Learning and Challenges in the Era of Industry 4.0 Revolution through Self-Regulated Learning

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Abstract. The rapid global changes brought about by the industrial revolution have led to transformations across various spheres of life, including training management. However, the pace of change in training management lags behind that of the industrial domain, often referred to as the evolution of training management. Changes in training approaches, shifting from pedagogy to andragogy, heutagogy, and cybergogy, pose challenges for trainees, educators, and training institutions. One of these challenges is how to foster and strengthen self-regulated learning (SRL) as a driver of trainees' success in the learning process. SRL generally encompasses three phases: preparation, implementation, and assessment. Each phase involves intricate micro processes within the self-regulated learner, influenced by various factors including motivation, emotions, behavior, time management, cognition, metacognition, executive functions, physical well-being, context management, and academic skills. Educators or presenters act as facilitators in the development of SRL among trainees. Therefore, they are expected to possess SRL skills as well as other competencies, including the ability to embrace and manage ambiguity, foster engagement, nurture a learning disposition, and apply a mindset of open thinking.

Keywords:self-regulated learning, 21st-century skills, industrial revolution.

1 Introduction

Currently, we are living in a rapidly changing world that demands individuals to possess the ability to adapt faster than ever before. The field of human resource management (HRM), particularly in the realm of human resource development (HRD) through training, is not immune to these changes, even though it is considered a conservative domain. The training field has undergone a series of changing approaches, progressing from pedagogy to andragogy, then to heutagogy, and eventually cybergogy, necessitating the adoption of various new skills by educators and learners alike. Changes in training approaches do not occur as swiftly as those in the industrial sector, leading to what is often termed as "evolution" within training, while the industrial sector is characterized by "revolution." These evolutionary stages have been labeled as training evolution 1.0, training evolution 2.0, training evolution 3.0, and

training evolution 4.0. In the following overview, the four approaches to HRD through education and training associated with the management evolution are elaborated upon, drawing partly [1].

Training evolution 1.0 prioritizes the pedagogical approach, where knowledge is transferred from instructors/experts to trainees in a passive manner. The expert serves as the knowledge transmitter, and this model is referred to as "expert-centered." Training evolution 2.0 introduces andragogy, where learning is more active, and trainees engage in formulating solutions and seeking information from various sources. Trainers transition into facilitators. Training evolution 3.0, rooted in heutagogy, emphasizes granting autonomy to trainees, and the internet transforms the expert's role into that of a facilitator within a technology-supported learning environment.

The concept of cybergogy combines pedagogy and andragogy within a virtual environment. This type of training concept leverages computers and the internet to provide enhanced learning experiences, leading to collaborative and autonomous training evolution 4.0. In this era of innovation, training management aims to develop trainees' abilities to navigate societal changes using new technologies [2].

Based on the aforementioned analysis, education and training have evolved from the pedagogical model to andragogy and heutagogy, reflecting a shift from passive knowledge transfer to active and autonomous learning. Within this context, cybergogy emerges, blending pedagogical and andragogical approaches in a virtual environment, with a focus on technology-mediated learning. Education and training 4.0 view cybergogy as a bridge to collaborative and innovative learning, where educators act as facilitators in cultivating trainees' abilities to meet the demands of a rapidly evolving society.

The echoes of the Industrial Revolution reverberate across various sectors, spanning industries, education, and even human resource management. Yet, there are still those who are unfamiliar or have only recently become aware of this concept, necessitating its introduction. Technological advancements have transformed the way humans produce things. The step-by-step journey towards production technologies, distinct from the past, is what is referred to as the industrial revolution. Fundamentally new production technologies have altered working conditions and lifestyles. We are currently in the midst of the fourth industrial revolution, aptly named Industry 4.0, having previously traversed the paths of Industry 3.0, Industry 2.0, and Industry 1.0 (Figure 1). Further explanations about the Industrial Revolution can be found in Zubaidah's writings [1], [3].

The first industrial revolution emerged in the 18th century, utilizing steam power and mechanization in production. The formerly slow process of spinning yarn saw an eightfold increase in speed due to machinery. Subsequently, the second wave emerged in the 19th century with the advent of electricity and assembly-line production, exemplified by Henry Ford's revolution of automobile manufacturing. The 20th century marked the third era with partial automation through the use of memory-based controls and computers. Finally, in the 21st century, Industry 4.0 emerged, integrating information and communication technologies into the production process, erasing boundaries between the physical, digital, and biological worlds. Smart factories with cyber-physical systems and near-total autonomy represent the pinnacle of this evolution.

