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AN OVERVIEW OF STEM EDUCATION AND INDUSTRY 4.0 FOR EARLY CHILDHOOD EDUCATION IN MALAYSIA

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ABSTRACT

Industry 4.0 relates to physical cyber, the Internet of Things (IoT), knowledge, innovation, and human capital in the current world. These requirements must be accomplished if Malaysia is to grow toward becoming a developed country. While countries such as Malaysia strive to improve STEM education to better prepare students for Industry 4.0, students' interest in the subject begins to wane throughout their schooling, especially in early childhood education, leading them to avoid STEM-related fields while pursuing postsecondary education. The integration of STEM disciplines into school curricula is the most important problem on educators' concerns today. Without a question, how instructors view and implement STEM education in the classroom will have an impact on the quality of STEM education offered to students. Due to these factors, the focus of this study is on early childhood STEM education classroom activities (i.e., Informal Cooperative Learning). Teachers can utilise the ICL activity pattern to develop their own activities that are suited to their individual courses and designed to meet certain objectives. This article discusses Advance Organizer, Intermittent Discussion, and Closure techniques. However, using ICL for STEM education in early childhood education to prepare children for Industry 4.0 has its own set of problems. Divide the students into groups, keep group socialising under control, encourage students to work together in groups, create instructional materials and activities for students, educate students how to report on group projects, and assess student successes are some of the problems. This study offers a thorough evaluation of STEM education and its relationship to the Fourth Industrial Revolution. A systematic review is a summary of the medical literature that uses clear and repeatable techniques to systematically search out, critically evaluate, and synthesise information on a specific topic. This research over all the aspect of STEM in Malaysia and beneficial for the society and Malaysian school as well. Paper does focus on the Malaysian industrial revolution. This paper will be useful to a variety of Malaysian early childhood schools, stakeholders, and policymakers.

INTRODUCTION

Industry 4.0 refers to the physical cyber, the Internet of Things (IoT), knowledge, innovation, and human capital in the modern world. These conditions must be met if Malaysia is to progress toward becoming a developed nation. According to the National Council for Scientific and Research Development, Malaysia will require at least 500,000 scientists and engineers by 2020 (Kamsi et al., 2019). However, according to the most recent data, only 17 percent of that number — or 70,000 people — are actually registered engineers (Vijaindren, 2018). To be effective in meeting the needs of its workforce, a country's higher education system must be tailored to the requirements of Industry 4.0. It is necessary to make changes to a country's educational system in order for it to continue to grow and attract investment (Boev, 2017). Participants in the education market will be shaped by market mechanisms that will have an impact on their performance and productivity (Hoxby, 2007). While countries such as Malaysia strive to improve STEM education, students' interest in the subject begins to wane during the course of their schooling especially starting from early childhood education, causing them to steer clear of STEM-related fields while pursuing postsecondary education.

THE FOURTH INDUSTRIAL REVOLUTION (INDUSTRY 4.0)

In this period of knowledge development known as the fourth industrial revolution (the fourth IR), there are no obvious boundaries between the physical, digital, and biological domains (Philbeck & Davis, 2018). Change and digitization are at the heart of any IR's ability to have an impact. Managers and employees alike must be adaptable if they are to keep up with the rapid pace of change in the workplace. Understanding that risks and changes are unavoidable can help us better prepare for the implementation of a new strategy and plan ahead of time. Organizations that lack the necessary expertise and endurance to compete in a constantly changing environment will find themselves unable to compete (World Economic Forum, 2016a). Workers can grow and evolve in their thinking, ideas, and attitudes over time with the assistance of their supervisors and managers. Knowledge management is a technique that businesses should consider implementing. As a result, in order to improve system performance and operations, it is critical to understand exactly how the Knowledge Management (KM) concept should be propagated and implemented. It has become necessary to develop a new educational paradigm for the future as a result of the rapid evolution of knowledge. The fourth IR is more complex than the third IR due to the increased speed, convergence of diverse technologies, increased widths and depths, as well as scale regression. The fourth IR will assist students in developing the kinds of abilities that they will require in today's world.

