' emotional states (Zheng et al., 2020).

Self-regulated learning encapsulates students' capacity to take charge of their learning journey through cognitive, metacognitive, and motivational strategies (Kuiper-Anne & Pesut, 2016). It entails active participation in activities that amplify learning, including goal setting, strategic selection, progress monitoring, and requisite adaptations (Schunk & Zimmerman, 2012). Self-regulated learners emerge as active architects of their learning process, adept at steering their cognitive and emotional facets. Extensive research underscores the multitude of advantages offered by self-regulated learning to students. It augments motivation and a proactive enthusiasm for studying as students become active participants capable of orchestrating their own learning (Hadwin, Järvelä, & Miller, 2015). Empowering students with control over their learning process fosters heightened engagement and investment in their educational journey. Furthermore, self-regulated learners are predisposed to perseverance amidst challenges, setting realistic goals, and deploying effective learning strategies (Zimmerman, 2002). A pivotal component of self-regulated learning is metacognition, reflecting the ability to introspect on and oversee one's cognitive processes (Kramarski & Michalsky, 2010). Metacognitive strategies encompass planning, monitoring, and evaluating one's learning progress. Through these metacognitive actions, students identify their strengths and areas requiring improvement, set attainable goals, and make informed choices regarding learning strategies. Cognitive strategies also underpin self-regulated learning, signifying techniques that optimize learning and memory retention (Pintrich, 2004). Organizational strategies, elaboration, and summarization are examples of such cognitive strategies. By employing these techniques, students effectively process and encode information, facilitating comprehension and retention.

In tandem with cognitive and metacognitive strategies, self-regulated learning encompasses motivational strategies (Zimmerman, 2002). Motivation is a pivotal force in learning, influencing students' dedication, perseverance, and involvement. Self-regulated learners deploy strategies like goal setting, self-reinforcement, and cultivation of self-efficacy beliefs to sustain motivation and amplify learning outcomes. Educators wield a crucial role in nurturing self-regulated learning in students. They can impart explicit instruction on learning strategies, embody self-regulatory behaviours, and forge a supportive learning environment that encourages students to embrace learning ownership (Zimmerman, 2008). By fostering self-regulated learning skills, educators empower students to evolve into lifelong learners who can independently manage their educational pursuits. Self-regulated learning is a potent approach, propelling students to become active architects of their educational voyage. Through cognitive, metacognitive, and motivational strategies, students assume control of their learning journey, set objectives, track progress, and make necessary adaptations. Self-regulated learners embody motivation, perseverance, and adaptability in their learning endeavours. Educators' pivotal role lies in cultivating self-regulated learning by providing guidance, support, and platforms for students to develop and apply these indispensable skills.

2.4 Problem Solving Skills

Problem-solving represents a strategic approach to learning that leverages context and motivation to guide students in resolving challenges (Argaw, Haile, Ayalew & Kuma, 2017). Chua, Tan, and Liu (2016) delineate the student problem-solving process across four stages: problem identification, problem analysis, discovery and reporting, and solution evaluation. The impetus for problem-solving has significantly impacted students' skill enhancement and critical assessment of knowledge (Han and Toh, 2019; Chua et al., 2016). Educators have widely embraced problem-solving methodologies to surmount science learning obstacles (Hu, Wu, and Gu, 2017). In the realm of science, problem-solving serves as the linchpin for devising resolutions to everyday predicaments, serving as the bedrock for informed actions and future phases (Laurens, Batlolona, Batlolona & Leasa, 2018). This sentiment concurs with Sukariasih, Tahang, Nursalam, and Fayanto’s (2020) viewpoint that problem-solving within physics education cultivates real-world problem-solving skills. Fitriani, Zubaidah, Susilo, and Al Muhdhar (2020) underscore problem-solving as a cognitive process with profound implications for knowledge construction.

Three studies have hitherto demonstrated the enhancement of students' problem-solving competencies. First, the multifaceted nature of problem-solving, embracing various perspectives (Retnowati, Fathoni & Chen, 2018). Critical thinking is pivotal within the sphere of problem-solving (Rodzalan & Saat, 2015). Second, specific subjects inherently necessitate problem-solving prowess (Schoenfeld, 2016). Even a game-like approach can be adopted to engage with problem-solving (Barzilai & Blau, 2014). Mobile Serious Games-based learning activities have demonstrated the capacity to refine high-level problem-solving skills (Sánchez & Olivares, 2011). Third, problem-solving has been employed to surmount scientific challenges, with conceptual problem-solving methodologies applied to address diverse physics predicaments (Carleo & Troyer, 2017). Hence, the implementation of problem-based learning amplifies students' learning acumen (English & Kitsantas, 2013).

Over time, problem-solving has evolved into a fundamental skill, systematically instructed, and honed to cater to students' needs (Franestian, Suyanta & Wiyono, 2020). Docktor and Heller (2009) delineate five elements influencing problem-solving skills in the context of science, particularly physics: 1) visualization/problem delineation; 2) science/physics approach; 3) innovative application of scientific/physics principles; 4) mathematical techniques; and 5) logical deductions. Elements such as students' limited experience with intricate problems, educators' hesitancy in guiding instruction, and students' challenges in relating science concepts to daily life significantly impact science problem-solving proficiencies (Wati et al., 2020). Notably, problem-based learning has demonstrated superior effectiveness over non-problem-based approaches in fostering students' problem-solving capacities (Valdez & Bungihan, 2019).