Each revolution has transformed the way humans live, work, and interact with each other, necessitating swift adaptation. Industry 4.0 has reshaped the working environment based on human quality. Many individuals have lost and will lose their jobs due to the collaboration between humans and machines. Service automation diminishes the need for human services. Author [4] state that higher education in the Industry 4.0 revolution is a rational and energizing path that can transform society for the better. Higher education institutions must be open and prepare new strategies, understanding that risk and innovation are unavoidable. Competing in this ever-changing environment necessitates adequate knowledge. Changes in teaching and learning methods, curriculum content, and roles of educators and learners are required. The logic of the educational system must evolve towards greater personalization.

Source: https://www.renaix.com/industry-4-0-the-fourth-industrial-revolution/
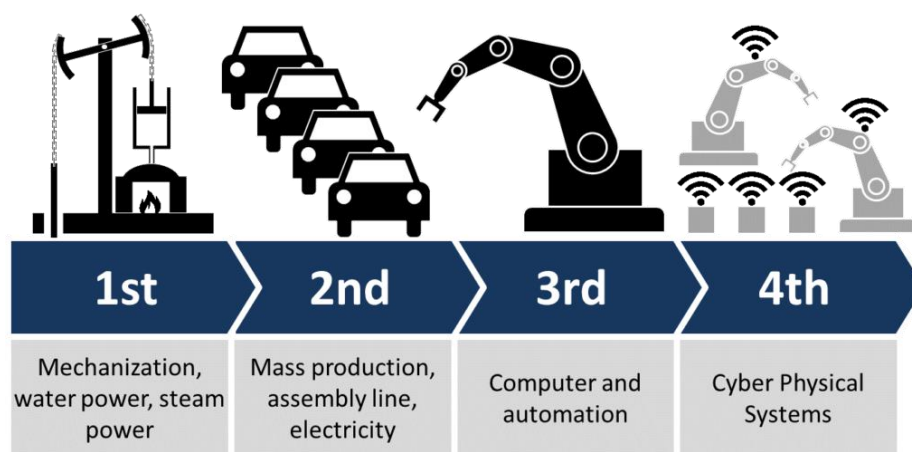
Fig. 1. Development of Industrial Revolution 1.0 to 4.0

The field of education and training has also evolved with Industry 4.0. Rapid changes in knowledge require new education and training models for the future. Nevertheless, the readiness of trainers to respond to Industry 4.0 remains uncertain, as does the readiness of higher education institutions to manage convergence, instability, policy changes, possibilities, and ethical issues arising with Industry 4.0 [5]. This relates to adaptation strategies involving technology investment and human connectivity, building digital resilience, and institutional capacities in digital governance and accountability. Adaptation is crucial in creating an environment that allows trainees, academics, and practitioners to overcome barriers, imagine, innovate, create, and collaborate, developing a 4.0 ecosystem aligned with institutional contexts. This stimulates greater human connectivity through employee exchanges and, at the school level, student and staff exchanges facilitated by global and regional networks and consortia of higher education institutions. This integration combines spiritual, ethical, and moral values, national identity, and societal connections through curricula and technology transfer, while considering the benefits and risks posed by the Fourth Industrial Revolution [6].

Based on the aforementioned issues, this research aims to investigate how Self-regulated Learning can serve as a learning model solution in the era of 4.0. Furthermore, the research seeks to identify the factors influencing the learning process through Self-regulated Learning, the trainer's role in training using Self-regulated Learning, and the challenges in research and learning to empower Self-Regulated Learning.

2 Method

In this research, the researcher employed a type of library research, which involves a series of activities related to the collection of literature data, reading, note-taking, and processing of research materials. Literature research is a type of research in which the object is sought through various literary sources such as books, scholarly journals, magazines, newspapers, and documents. This research differs from other types of research that require observation or interviews for data acquisition. In this study, the researcher sought data objects by exploring literature that was relevant to the raised issues, namely training and self-regulated learning. Data was collected to address the research questions by reading various appropriate references. The data collection technique employed by the author was documentation, which involved studying and searching for data in the form of notes, documents, transcripts, books, magazines, and so forth. This method was used to obtain the necessary data for addressing specific research questions.