According to the World Economic Forum (2016b), the skills required for success in the twenty-first century are divided into three categories: foundational literacy, competencies, and character characteristics. It is essential for educators to ensure that students are provided with the tools they will need to learn for the rest of their lives in order to keep up with the ever-changing world of technology. These tools should include the three 21st century domain skills. To keep up with the rapid pace of technological progress in our country, teaching and learning methods in STEM fields, in particular, will need to be improved.

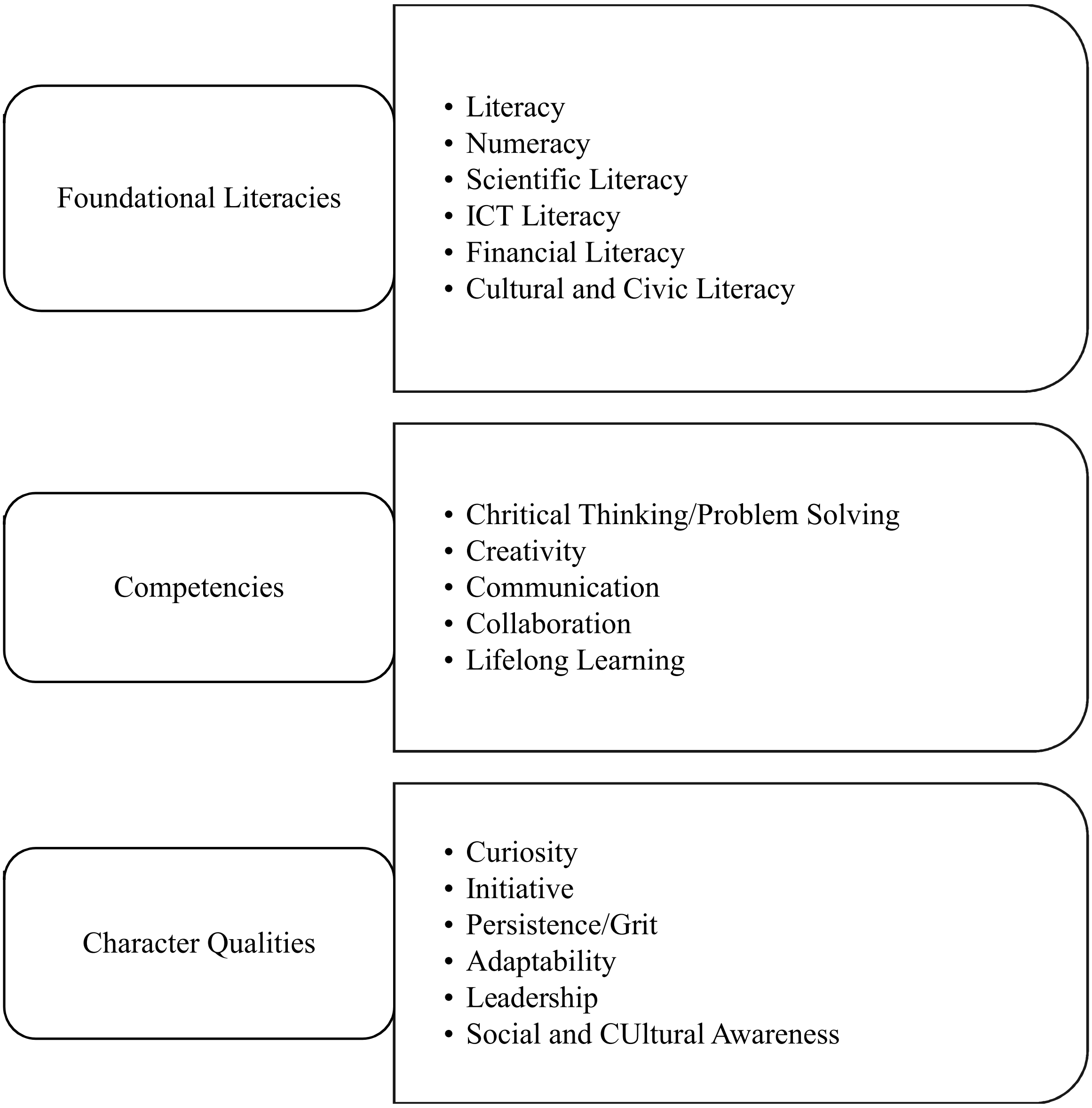

Figure 1: 21st Century Skills (World Economic Forum, 2016b)