2.5 Critical Thinking Skills

In the twenty-first century, an individual's competencies can be categorized into three key domains: (1) navigating life and career, (2) fostering learning and innovation, and (3) harnessing information media and technology (Trilling & Fadel, 2009). The ability to learn and innovate, thereby effectively addressing real-world challenges, along with the aptitude for critical thinking and problem-solving, are considered foundational for modern education. This perspective gains significance as contemporary challenges continue to evolve in complexity and distinctiveness from those of the past (Putri et al., 2020).

Critical thinking embodies the process of deliberate decision-making through in-depth logic and contemplation (Ennis, 2011). By posing queries, scrutinizing assumptions, adopting multiple perspectives, and methodically traversing thought processes, critical thinkers navigate away from errors. Mayer's insights depict problem-solving as a method or set of mental operations to transition from an existing scenario to a desired outcome. Additionally, Gagne posits problem-solving as the synthesis of existing knowledge with situational context to generate solutions (Foshay & Kirkley, 2003). Consequently, it is evident that problem-solving skills underscore the manifestation of behaviour acquired through learning and prior experience, culminating in effective issue resolution.

The core competencies of critical thinking encompass effective reasoning, systemic thinking, judgment and decision-making, and problem-solving (Trilling & Fadel, 2009). Thereby, an intrinsic connection exists between critical thinking and problem-solving proficiencies. Fundamental problem-solving competencies include: 1) discerning pertinent data, denoting the skill to extract crucial and relevant data from a pool of information to address a problem; 2) devising optimal problem-solving strategies, involving amalgamating data from diverse sources to fashion suitable solutions; 3) contrasting data across diverse formats, spotlighting the ability to discern matching information for potential reversal; and 4) identifying the apt protocol to tackle a given problem (Butterworth & Thwaites, 2013).

Mastery of an individual's or a student's critical thinking and problem-solving abilities necessitates deliberate instruction. While educators anticipate independent learning, the art of learning itself is rarely taught. It is incumbent upon educators to nurture thinking skills over prescribing thoughts (Snyder & Snyder, 2008). Consequently, an apt strategy or model is imperative to structure the learning process within the classroom. Science education equips students with the skills to accumulate data, concepts, and principles through exploratory or inquiry-based activities. In science classrooms, investigative exercises facilitate novel discoveries using the scientific method. For this purpose, students must be consistently engaged with real-world scientific dilemmas. Such challenges can be tailored to enhance thinking skills while fostering more engaging learning experiences.

The essence of critical thinking skills lies in their indispensability within the dynamic and intricate contemporary landscape. These skills empower individuals to navigate the deluge of information, scrutinize its authenticity and relevance, and make judicious choices (Trilling & Fadel, 2009). In an era inundated with misinformation and false narratives, the capacity to think critically is imperative for discerning reliable sources from unreliable ones. Interrogative proficiency is a pivotal facet of critical thinking. Through probing inquiries, individuals unveil assumptions, challenge preconceived notions, and explore diverse perspectives (Ennis, 2011). Critical thinkers approach problems with a spirit of curiosity, delving into the underlying intricacies and dimensions.

Assumption analysis forms another integral tenet of critical thinking. Critical thinkers remain cognizant of the assumptions underpinning arguments, assertions, or beliefs, critically assessing their validity and reliability (Ennis, 2011). This equips them to detect potential biases, fallacies, or gaps in reasoning, facilitating a comprehensive and accurate comprehension of the situation. Furthermore, critical thinking embraces the capacity to consider multiple vantage points. Critical thinkers recognize the prevalence of diverse viewpoints on a given issue, striving to comprehend and value contrasting outlooks (Ennis, 2011). This openness to diverse perspectives fosters intellectual humility and enriches the analysis of the problem. Systematic thinking also lies at the heart of critical thinking. It entails structuring and arranging thoughts in a coherent and logical manner (Ennis, 2011). Critical thinkers approach challenges systematically, deconstructing them into manageable components and assessing each facet in relation to the larger picture. This structured approach enables them to discern patterns, connections, and potential solutions with greater efficacy.

In today's rapidly evolving world, nurturing critical thinking skills is essential for personal growth and adaptability. These skills equip individuals to navigate complex predicaments, critically assess information, and make well-informed decisions. Moreover, critical thinking spurs creativity, innovation, and adept problem-solving, enabling individuals to effectively respond to the changing landscape. Educational institutions play a pivotal role in fostering critical thinking skills. By integrating instructional methods and strategies that promote critical thinking, educators empower students to cultivate these indispensable abilities (Trilling & Fadel, 2009). Encouraging open-ended discussions, analysing real-world predicaments, and evaluating diverse viewpoints can significantly enhance students' critical thinking proficiencies. In the contemporary complex and information-rich environment, critical thinking skills remain paramount. They empower individuals to question assumptions, analyse data, embrace various perspectives, and approach challenges

3. Data Collection and Examination

The purpose of the questionnaire survey was to assess the significance of innovative learning skills in the context of Education 4.0 among high school students in the UAE. The innovative learning skills that needed evaluation are outlined in Table 1. Participants, comprising high school students, were requested to express their degree of concurrence with provided statements using a 5-point Likert scale. The response choices ranged from Strongly Disagree to Strongly Agree.

