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STEM Education

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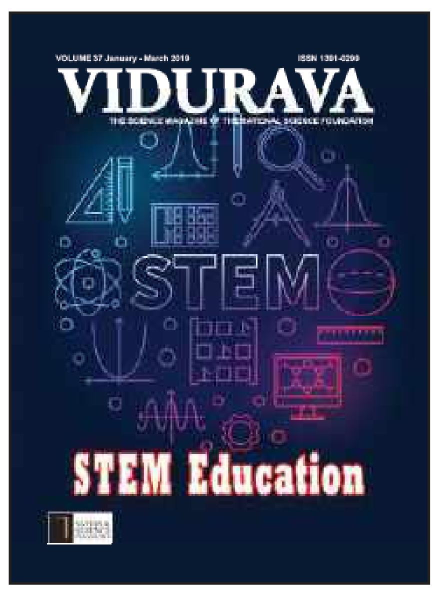

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Editorial

STEM Education in the Context of Traditional Multi-disciplinary Wisdom

The current edition of the NSF Science Magazine is devoted to the theme of STEM (or STEAM) Education, which is apparently a system of education expected to generate innovation skills through integration of the essential elements of science, technology, engineering, mathematics and humanities.

However, it has been claimed that despite massive STEM education reforms in the US, implementation of this system had not realized the expected outcome. On the other hand, it has also been claimed that this cross-disciplinary system of education as practiced in Finland had shown signs of success, although no specific reference is made by them to this system as STEM Education.

In the above context it would be relevant to re-visit briefly Sri Lanka's spectacular technological genius of a bygone era when the country prospered and developed under a feudal system of administration. Although there is no clear understanding of how education and knowledge were inculcated in ancient times (except in *Gurukula* education and the system of apprenticeship training), it is amply clear that a system of 'multi-disciplinary wisdom' had prospered and played a significant role in the development strategy of ancient Sri Lanka. A few technological marvels of that bygone era will illustrate this contention.

According to Henry Parker (1909), the British engineer in colonial Ceylon, who investigated most of Sri Lanka's ancient hydraulic contraptions, the *Bisokotuwa* was a unique water-tight device to control the delivery of water from a massive reservoir to the low lying paddy fields. Interestingly, about the middle of the 19th Century, similar open wells called 'valve-towers' and 'valve-pits' had been built at numerous reservoirs in Europe. These were also meant to regulate the flow of water from reservoirs. Parker (1909), concludes in this context that, *"such also was the function of the bisokotuwa of the Sinhalese engineer, they were in fact the first inventors of the valve pits more than 2100 years ago"*.

The technological brilliance of the ancient Sinhalese engineer, who constructed these contraptions, essentially required multi-disciplinary wisdom comprising a sound knowledge in the disciplines of structural engineering, mechanical engineering, hydraulics, hydrography, hydrodynamics, geology, geophysics, soil science, and the mystique science of astrology.

There are numerous such examples which include the ecosystem based trans-basin 25 mile long Elahera – Minneriya Yoda Ela in the ancient district of Thamankaduwa, and the 50-mile long Jaya Ganga in the Kala Oya Basin taking water to Anuradhapura. R. L. Brohier (1965) commenting on the magnificent engineering feat of the latter, states that *"it verily baffles understanding how a canal of this magnitude could have been planned and executed over a difficult terrain nearly 1500 years ago, which meanders over the first 17 miles at an unbelievable gradient of no more than 6 inches per mile"*. Attempts to renovate these canals in recent times resulted in disastrous consequences.

It is also not possible to ignore the multi-disciplinary capability of our ancient iron masters, who not only excelled in design engineering several types of iron smelting furnaces for the production of high grade iron, but also pioneered for the first time in a global context more than 1000 years ago, the production of export quality 'crucible steel' and 'high-carbon stainless steel'. Gil Juleff (1996), the British archeologist, who discovered the west-facing, wind operated furnaces in Samanalaweva in the *1990's, records that Sri Lanka's ancient iron smelting technology appears to have its roots in the 3rd Century BC, and after reaching a zenith in the 9th Century AD, the industry disappears from the archeology records in the 11th Century,* believed to be due to frequent invasions from South India.