The present educational strategy has identified the characteristics that are required for success. In the absence of a well-defined mechanism to assist in the transformation process, it is difficult to achieve just these two characteristics. Increasingly popular in schools are 21st Century Learning techniques, which emphasise the application of Informative Cooperative Learning (ICL) and the holistic education of students (Dunn, 2018; Liu, 2019). In spite of the fact that early childhood educators were required to conduct research as part of their coursework, little guidance was provided on how to actually teach and create a learning environment that is beneficial for children. As a result, many teachers believe that implementing ICL is a challenging task.

STEM COMPETENCES

We can refer to the four pillars of contemporary education as follows, abbreviated STEM: (Science, Technology, Engineering, And Mathematics) (Zdybel et al., 2019):

i. ***Science:***It is possible to use positivist and quantitative methods like observation, experiment, or measurement to try to formulate the regularities that best describe what you are studying in many branches of natural science, including systemic studies of nature and the workings of materials and the physical world (the universe). It is used to refer to a broad range of disciplines, including biology, physics, chemistry, geology, and other related fields.

ii. ***Technology:***Technology is the scientific study of how technological tools interact with human life, society, and the environment. Fundamental concepts in industrial art, engineering, and applied sciences form the basis of this field of study.In contrast to current technologies such as information technology or robotics, the letter T in STEM stands for any tool that is used to assist people or solve problems in their daily lives (not just modern technology like a screwdriver or drill, but also common household instruments like a mixer or knife).

iii. ***Engineering:***To put it another way, engineering is the art of applying scientific knowledge to practical applications, such as the construction of bridges and automobiles, as well as the design and construction of engines and other machinery. This section of the curriculum is the least recognised in pedagogy, and it is generally regarded as inaccessible or even useless for the development of a young child.

iv. ***Mathematics:***Geometry, algebra, and mathematics are just a few examples of mathematical disciplines that concentrate on the investigation of the concept of a number and how it relates to other concepts such as form and space. These concepts, as well as the relationships between them, are described in terms of mathematical concepts.

It has been pointed out previously by Kennedy and Odell(2014) that the components of STEM education are not simply a sum of the specific aspects, and that STEM education cannot be seen as a new label for the traditional ways of teaching biology and mathematics. As a result, there will be no attempt to incorporate or add new layers of engineering and technology to the existing educational standards and curricula. STEM education, on the other hand, is a method of teaching that aims to break down traditional barriers between subjects and refocus teachers' energy and effort on the practical application of knowledge in the process of designing solutions to multidimensional, complex problems using modern tools and technologies.

STEM EDUCATION IN EARLY CHILDHOOD EDUCATION

In a world where the pace of technological change is increasing and the global economy is becoming increasingly competitive, there is an increasing demand for better education. Because of the constant flow of technological advancements around the world, this project is not being driven by that constant flow. Because of this, educational technology, particularly science, has been integrated into the curriculum through the implementation of the education STEM programme (Science, Technology, Engineering, and Mathematics) (Campbell et al., 2018). Science, technology, engineering, and mathematics (STEM) subjects are becoming increasingly important in today's educational system (Science, Technology, Engineering, and Mathematics). Education in STEM fields is more than just a discipline or subject; it is a method of teaching and learning that is project-based, collaborative, and focused on solving real-world problems. Problem-solving, creativity, and innovation are stressed in STEM fields education, which is taught in the classroom (Jabatan Kemajuan Masyarakat, 2019). Our everyday lives are directly influenced by the tools and technological breakthroughs that have been made possible as a result of STEM education. Incorporating STEM concepts into a variety of techniques, such as problem-based learning, project-based learning, and activities based on environmental studies, can assist students in developing higher-order thinking abilities through a student-centered and hands-on approach.