Table 1 - List of innovative learning skills

No.	Statements	Source
Technology skills (TS)		
TS1	I am familiar with online learning tools used in my school.	(Vivolo, 2016),
TS2	I am able to navigate the content on the my school online learning system.	Sevillano-Garcia and
TS3	I can solve technical issues that appear during my online learning.	Vazquez-Cano (2015),

TS4	I have a good experience in using online learning.	Patrick (2011), Girardi (2016)
TS5	I can easily do my learning tasks online.	
Online collaborative learning skills (OCL)		
OCL1	I learn online collaboratively with my classmates.	Antony et al. (2015), Syakur et al. (2020), Ananga, (2020), and Nasir and Aziz (2020)
OCL2	I discuss the lessons with my peers using online learning platforms.	
OCL3	I interact with my classmates online to talk about our classes.	
OCL4	I request my friends through online tools to get help in my study.	
OCL5	I discuss with my classmates about our course materials online at school.	
Self-regulated learning (SRL)		
SRL1	I depend on myself to do my assignments.	Kuiper-Anne and Pesut (2016), Schunk and Zimmerman (2012), Hadwin, Järvelä, and Miller (2015), and Syaf, Kuryadinata, and Widiasty (2017)
SRL2	I can learn independently.	
SRL3	I am able to enhance my knowledge using my learning skills.	
SRL4	I set objectives for my study to achieve.	
SRL5	I do assessment for my learning outcomes.	
Problem-solving skills (PSS)		
PSS1	I am able to identify my learning problems.	Docktor and Heller (2009), Chua, Tan, and Liu (2016), Hu, Wu, and Gu (2017), and Laurens, Batlolona, Batlolona and Leasa (2018)
PSS2	I have the skills to find solutions for my learning obstacles.	
PSS3	I do evaluation for the solutions of my learning problems.	
PSS4	I am able find solutions for math and physics problems easily.	
PSS5	I do logical conclusions for the problems which I face in my study.	
Critical thinking skills (CTS)		
CTS1	I think critically about my learning challenges.	Trilling and Fadel (2009), Ennis (2011), Foshay and Kirkley (2003), and Butterworth and Thwaites (2013)
CTS2	I can create innovative ideas to enhance my learning.	
CTS3	I think logically about my learning goals.	
CTS4	I think about my learning mistakes from different perspectives.	
CTS5	I think analytically for my learning at school.	
Technology self-efficacy (TSE)		
TSE1	I have confidence on my skills in using technology.	Revythi and Tselios (2019), Sun et al. (2008), Al-Rahmi et al. (2018)
TSE2	I trust my skills to do my online learning tasks.	
TSE3	I have good skills in finding learning resources using the internet.	
TSE4	I have confidence on my skills to do all my online learning requirements.	
TSE5	My technology skills help me to do my online learning tasks successfully.	

Table 1 displays a compilation of 30 innovative learning skills, categorized into six distinct groups or domains: Technology Skills (TS), Online Collaborative Learning Skills (OCL), Self-Regulated Learning (SRL), Problem-Solving Skills (PSS), Critical Thinking Skills (CTS), and Technology Self-Efficacy (TSE). These skills served as the focal components in shaping the questionnaire for this research endeavour, wherein participants were required to employ a Likert scale to indicate their level of agreement.

Utilizing a quantitative approach, data was collected through a questionnaire survey to elicit insights and viewpoints from the targeted respondents regarding the subject of investigation. The questionnaire employed in this study comprised two sections: the initial segment encompassed demographic information of the respondents, while the subsequent part featured a compilation of 30 innovative learning skills deemed significant for Education 4.0. Each skill was assessed using a 5-point Likert scale to gauge agreement, prompting respondents to rank the relevance of these skills within the context of Education 4.0.

The questionnaire survey for this study encompassed the distribution of 150 questionnaire sets among a specific group of high school students in Abu Dhabi, UAE. Analysis of respondent demographics unveiled that most participants were male, accounting for 60.1% of the responses, while the remaining 39.9% identified as female. In terms of age distribution, the largest percentage of respondents fell within the 17-year-old age bracket, representing 42.6% of responses. Following closely, the age group of 18 years constituted 31.3% of responses. Respondents aged 20 years and above constituted 21.0%, while 16-year-olds contributed 15.2% and 19-year-olds comprised 11.6% of the participant pool.

3.1 Reliability of The Collected Data

Initially, the gathered data underwent an analysis of its reliability to ascertain its strong internal consistency. This consistency implies that the items within each construct should exhibit a high degree of interrelatedness, a principle supported by Pallant (2011) and David and Sutton (2012). Reliability pertains to the extent to which research measurements are devoid of random errors and yield consistent outcomes upon repeated measurements of the variable of interest. Cronbach's alpha, a widely utilized reliability measure, evaluates the internal coherence of a measurement scale. To establish satisfactory internal consistency, Cronbach's alpha should surpass 0.7, a guideline endorsed by Joe F Hair et al. (2011), Memon and Rahman (2014), Pallant (2011), and Wong (2013b). Consequently, for assessing the reliability of the research constructs, Cronbach's alpha was employed, with the outcomes presented in Table 2. By scrutinizing the Cronbach's alpha values associated with the constructs, researchers can assess the internal consistency of the measurement scale, thereby ensuring the dependability of the study's obtained results.