3 Result and Discussion

3.1 Result
Based on the literature review conducted, here are some expert opinions on Self-regulated Learning and the factors influencing the learning process:

3.1.1 Self-regulated Learning

Self-regulated Learning and Self-regulated Learner Self-regulated learning (SRL) is not a new concept, yet it remains highly relevant. Various definitions of SRL exist, one of which refers to how trainees become the "masters" of their own learning [7]. This suggests that SRL provides trainees the opportunity to independently direct and manage their learning. SRL entails self-guidance in both mental abilities and performance skills, enabling trainees to transform their mental abilities into skills across various domains, such as academics, sports, music, and health. SRL is a learning process wherein individuals set their learning goals and subsequently strive to monitor, regulate, and control their cognition, motivation, and behavior to align with their objectives and contextual conditions within their environment.

A self-regulated learner is defined as an individual who is actively metacognitive, motivated, and in control of their own learning behavior; hence, an individual's self-regulation can be observed through three main components: (a) metacognitive processes, (b) motivational processes, and (c) behavioral processes [8]. Self-regulated learners plan their own learning processes, set goals for themselves, manage their own learning tasks, monitor their own

learning processes, and continuously evaluate their own learning processes, a concept referred to as metacognition. The first capability, metacognition, drives the self-regulated learner who possesses self-awareness and broad knowledge about the learning process. Apart from metacognition, a self-regulated learner also requires a high level of motivation as the second component. A motivated learner exhibits exemplary effort, perseverance, and tenacity throughout the learning process. The third component, behavioral processes, involves the self-regulated learner selecting and creating an environment conducive to optimal learning. Furthermore, self-regulated learners differ from their non-self-regulated peers in terms of (a) recognizing the connection between self-regulation strategies and learning outcomes, (b) understanding the conducive nature of self-regulation for learning, and (c) employing self-regulation strategies to achieve their learning goals and outcomes.

Self-regulated learners are participants in training who are not passive; rather, they actively engage in learning, are aware of their strengths and weaknesses, and can seek and access needed information for learning during and after the training. Even when faced with unfavorable learning conditions, such as limited learning resources, confusing instructors, or inadequate training conditions and facilities, these conditions are not obstacles for them. They view failures as stepping stones to success [7],[9].

Self-regulated learners develop a systematic and controlled knowledge acquisition process. They possess qualities such as learning resilience, self-confidence, perseverance, critical thinking, and the like; they appear as individuals who are consistently motivated, hardworking, strategically adept, and academically competent. They stand apart from their non-self-regulated peers in terms of emotional resilience, stress levels, and the need for achievement; they are always focused on strong goals and exhibit problem-solving initiative in their learning environment.

SRL can be divided into three phases: planning, performance control, and self-reflection [10], as depicted in Figure 2.
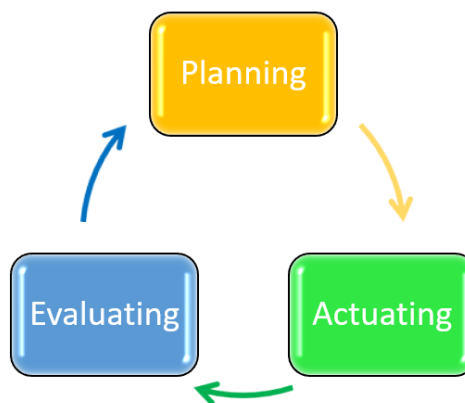

Fig. 2. Self-Regulation Cycle

Phase one involves trainees planning their work for upcoming learning tasks. A self-regulated learner will develop realistic expectations, set learning goals with specific outcomes, and identify plans to maximize success in a particular learning task. In this phase, self-regulated

learners may ask questions such as "Where is the best place for me to complete the work?", "What conditions will pose challenges for me?", and "How should I start?"

Phase two entails trainees engaging in self-performance control, a process involved throughout the learning journey. This phase includes specific strategies such as self-talk and self-monitoring to optimize learning task success. Questions that self-regulated learners might ask themselves in the second stage are "Am I following my plan correctly?", "Am I getting distracted?", and "What strategies can I use to help me stay focused on learning?"

Phase three involves self-reflection at the end of the learning activity. This self-evaluation compares performance outcomes with the initially set objectives. Questions they might ask themselves during self-reflection include "Did I achieve all my goals?", "Which conditions helped me succeed and which hindered me?", and "Which strategies were effective for my learning activities?"

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3.1.2 Factors Influencing the Self-regulated Learning Process

The learning process within an individual involves several components of a dynamic system that continuously occurs and mutually influences other factors within the system [8]. Within each factor, numerous micro-processes are involved, including: positive self-beliefs about one's abilities, positive learning experiences and emotional development, goal orientation management, goal setting in learning; strategic planning, presence, and concentration in learning; effective use of cognitive strategies to organize and encode information for recall, use of metacognitive strategies to evaluate learning and the strength of learning strategies, performance monitoring, effective time management, creation of a pleasant and productive work environment, efficient resource utilization, and seeking assistance when needed.