As a result of the Fourth Industrial Revolution (4.0), it also had an impact on the Department of Community Development (KEMAS), particularly in early childhood education. KEMAS is committed to providing high-quality early childhood education that is both relevant and competitive in order to meet the demands of the Fourth Industrial Revolution. With the help of education experts from institutions such as Sultan Idris Education University (UPSI), the Academy of Cultural Arts and Heritage (ASWARA), the

Competency in Early Childhood Education (CECD Group – CACHE UK), and Wilderness School Organization, KEMAS has developed the e-STEM Tabika KEMAS module, which will be implemented across the entire kindergarten under this programme. The module is supplied with interactive practical or simulation training relating to industrial topics such as astronomy, maritime, oil and gas, health, robotics, and automotive in order to motivate children to attend school sessions. The following STEM-related subjects are covered in each state: oil and gas in Sarawak, marine science in Sabah, agrotechpreneurship in Perlis, environmental education in Kedah, aquatic science in Penang, aerospace in Perak, robotics in Kuala Lumpur, automotive in Selangor, aviation in Melaka, military safety in Negeri Sembilan, astronomy in Johor, medical science in Pahang, and oil and gas in Terengganu (Geoscience).

In accordance with the country's higher education development plan 2015-2025, the Malaysian government seeks to prepare the younger generation for the Fourth Industrial Revolution (Industrie 4.0). Malaysia is seeing an increase in the demand for science education and training, as the country strives to advance its economy by the year 2020(Daud et al., 2019). Therefore, they must be able to deal with the challenges that Malaysia is facing as a result of the Industrial Revolution, even if they are not professionals in STEM fields (science, technology, engineering, mathematics) (Rahaman et al., 2018). When it comes to determining the criteria for implementing STEM education, preschool should serve as the starting point. STEM education should begin as early as possible in a child's life because children are more likely than adults in their immediate environment, such as parents and teachers, to ask them questions about anything (Razali & Rahman, 2021).

STEM education instructors must be knowledgeable and skilled in the fields of science, technology, engineering, and mathematics in order to effectively teach the subject. Teacher preparedness was a problem in Malaysia's education system when reforms were implemented, according to the country's education minister. Malaysia's KPM has focused on the issue of educational preparedness as part of its integrated STEM education strategy, which was launched in 2015 (Rahaman et al., 2018). According to Ramli et al. (2017), teachers' preparation for STEM education in the classroom is still insufficient. Only three of the ten teachers who took part in the study were qualified to instruct in the field of stem education. More than half of the ten instructors discovered that they were unqualified to teach in the STEM fields.

A solid foundation in science, technology, engineering, and mathematics (STEM) is required before one can make effective use of the fields of these disciplines (Eckman et al., 2016). Additional assessments should be conducted to determine how well instructors understand how to apply STEM lessons to their students (Thibaut et al., 2018). Science, technology, engineering, and mathematics (STEM) education must be implemented in a manner that emphasises student skill development, and this can only be accomplished through research into the most effective classroom activities. By implementing activities that can stimulate STEM knowledge will develop 21st century students. It is similar with a study conducted by Mustafa et al. (2021) where intervention activities can prepare kindergarten students to be 21st century individual. As the pace of technological change accelerates, society has become increasingly obsessed with technology and its applications. As opposed to instructing children in technology or early childhood engineering, many preschool instructors place a strong emphasis on science and arithmetic (Daud, 2019). The integration of STEM subjects into the school curriculum is the most pressing issue on the minds of educators today. With no doubt, the way teachers perceive and implement STEM education in the classroom will influence the quality of STEM education delivered to students (Bell, 2016). The focus of this research is on early childhood STEM education classroom activities (i.e., Informal Cooperative Learning) as a result of these considerations.