Table 2 - Reliability test

Construct	Code	No. of items	Cronbach's Alpha
Technology Skills	TS	5	0.770
Online Collaborative Learning	OCL	5	0.836
Self-Regulated Learning	SRL	5	0.813
Problem Solving Skills	PSS	6	0.873
Critical Thinking Skills	CTS	5	0.836
Technology Self Efficacy	TSE	5	0.833

Table 2 showcases the outcomes derived from evaluating the internal consistency of the constituent items within the research constructs, utilizing Cronbach's alpha. The results unveil that all constructs exhibit Cronbach's alpha values surpassing the recommended minimum threshold of 0.7. This observation affirms their internal consistency and reliability. Among the constructs, Technology Skills (TS) possesses the lowest Cronbach's alpha value at 0.770, still exceeding the 0.7 threshold. Conversely, the construct with the highest Cronbach's alpha value is Technology Self-Efficacy (TSE), registering at 0.833. Collectively, these findings affirm the internal coherence and dependability of all research constructs, instilling confidence in the validity of the study's outcomes.

3.2 Normality of The Collected Data

Data normality refers to a distribution that is symmetric and bell-shaped, representing the population's structure. Deviating from this pattern poses challenges for statistical analysis (Tabachnick & Fidell, 2007; Hair et al., 2010). To assess data normality, various statistical and graphical techniques are employed, including normality probability plots (Normal Q-Q plot), histograms, skewness, and kurtosis. Skewness gauges the symmetry of data distribution, while kurtosis assesses the level of peakiness or flatness in a variable's distribution, identifying if it's excessively peaked or overly flat (Tabachnick & Fidell, 2007). In this study, the examination of data normality employed skewness and kurtosis values. These values were utilized to scrutinize the distribution's normality in the collected data for this research. The outcomes of the skewness and kurtosis tests are presented in Table 3.

Table 3 - Results of skewness and kurtosis analysis

Innovative Learning Skills Code	Kurtosis	Skewness
TS1	2.956	-1.626
TS2	0.653	-1.010
TS3	3.690	-1.415
TS4	1.475	-1.208
TS5	2.769	-1.572
OCL1	0.554	-1.169
OCL2	2.056	-1.670
OCL3	0.702	-1.106
OCL4	-0.081	-0.729
OCL5	2.383	-1.256
SRL1	-0.244	-0.903
SRL2	0.246	-0.974
SRL3	1.676	-1.542
SRL4	1.314	-1.487
SRL5	1.759	-1.183
PSS1	0.335	-1.050
PSS2	2.187	-1.528
PSS3	1.270	-1.502

PSS4	3.381	-1.808
PSS5	1.199	-1.426
CTS1	0.542	-1.125
CTS2	2.956	-1.626
CTS3	0.653	-1.010
CTS4	3.690	-1.415
CTS5	1.475	-1.208
TSE1	2.769	-1.572
TSE2	0.554	-1.169
TSE3	2.056	-1.670
TSE4	0.702	-1.106
TSE5	-0.081	-0.729

According to the recommendation of George & Mallery (2010), a distribution is considered symmetrical and suitable for parametric tests when the skewness and kurtosis values fall within the range of -3 to +3, assuming a normal distribution. Based on table 3 results, all the variables in the study fall within this range, indicating that they are normally distributed. This finding is important because it supports the assumption of normality, which is often required for further statistical analyses.

4. Level of Importance of Innovative Learning Skills

In deciding the level of importance of each innovative learning skills toward Education 4.0, this study used mean score decision interval-based approach which is to estimate the uncertainty or variability associated with a mean score or average. Instead of providing a single point estimate for the mean, this approach calculates a range of values (interval) within which the true mean is likely to lie with a certain level of importance. It employed a mean score decision interval based on the works of Ramli, Mohamed, Abdullahi, Jaafar, and Lazim (2017), which yielded the following decision intervals:

- ❖ (1-1.80) = Very low level of importance,
- ❖ (1.81-2.60) = Low level of importance,
- ❖ (2.61-3.40) = Moderate level of importance,
- ❖ (3.41-4.20) = High level of importance, and
- ❖ (4.21-5.0) = Very high level of importance.

Table 4 - Level of importance of innovative learning skills to Education 4.0

Innovative Learning Skills Code	Mean	Level of importance
TS1	4.440	Very high
TS2	4.270	High
TS3	4.200	High
TS4	4.190	High
TS5	3.830	Very high
OCL1	4.400	Very high
OCL2	4.350	Very high
OCL3	4.200	High
OCL4	4.070	High
OCL5	3.980	Very high
SRL1	4.370	Very high
SRL2	4.370	High
SRL3	4.300	Very high
SRL4	4.200	Very high
SRL5	4.120	Very high
PSS1	4.510	High
PSS2	4.260	High
PSS3	4.260	High
PSS4	4.250	Very high
PSS5	4.180	Very high
CTS1	4.270	High
CTS2	4.200	Very high
CTS3	4.190	High

CTS4	4.150	High
CTS5	3.830	High
TSE1	4.440	Very high
TSE2	4.400	Very high
TSE3	4.350	Very high
TSE4	4.070	High
TSE5	3.980	High

Table 4 presents the required skills for education 4.0 which are categorized into six groups: Technology Skills (TS), Online Collaborative Learning (OCL), Self-regulated Learning (SRL), Problem-solving Skills (PSS), Critical Thinking Skills (CTS), and Technology Self-Efficacy (TSE). It reveals that several skills are perceived as highly important, with mean scores indicating "Very high" levels of importance. For example, TS1 ("I am familiar with online learning tools used in my school"), OCL1 ("I learn online collaboratively with my classmates"), and TSE1 ("I have confidence in my skills using technology") received very high mean scores, indicating their significance in the context of innovative learning. Skills related to self-regulated learning (SRL) and problem-solving (PSS) are also highly valued, with many items scoring in the "Very high" level of importance category. On the other hand, some specific critical thinking skills (CTS) and technology skills (TSE) received "High" levels of importance, indicating their relevance but not as highly ranked as other skills. Overall, the table highlights the perceived importance of various innovative learning skills, providing valuable insights for educators and institutions to focus on the most critical areas in their educational programs.