These micro-processes are involved in self-regulation within the domains of the three phases, namely: motivation, emotion, behavior, time management, cognition, academic skills, and context management, each of which can be developed in accordance with the preparation,

execution, and assessment phases [9]. For example, a self-regulated learner manages themselves in handling motivation and emotions across the three phases of self-regulation. In the preparation phase, they engage in effective goal orientation in relation to success or failure and take responsibility for their own learning. In the execution phase [10], they monitor their learning and implement strategies to maintain motivation and regulate their emotions. In the assessment phase, they reflect on the emotions and motivation experienced during the learning process and utilize this reflection to design better learning goals, motivation, and emotions for the future.

3.1.3 The Role of Instructors in Developing Self-Regulated Learning

Various references highlight how one should act as an instructor in education and training in the era of the fourth industrial revolution or an era where trainees need to be equipped with 21st-century skills. The authors [9], [10] outlines that instructors nowadays need to possess a range of competencies including:

a. Scholarly knowledge,
b. Classroom management,
c. Enthusiasm,
d. Professionalism,
e. Sociability,
f. Clear teaching and assessment,
g. Effective communication,
h. Understanding of inclusion and diversity,
i. Understanding of developmental psychology and group dynamics,
j. Usage of technology and social media, reflective and metacognitive skills,
k. Adaptability to educational contexts,
l. Ability to embrace change,
m. Teamwork, collaboration, and networking skills,
n. Planning and organization,
o. Self-efficacy,
p. Ability to develop problem-solving and critical thinking skills in trainees,
q. Curriculum development skills, and
r. Ability to facilitate more constructive learning.

As instructors, they play a crucial role in fostering self-regulated learning. They provide guidance, create conducive learning environments, and equip trainees with the necessary skills and tools for independent learning and regulation. Instructors' competencies not only contribute to the trainees' immediate learning experience but also empower them with the lifelong skills required to navigate the rapidly changing landscape of the fourth industrial revolution and beyond.

3.2   Discussion

3.2.1   Challenges in Research and Learning to Empower Self-Regulated Learning

Novel and unconventional learning situations necessitate awareness and attention to the preparation, execution, and assessment phases. Despite self-regulated learning (SRL) not being a novelty, its implementation and habituation present distinct challenges. The following

are several challenges in empowering SRL that trainees, trainers, and training institutions may encounter.

3.2.2 Challenges for Trainees

The findings of previous research indicate that in the context and scope of the Fourth Industrial Revolution, the focus of learning should ideally shift entirely from training to the trainees themselves [3]. This can be an "intimidating" situation for trainees who do not possess advanced skills in self-regulated learning (SRL). This is highly relevant to the perspective of a self-regulating learner, initially, trainees may struggle to control their learning, as it requires high self-efficacy and confidence. Indeed, adapting to engage in SRL is not straightforward [11]. However, once they gain more confidence in their self-determined learning abilities, they often dislike reverting to "old" methods. Self-efficacy and confidence are abilities that can be developed and nurtured within learners by effective educators.

Psychological encouragement with an educational nature is pivotal in nurturing intelligence and talents, leading to success in the learning process. One form of such encouragement includes motivation and self-confidence, essential for optimizing learning outcomes along with self-motivation, self-efficacy, and self-evaluation, besides inherent intelligence and talents.

SRL emphasizes the cultivation of self-motivation in trainees [12]. However, most of the conventional learning processes they have experienced offer limited opportunities for trainees to set goals and face challenges aligned with their own abilities. This leads to a lack of motivation to learn new things, resulting in passive behavior during learning activities and ultimately inadequate knowledge acquisition.

Self-efficacy, the belief in one's capability to achieve desired learning targets and goals [12], [13], indeed poses a challenge for trainees. The primary sources of self-efficacy are: 1) learning experiences, 2) feedback from others, and 3) the sense of engagement in learning. However, sometimes these three factors cannot be obtained fully by learners, resulting in relatively low self-efficacy among trainees. Trainees are insufficiently trained and provided with learning experiences to develop self-efficacy, as the prevalent learning process tends to be trainer-centered and lacks experiential problem-solving training. Trainers often believe that trainees are incapable of solving problems, overlooking the fact that this perception is a consequence of the lack of learning experiences geared toward problem-solving processes.