INFORMAL COOPERATIVE LEARNING FOR EARLY CHILDHOOD EDUCATION

Groups of two to four students work together informally to solve questions posed by the teachers over the course of a few minutes to an entire class hour in informal cooperative learning (Johnson et al., 1994; Salim et al., 2019). Using this type of instruction, students can better focus their attention on the content they're learning, while also cultivating a positive attitude and motivation to study, as well as ensuring students' cognitive processing of what they're learning. In ICL, brief exercises and responses to questions posed by the instructor are the rule rather than exception. Such a method allows for the correction of any mistakes or gaps in knowledge that students may have as soon as they occur. As a result, students' learning would be improved overall. It is possible to make use of ICL in a lecture or demonstration environment.

Teachers who use ICL are required to conclude their class sessions with a summary of the material they have discussed. Think pair-share, peer teaching, and jigsaw are just a few of the ICL strategies that could be used in the classroom to promote collaboration (Jusoh et al., 2016). An ICL that uses Ponder-pair-share is one in which the teachersask a question and then instructs the students to think or write about the solution. When this happens, the student turns to a fellow classmate for help in explaining their solution. Finally, each group gives a presentation to the rest of the class about their response. In this approach, students use their own response device (a clicker) instead of the traditional Think-pair-share method (Brame & Biel, 2015). The majority of the time, a professor will ask a conceptual question to which several possible answers can be given. Students think about their response before speaking with a classmate who sits next to them and then vote on it. In order to stimulate class discussion, a teachers presented a graph of students' responses and used it as a catalyst for the exchange of ideas. It is similar with a study conducted by Ismail et al. (2019) where stated that creative activities should be addedto develop teachers' creativity.This method is best suited for large classrooms with many students.

There are two rounds of Jigsaw ICL in this game. Round 1 is referred to as a focus group, and it consists of students working in groups to solve problems (i.e. four students per group). Reading and discussing a new topic in groups helps each person become an expert on the subject matter they are learning about. During the second round, a new group known as task groups is established. The task group is comprised of one representative from each of the expert groups. Their roles alternate in terms of educating one another about the subject matter on which they are each an expert (Brame & Biel, 2015).

Teachers can use the ICL approach to teaching approaches in any scenario, regardless of whether they have additional facilities, a small number of students, a change in classroom setting, or a large number of students. To engage students in the ICL learning process, a variety of active learning activities may be used to help them learn more effectively. The three types of events that can be divided into three categories are the beginning, intermission, and conclusion of the event (Helmi et al., 2019). When using the bookends division strategy, it is extremely simple and quick to put these activities into action. As illustrated in Figure 2, the instructional design for a 50-minute lesson plan based on the division bookends is depicted.