5. Ranking of Innovative Learning Skills

For ranking analysis on the innovative learning skill for education 4.0, it is essential for several reasons such as:

- **Prioritization**: In a rapidly changing world, resources are limited, and we need to prioritize certain skills or aspects over others. Ranking analysis helps identify the most critical skills or factors that will have the most significant impact on achieving our goals.
- **Decision-making**: When making strategic decisions, ranking analysis provides valuable insights into what should be focused on first or where efforts and investments will yield the most significant returns.
- **Resource allocation**: educational institutions and organizations have limited time, budget, and capacity. By conducting ranking analysis, they can allocate their resources more effectively to address the most important areas of improvement or development.
- **Benchmarking**: Ranking analysis allows comparison with peers, best practices, or previous assessments, enabling educators and policymakers to set targets and monitor progress over time.
- **Future-readiness**: In the context of Education 4.0 and preparing students for the future, ranking analysis helps identify the most relevant and essential skills that will equip learners with the tools they need to succeed in the digital age and beyond.

Ranking analysis is conducted on the six groups and are based on the mean score values of each group. If there are two or more group having the same mean value than the rank will be decided on second criteria which is standard deviation score of the individual group. Hence the results of level of importance and ranking are as in table 5

Table 5 - Results of ranking

Code	Innovative Learning Skill Groups/Domains	Averaged Mean score	Averaged Standard Deviation	Ranking
TS	Technology Skills	4.186	0.902	5
OCL	Online collaborative learning skills	4.200	0.919	4
SRL	Self-regulated learning	4.272	0.885	1
PSS	Problem-solving skills	4.222	0.991	3
CTS	Critical thinking skills	4.128	0.940	6
TSE	Technology Self-Efficacy	4.248	0.897	2

Table 5 displays the ranking Innovative Learning Skill Groups or Domains. It indicates that Self-regulated learning (SRL) group is ranked highest with a mean score of 4.272, closely followed by Technology Self-Efficacy (TSE) groups with a mean score of 4.248. Conversely, Critical thinking skills (CTS) group is ranked lowest with a mean score of 4.128. The rankings indicate that respondents perceive Self-regulated learning skills as the most proficient skill group and Critical thinking skills as the least proficient among the listed domains.

6. Conclusion

This study aimed to assess the significance and hierarchy of innovative learning skills for Education 4.0 among high school students in the UAE. The methodology involved distributing 150 sets of questionnaires to selected high school students in Abu Dhabi, UAE. The collected data underwent statistical analysis using SPSS software.The findings regarding importance highlighted key outcomes. Specifically, the skills TS1 ("I am familiar with online learning tools used in my school"), OCL1 ("I learn online collaboratively with my classmates"), and TSE1 ("I have confidence in my skills using technology") were identified as of paramount importance for addressing the demands of Education 4.0 among UAE high school students. Regarding the ranking of innovative learning skill groups, the analysis revealed that the Self-regulated learning (SRL) group garnered the highest rank, achieving a mean score of 4.272. Following closely, the Technology Self-Efficacy (TSE) group achieved a mean score of 4.248. Conversely, the Critical thinking skills (CTS) group attained the lowest rank, with a mean score of 4.128. These rankings underscore respondents' perception of Self-regulated learning skills as the most proficient among the domains assessed, while Critical thinking skills are regarded as comparatively less proficient.

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References

Ahmad, M. K., Adnan, A. H. M., Azamri, N. M., Idris, K. B., Norafand, N. N., & Ishak, N. I. (2019, February). Education 4.0 technologies for English language teaching and learning in the Malaysian context. In Proceedings of the International Invention, Innovative & Creative (InIIC) Conference, Series (pp. 6-16).

Al-Rahmi, W. M., Alias, N., Othman, M. S., Alzahrani, A. I., Alfarraj, O., Saged, A. A., & Rahman, N. S. A. (2018). Use of e-learning by university students in Malaysian higher educational institutions: A case in Universiti Teknologi Malaysia. Ieee Access, 6, 14268-14276.

Ananga, E. O. (2020). Online learning in higher education: Benefits and challenges. International Journal of Scientific & Technology Research, 9(4), 1845-1848

Antony, J., Kumar, M., & Madu, C. N. (2015). Advances in service quality management: Quality in education. In C. N. Madu & C. Kuei (Eds.), Handbook of Total Quality Management (pp. 525-553). World Scientific

Argaw, A.S., Haile, B.B., Ayalew, B.T., & Kuma, S.G. (2017). The Effect of Problem Based Learning (PBL) Instruction on Students' Motivation and Problem-Solving Skills of Physics. Eurasia Journal of Mathematics, Science and Technology Education, 13(3), 857-871.

Arora, A. K., & Srinivasan, R. (2020). Impact of pandemic COVID-19 on the teaching–learning process: A study of higher education teachers. Prabandhan: Indian journal of management, 13(4), 43-56.