3.2.3 Challenges for Trainers

The results of prior research have stated that not only for trainees, this situation is also somewhat "intimidating" for trainers regarding their role on the "learning stage" in the classroom, as trainers are guides for learning and provide the necessary guidance to trainees [4]. Trainers are also expected to focus on their own SRL skills as it enables them to reflect more on their teaching practices, which in turn leads to improved trainee performance.

Trainers also need to hone their SRL skills due to the ever-changing curriculum, which requires innovation and adaptability [9], [14], [15].Trainers proficient in SRL will be better able to meet the demands of evolving training curricula because they can balance various professional requirements, engage in reflective thinking, and adapt to changes. Many studies

have found a significant relationship between trainers' personal beliefs and their teaching pedagogy. Trainers who are unable to manage SRL and/or lack personal belief that trainees can engage in SRL tend to provide less support for trainees' SRL skill development in the classroom.

One of the most challenging aspects for trainers during training is "letting go" of control over the classroom and allowing trainees to freely express themselves in their learning. However, when we release that control, "amazing" things can happen. Initially, groups undergo a process of self-organization and delegation of responsibilities to each group member. With the guidance of the trainer, they will learn to take control of their collaborative activities, collaborative skills will emerge, and the processes of mutual assistance and information sharing will flourish.

The implementation of SRL aligns with the principles of a heutagogical approach, where learning is self-determined by trainees, which naturally impacts the assessment process. Assessment in the context of heutagogy becomes a metacognitive aspect of the learning process. Assessment within the heutagogical framework does not position trainers as authoritative evaluators but places learners as unique informants about their own learning [16].

3.2.4 Challenges for Educational and Training Institutions

It was discovered in previous research that despite all the positive benefits of implementing SRL, there are several challenges [6]. Facilities, institutional culture, time, and assessment are factors that need to be considered before implementing this approach [17]. Facilitation and culture are related to the approach and design of specific institutions for online education and training [10]. Not all institutional learning cultures are conducive to the SRL approach. Nevertheless, adopting the SRL approach will provide trainees with greater opportunities and enhance their capabilities. Training institutions are challenged to design educational and training systems that focus on developing trainees with various skills, broad knowledge, competence, and the ability to develop their capabilities in various different contexts [18], [19]. Aspects that need to be explored include the connection between 21st-century skills and existing facts, as outlined below [20].

  a. How can trainees become self-regulated learners?
  b. What is the best way to instill critical thinking skills?
  c. How to nurture creativity, enabling trainees to effectively solve new problems?
  d. How to teach collaboration and effective communication skills?
  e. Which aspects of metacognition should be introduced, in which subjects, and at what stage of trainees' development?
  f. How can trainers best teach problem-solving skills, learning in the classroom for life outside?
  g. How can trainers assist trainees in developing self-motivation, for excelling in both indoor and outdoor learning?
  h. How can training institutions instill self-efficacy and positive mindset development? What is the best way for institutions to assist trainees in learning and simultaneously boost their self-confidence? How can organizations help leaders learn how to praise and motivate their employees to achieve their best? How can schools create a

workspace and work environment that encourages trainees' enthusiasm for learning? How can leaders create a comfortable working environment in their offices?

i. Various strategies need to be further identified and implemented to address the challenges of preparing trainees to master 21st-century skills and adapt to the rapidly changing landscape of life.

4. Conclussion

Trainees today are in the era of industrialization, and if trained in a system that specifically focuses on rote memorization and text-centered learning, there is a concern that their ability to be creative, self-regulatory, and reflective may not fully develop. At the same time, the complexity of the 21st-century workforce demands that individuals possess self-motivation and adaptability, along with a range of cognitive and metacognitive skills, critical thinking, creativity, self-regulation, innovation, and knowledge about how they learn.

Our role as trainers is to provide trainees with a safe, open environment that encourages exploration and gives them the freedom to seek knowledge through the concept of andragogy. Educational and training institutions, especially colleges, need strategies to succeed in facing the challenges of Industry 4.0 transformation. This is due to the challenges posed by technological developments like big data and AI, which will replace many processes. Another challenge is that the next generation is more interested in using smartphones and applications. New technologies are changing our lives by creating new, previously unimaginable things and approaching them in novel ways.

The challenges for trainers, presenters, facilitators, and the like, as well as educational and training institutions, lie in creating learning experiences for trainees to develop various 21st-century skills that will enable them to thrive in a rapidly changing world. The principles of SRL need to be specifically developed to provide a broad learning experience based on the concept of learner-centeredness. The SRL approach is more likely to develop the personal skills mentioned above, including the capacity for learning. The development of these 21st-century skills requires specific skills from trainers, and this is one of the challenges.

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