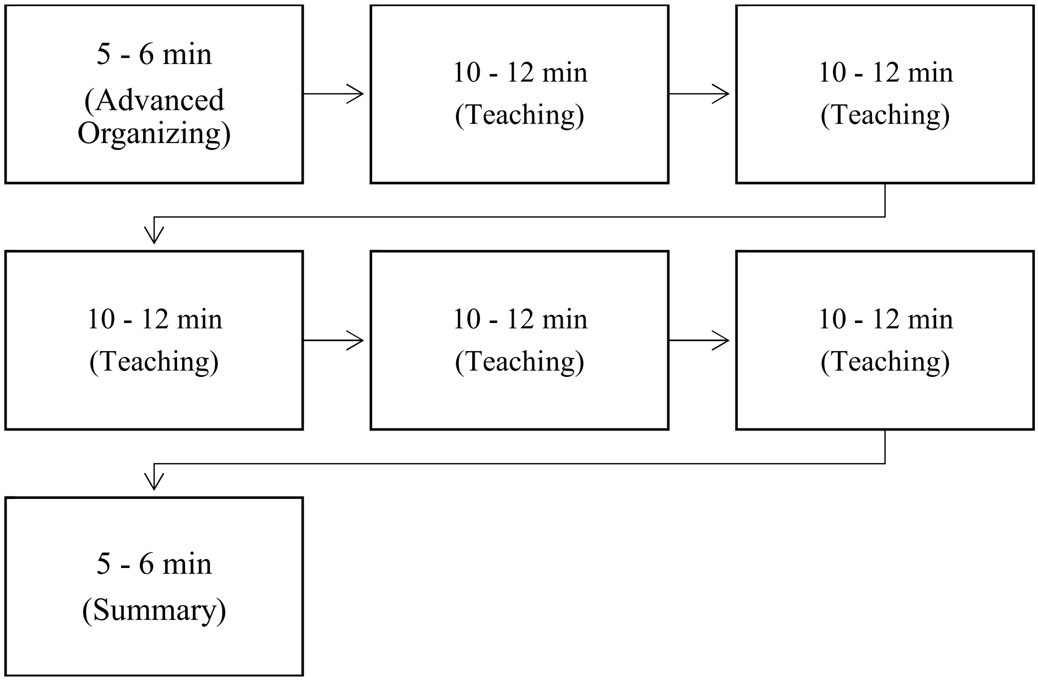

Figure 2: Bookend Division (Smith et al., 2009)

Introduction exercises, such as those shown in Figure 2, which last approximately 5 to 6 minutes and are also known as Advanced Organizing, are the first step in the learning process. This first activity is critical in establishing a positive learning environment and in igniting children's interest in the subject matter. For the purpose of assessing what students already know about the topics they will be studying and what they will be learning, this exercise may be used to assist students in making connections between their prior knowledge and what they will be learning. Opening activities such as opening questions, brainstorming, and creating a concentrated list of ideas are all examples of what is meant by opening activities. After that, there will be a brief lecture. The inclusion of Intermittent Discussions every 10 to 12 minutes into lectures helps to ensure that students are fully engaged in the content. By listening to the students' conversation, the instructor will be able to determine whether or not they have any deficiencies in their understanding of the material they are learning.

They also hope to instil high-level thinking in students and aid them in recalling information that they have studied for a long period of time. Consider the activities of think-pair-share, pair testing, note-checking, and question-and-answer pairs as examples of what can be done. The Closure, which should be a brief summary activity, should take place at the conclusion of the lecture and should last approximately five minutes. Finally, the Closure serves as a checkpoint to ensure that students have retained all of the information, they have learned throughout the course of the class session. Furthermore, it is intended to assist students in preparing for the upcoming lesson at the following meeting. Among other things, there will be a final question, a two-minute paper, and pairs of closure reviews to complete. Almost all of these activities are based on the cooperative learning concepts depicted in Figure 3 of this paper (Mohd-Yusof et al., 2017). Through the use of a pattern, it is possible to ensure that all students are involved in these activities. In these exercises, students begin by creating their own projects from scratch. For the activities to begin, students will be expected to think for themselves, respond to questions, and complete tasks that have been assigned by the teacher. Individual performances are followed by presentations of the students' work by groups or teams of students.

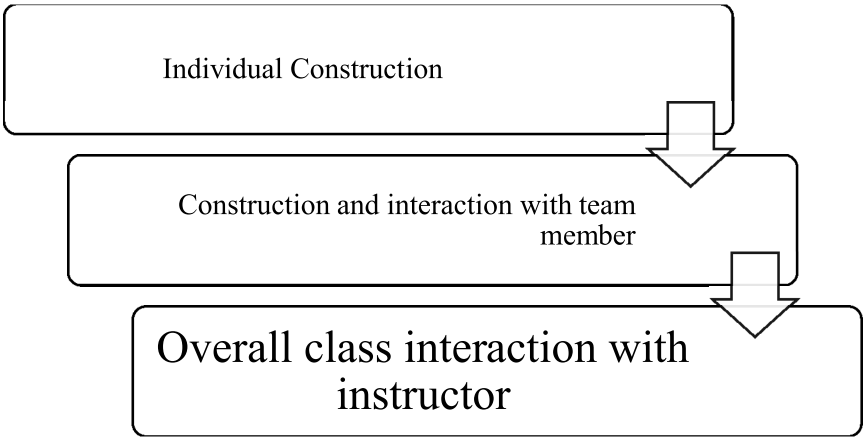

Figure 3: ICL Pattern (Mohd-Yusof, 2017)