Baepler, P., Walker, J. D., & Driessen, M. (2016). It's not about seat time: Blending, flipping, and efficiency in active learning classrooms. Computers & Education

Bai, Y., & Krishnan, S. (2020). Technology skills for online learning during COVID-19: A perspective from graduate students. Journal of Technology and Teacher Education, 28(2), 355-362

Barbera, E., Clara, M., & Linder-Vanberschot, J. A. (2013). Factors Influencing Student Satisfaction and Perceived Learning in Online Courses. E-Learning and Digital Media, 10(3), 226–235.

Barzilai, S., & Blau, I. (2014). Scaffolding game-based learning: Impact on learning achievements, perceived learning, and game experiences. Computers and Education.

Bawden, D. (2008). Origins and concepts of digital literacy. In Digital literacies: Concepts, policies, and practices (pp. 17-32). Peter Lang

Bozkurt, A., & Sharma, R. C. (2020). Education in normal, new normal, and next normal: Observations from the past, insights from the present and projections for the future. Asian Journal of Distance Education, 15(2), i-x.

Butterworth, J., & Thwaites, G. (2013). Thinking skills: Critical thinking and problem solving. Cambridge University Press.

Carleo, G., & Troyer, M. (2017). Solving the quantum many-body problem with artificial neural networks. Science, 355(6325), 602-606.

Cashion, J.L., & Palmieri, P. (2002). The Secret is the Teacher: The Learner's View of Online Learning. Leabrook, S. Aust: National Centre for Vocational Education Research.

Castro-Schez, J. J., Glez-Morcillo, C., Albusac, J., & Vallejo, D. (2021). An intelligent tutoring system for supporting active learning: A case study on predictive parsing learning. Information Sciences, 544, 446-468.

Chen, C. M., & Jones, K. T. (2007). Blended learning vs. traditional classroom settings: Assessing effectiveness and student perceptions in an MBA accounting course. The Journal of Educators Online, 4(1), 1-20

Chen, Y., Wang, Y., & Chen, N. S. (2020). A Structural Model of Innovative Learning Skills, Learning Sustainability, and Academic Performance for College Students. Sustainability, 12(6), 2485. doi:10.3390/su12062485

Chua, B.L., Tan, O.S., & Liu, W.C. (2016). Journey into the problem-solving process: cognitive functions in a PBL environment. Innovations in Education and Teaching International.

Clark, I. (2012). Formative Assessment: Assessment Is for Self-regulated Learning. In Educational Psychology Review.

Daniel, J. (2020). Education and the COVID-19 pandemic. Prospects, 49(1), 91-96.

Dewi, R., Muslimat, A., Yuangga, K. D., Sunarsi, D., Khoiri, A., Suryadi, S., ... & Iswadi, U. (2021). E-Learning as Education Media Innovation in the Industrial Revolution and Education 4.0 Era. Journal of Contemporary Issues in Business and Government, 27(1), 2868-2880.

Dillenbourg, P. (1999). What do you mean by collaborative learning?.

Docktor, J., & Heller, K. (2009, April). Robust assessment instrument for student problem solving. In Proceedings of the NARST 2009 Annual Meeting, Garden Grove, CA (Vol. 1, No. 1, pp. 1-19).

Encuentra, Eulàlia Hernández, and Elena Barberà Gregori. "Online readiness in universities from disabled students' perspective." Digital Education Review 39 (2021): 172-191.

English, M.C., & Kitsantas, A. (2013). Supporting Student Self-Regulated Learning in Problem- and Project-Based Learning. Interdisciplinary Journal of Problem-Based Learning.

Ennis, R. H. (2011). The nature of critical thinking: An outline of critical thinking dispositions and abilities. In J. B. Baron & R. J. Sternberg (Eds.), Teaching thinking skills: Theory and practice (pp. 9-26). W. H. Freeman

Ennis, R. H. (2011). The nature of critical thinking: An outline of critical thinking dispositions and abilities. University of Illinois, 2(4), 1-8.

Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M.H.I. (2020). The Effects of Integrated Problem‐ Based Learning, Predict, Observe, Explain on Problem-Solving Skills and Self-Efficacy. Eurasian Journal of Educational Research, 85, 45-64.

Foshay, R., & Kirkley, J. (2003). Principles for teaching problem solving. Technical paper, 4.

Franestian, I. D., Suyanta, & Wiyono, A. (2020). Analysis problem solving skills of student in junior high school. Journal of Physics: Conference Series, 1440(1), 012089. doi:10.1088/1742-6596/1440/1/012089

George, D., & Mallery, P. (2010). SPSS for Windows step by step: A simple guide and reference, 17.0 update (10a ed.). Pearson.

Gikas, J., & Grant, M. M. (2013). Mobile computing devices in higher education: Student perspectives on learning with cellphones, smartphones & social media. The Internet and Higher Education, 19, 18-26.

Girardi, T. (2016). Lost in Cyberspace: Addressing Issues of Student Engagement in the Online Classroom Community. In Ruefman D. & Scheg A. (Eds.), Applied Pedagogies: Strategies for Online Writing Instruction (pp. 59-74). Boulder, Colorado: University Press of Colorado.

Hadwin, A. F., Järvelä, S., & Miller, M. (2015). Self-regulated, co-regulated, and socially shared regulation of learning. In Handbook of self-regulation of learning and performance (pp. 65-84). Routledge

Hague, C., & Payton, S. (2010). Digital literacy across the curriculum. Futurelab

Hair Jr., J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). Multivariate Data Analysis (7th ed.). Pearson.

Hair, J. F., Ringle, C. M., & Sarstedt, M. (2011). PLS-SEM: Indeed, a silver bullet. Journal of Marketing Theory and Practice, 19(2), 139-152

Han, H., Moon, H., & Lee, H. (2019). Physical classroom environment affects students' satisfaction: Attitude and quality as mediators. Social Behavior and Personality: an international journal, 47(5), 1-10.

HIMMETOGLU, B., AYDUG, D., & BAYRAK, C. (2020). Education 4.0: Defining the teacher, the student, and the school manager aspects of the revolution. Turkish Online Journal of Distance Education, 21(Special Issue-IODL), 12-28.

Hodges, C., Moore, S., Lockee,B., Trust, T., & Bond, A. (2020). The Difference between Emergency Remote Teaching and Online Learning. EDUCAUSE Review.

Hrastinski, S. (2008). What is online learner participation? A literature review. Computers & Education, 51(4), 1755-1765.

Hu, Y., Wu, B., & Gu, X. (2017). Learning analysis of K-12 students' online problem solving: a three-stage assessment approach. Interactive Learning Environments, 4820(March), 262-279.

Järvenoja, H., Järvelä, S., & Malmberg, J. (2020). Supporting groups' emotion and motivation regulation during collaborative learning. Learning and Instruction, 70, 101090.

Kajee, L. (2014). Integrating digital skills in an e-learning strategy. International Journal of Education and Development using Information and Communication Technology, 10(1), 102-117

Kong, S.C., Chan, T.-W., Griffin, P., Hoppe, U. Huang, R., Kinshuk, Looi C.K., Milrad, M., Norris, C., Nassbaum, M., Sharples, M., & Shengquan Yu. (2014). E-learning in School Education in the Coming 10 Years for Developing 21st Century Skills: Critical Research Issues and Policy Implications. Journal of Educational Technology & Society, 17(1), 70-78.

Kramarski, B., & Michalsky, T. (2010). Investigating preservice teachers' professional growth in self-regulated learning environments. Journal of Research in Science Teaching, 47(6), 670-699

Kuiper-Anne, H., & Pesut, D. J. (2016). Self-regulated learning: A practical guide to developing students' metacognition. Routledge

Laurens, T., Batlolona, F.A., Batlolona, J.R., & Leasa, M. (2018). How Does Realistic Mathematics Education (RME) Improve Students' Mathematics Cognitive Achievement? Eurasia Journal of Mathematics, Science and Technology Education, 14(2), 569-578.

Lea, Q. T. (2020). Orientation for an Education 4.0: A New Vision for Future Education in Vietnam. International Journal of Innovation, Creativity and Change, 11(3), 514, 526.

Mahmood, A. (2020). Investigating the digital divide in remote learning during the COVID-19 pandemic: A case study of disadvantaged students in Pakistan. Information and Learning Sciences, 121(7/8), 562-576

Memon, M. A., & Rahman, M. (2014). Multivariate data analysis using SPSS. LAP LAMBERT Academic Publishing

Memon, M. A., & Rahman, M. M. (2014). Developing marketing mix strategies for tourism industry to attract Japanese outbound tourists. International Journal of Business and Social Science, 5(6), 77-86.

Miller, M. (2014). Is Online Learning Here to Stay? Minds Online: Teaching Effectively with Technology, (pp. 1-18). Cambridge, Massachusetts; London, England: Harvard University Press.

Nasir, N. A. M., & Aziz, A. A. (2020). Implementing Student-Centered Collaborative Learning When Teaching Productive Skills in an ESL Primary Classroom. International Journal of Publication and Social Studies, 5(1), 44-54.

Pallant, J. (2011). SPSS survival manual: A step by step guide to data analysis using IBM SPSS (4th ed.). Open University Press

Pallant, J. (2011). SPSS survival manual: A step by step guide to data analysis using SPSS (4th ed.). Open University Press.

Pallant, J. (2011). SPSS survival manual: A step by step guide to data analysis using SPSS. Allen & Unwin

Pallant, J. (2011). SPSS Survival Manual: A Step-by-Step Guide to Data Analysis Using SPSS. McGraw-Hill Education

Patrick, C. L. (2011). Student evaluations of teaching: effects of the Big Five personality traits, grades and the validity hypothesis. Assessment & Evaluation in Higher Education, 36(2), 239-249.

Phillips, M., & Gilding, T. (2016). Student voice and feedback: Using quantitative and qualitative tools to enhance online learning experiences. Distance Education, 37(1), 85-105

Pintrich, P. R. (2004). A conceptual framework for assessing motivation and self-regulated learning in college students. Educational Psychology Review, 16(4), 385-407

Puncreobutr, V. (2016). Education 4.0: New challenge of learning. St. Theresa Journal of Humanities and Social Sciences, 2(2), 92-97.

Putri, N. S., Walid, R. Q., Fadri, A., & Nafila, R. (2020). The implementation of critical thinking skills: Challenges and strategies. Journal of Talent Development and Excellence, 12(1), 3615-3625

Putri, R. S., Purwanto, A., Pramono, R., Asbari, M., Wijayanti, L. M., & Hyun, C. C. (2020). Impact of the COVID-19 pandemic on online home learning: An explorative study of primary schools in Indonesia. International Journal of Advanced Science and Technology, 29(5), 4809-4818.