When students are given the opportunity to think for themselves at the beginning of the process, they are better able to develop their own ideas, which they can then share with their classmates. The end result will be that the student and their companions will be able to engage in more fruitful conversation. After students have had the opportunity to discuss the topic among themselves or in small groups, the topic is opened up to the rest of the class under the guidance of the teacher. Talking now will be much more interesting and engaging than it was previously. The length of each activity, on the other hand, should be determined by the teacher and should not exceed a specified period of time. Each activity should last no more than 3 to 4 minutes at a time. These activities must be meticulously planned in order to maximise their effectiveness, and students must be made aware of their objectives and outcomes in order for them to understand what they must do in order to reap the benefits of these activities.

CHALLENGES IN IMPLEMENTING COOPERATIVE LEARNING FOR STEM EDUCATION IN EARLY CHILDHOOD

While cooperative learning has been shown to benefit students' learning and achievement, it has also been shown to necessitate a significant amount of time and effort on the part of the teachers to put it into practise.

There are a few common threads that run through all of these difficulties and obstacles:

i. To divide the students into groups (i.e. group size, group member) (Gillies & Boyle, 2010; Wang, 2007; Chiriac & Granström, 2012; Salim et al., 2019)
ii. To keep the group's socialising under control (Gillies & Boyle, 2010; Chiriac & Granström, 2012; Salim et al., 2019)
iii. To encourage students to work together in groups (Gillies & Boyle, 2010; Wang, 2007; Chiriac & Granström, 2012; Salim et al., 2019)
iv. To prepare teaching materials and activities for students (Gillies & Boyle, 2010; Wang, 2007; Chiriac & Granström, 2012; Salim et al., 2019)
v. To teach students how to report on group projects (Chiriac & Granström, 2012; Salim et al., 2019)
vi. To evaluate the accomplishments of students (Gillies & Boyle, 2010; Wang, 2007; Chiriac & Granström, 2012; Salim et al., 2019)

DISCUSSION AND CONCLUSION

Market expansion, globalisation, and emerging competitivenesscontributing to the emergence of the so-called Fourth Industrial Revolution, as well as the concurrent development of the industry4.0 concept and its study area. Steam power, electricity, and the computer era of the 1970s are all examples of technological revolutions that have occurred in the previous century. The Fourth Industrial Revolution is the fourth revolution in the history of industry. For the so-called Fourth Industrial Revolution to take hold, the development of completely automated and intelligent manufacturing that can communicate autonomously with large corporations must take place. In Industry4.0, horizontal and vertical integration of production systems is driven by real-time data sharing and flexible production, which allows for the creation of bespoke products to meet specific customer requirements. During the fourth industrial revolution, there will be a complete automation and digitalization of all manufacturing processes and services in the private sector.The industry 4.0 focuses on increasing human populations' understanding of science, technology, engineering, and mathematics (STEM).

Teachers can use the ICL activity pattern as a framework for developing their own activities that are tailored to their specific courses and intended to achieve specific goals. The preceding section contains techniques that can be used as an Advance Organizer, Intermittent Discussion, and Closure. The activities of ICL are selected or designed in accordance with the anticipated objectives. The principle of constructive alignment advocates for the inclusion of an active verb in the outcomes so that students can develop their understanding at the appropriate level of outcome in the context of their learning environment. Students can benefit from such exercises by using them as learning scaffolds to help them achieve greater levels of success in their studies. The use of computers and robots is replacing a large number of people's jobs, but they are also creating new ones. Computers and robots will never be able to perform the type of creative work required for these emerging vocations. There are a lot of brand-new issues that teachers have to deal with in the future that did not exist before. Therefore, future generations must be brought up with ICL in STEM eduction as a primary concern. This concept is the foundation of the ICL approach, which is the most straightforward and promising method of practise. Essentially, this is a methodical strategy that can be implemented at any time and under any circumstance.

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