Ramli, N., Mohamed, M. S., Abdullahi, I., Jaafar, M. S., & Lazim, Z. M. (2017). Examining the relationships between project management maturity, organizational culture, and project success in a Malaysian government-linked company. International Journal of Advanced and Applied Sciences, 4(8), 89-95

Retnowati, E., Fathoni, Y., & Chen, O. (2018). Mathematics problem solving skill acquisition: Learning by problem posing or by problem solving. Cakrawala Pendidikan.

Revythi, A., & Tselios, N. (2019). Investigating the impact of e-learning on student performance using technology learning self-efficacy as a mediator. Educational Technology Research and Development, 67(2), 363-384

Rodzalan, S.A., & Saat, M.M. (2015). The Perception of Critical Thinking and Problem Solving Skill among Malaysian Undergraduate Students. Procedia - Social and Behavioral Sciences.

Schoenfeld, A. H. (2016). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics (Reprint). Journal of education, 196(2), 1-38.

Schunk, D.H., & Zimmerman, B.J. (2012). Motivation and self-regulated learning: Theory, research, and applications. In Motivation and Self-Regulated Learning: Theory, Research, and Applications.

Sevillano-García, M.L., & Vázquez-Cano, E. (2015). The Impact of Digital Mobile Devices in Higher Education. Journal of Educational Technology & Society, 18(1), 106-118.

Snyder, L. G., & Snyder, M. J. (2008). Teaching critical thinking and problem solving skills. The Journal of Research in Business Education, 50(2), 90.

Sukariasih, L., Tahang, L., Nursalam, L.O., & Fayanto, S. (2020). Description of physics problem-solving in the topic of static fluid: Case study of physics education in Halu Oleo University. Universal Journal of Educational Research.

Sun, A., Chen, X., & Zhang, M. (2020). Online education and its effective practice: A research review. Journal of Information Technology Education: Research, 19, 269-309

Sun, P. C., Tsai, R. J., Finger, G., Chen, Y. Y., & Yeh, D. (2008). What drives a successful e-learning? An empirical investigation of the critical factors influencing learner satisfaction. Computers & Education

Sutton, C., & David, M. (2010). Social research: An introduction. Social Research, 1-680.

Syaf, A., Kuryadinata, H., & Widiasty, T. (2017). Self-Regulated Learning Mahasiswa pada Implementasi Pembelajaran daring Mata Kuliah Kalkulus Vektor. Jurnal Ilmiah Pendidikan Matematika.

Syakur, A., & Sabat, Y. (2020). The Effectiveness of Coopertative Learning (STAD and PBL type) on E-learning Sustainable Development in Higher Education. Journal of Development Research, 4(1), 53-61.

Syakur, A., Musyarofah, L., Sulistiyaningsih, S., & Wike, W. (2020). The Effect of Project-Based Learning (PjBL) Continuing Learning Innovation on Learning Outcomes of English in Higher Education. Budapest International Research and Critics in Linguistics and Education (BirLE) Journal, 3(1), 625-630.

Sánchez, J., & Olivares, R. (2011). Problem solving and collaboration using mobile serious games. Computers and Education.

Tabachnick, B. G., & Fidell, L. S. (2007). Using Multivariate Statistics (5th ed.). Pearson Education.

Trilling, B., & Fadel, C. (2009). 21st century skills: Learning for life in our times. John Wiley & Sons.

UNESCO. (2017). Education for Sustainable Development Goals: Learning Objectives. Rieckmann, M., Mindt, L. and Gardiner, S. (Eds), UNESCO Publishing, Paris, France.

Valdez, J.E., & Bungihan, M.E. (2019). Problem-based learning approach enhances the problem solving skills in chemistry of high school students. Journal of Technology and Science Education, 9(3), 282-294.

Vivolo, J. (2016). Understanding and Combating Resistance to Online Learning. Science Progress (1933), 99(4), 399-412.

Vrasidas, C., & Zembylas, M. (2003). The impact of learner-centered approaches on student teachers' ICT integration: An empirical investigation. Journal of Technology and Teacher Education, 11(3), 423-461

Vázquez-Cano, E., & Sevillano, M. L. (2015). Dispositivos digitales móviles en educación: el aprendizaje ubicuo (Vol. 135). Narcea Ediciones.

Wati, M., Sutiniasih, N., Misbah, Mahtari, S., Annur, S., & Mastuang (2020). Developing of physics teaching materials based on authentic learning to train problem-solving skills. Journal of Physics: Conference Series.

Winne, P.H. (2015). Self-Regulated Learning. In International Encyclopedia of the Social & Behavioral Sciences (Second Edition).

Wong, J., Baars, M., de Koning, B.B., & Paas, F. (2021). Examining the use of prompts to facilitate self‐regulated learning in Massive Open Online Courses. Computers in Human Behavior.

Wong, K. K. (2013b). Partial least squares structural equation modeling (PLS-SEM) in tourism research: A comprehensive review. Tourism Management, 36, 41-60

Zheng, J., Huang, L., Li, S., Lajoie, S.P., Chen, Y., & Hmelo-Silver, C.E. (2020). Self-regulation and Emotion Matter: A Case Study of Instructor Interactions with a Learning Analytics Dashboard. Computers & Education.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. Theory into Practice, 41(2), 64-70