Nevertheless despite any shortfalls, let us hope that the current reforms in education will help to re-shape the mindsets of our student population.

M. Asoka T. De Silva

STEM (STEAM) Evolution – Understanding the Foundation of World Economic Development

Dr. Chandra Embuldeniya

This article will explore two things. The evolution of STEM and the impact on the economy and the society it can make in the future. It is written for the readership of Vidurava Science Magazine. I hope it throws enough light into STEM that is now attracting the attention of our students.

1. What is STEM

STEM is an acronym for Science, Technology, Engineering and Mathematics. We are quite familiar with Science and Mathematics. Science has physical and biological sciences such as physics, chemistry, biology, zoology and botany within it. Mathematics is the discipline of solving unknowns using variables and numbers. Technology is explained by the ability of these sciences to produce solutions to real life problems. Engineering is a concept in the minds of students at the school level. Engineering represents the designs and the constructions using the knowhow derived from the sciences.

2. What is STEAM

The sciences cannot stand the test of emotional recognition without humanities, social sciences and arts. Arts and commerce are fields that engage over 70% of our student population in schools. We naturally want to know if Arts and Commerce would find a place in the scheme of things under STEM. Therefore, modern STEM is connected to aesthetics and forms the acronym STEAM. Aesthetics would represent the arts, social sciences, humanities and includes other subjects such as economics, history, geography, and literature.

3. New Mindset - Integration of Knowledge

Our students are quite used to studying science and mathematics

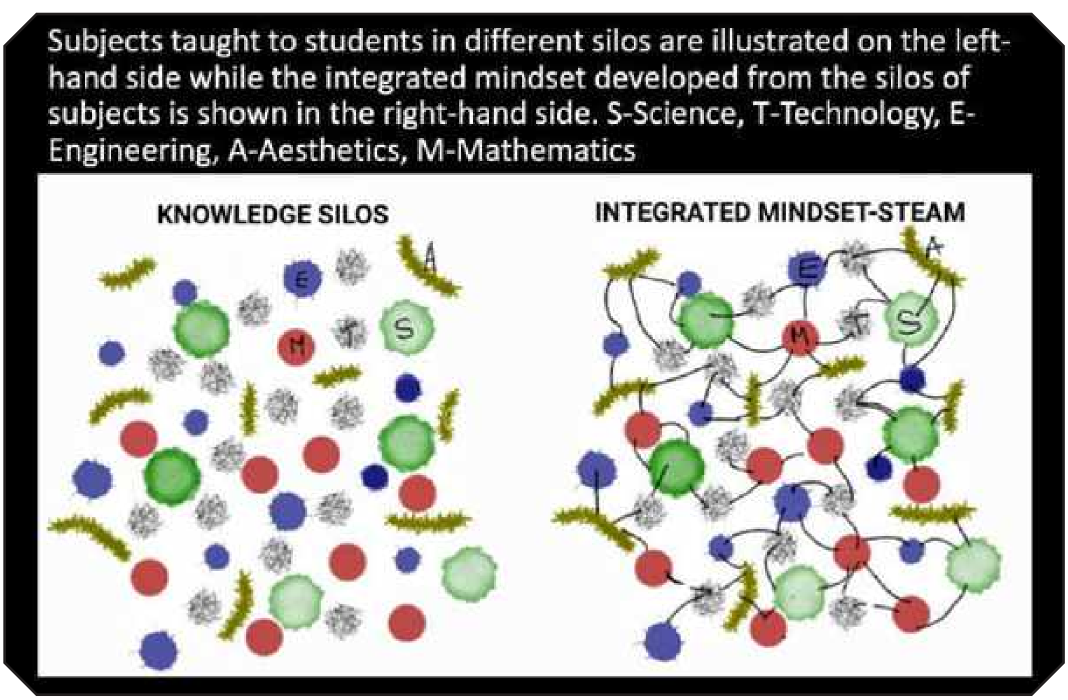

Fig 01 : Integrated Mindset in STEAM Education

while technology is studied by a few. Students learn these subjects with the theory and do various exercises answering questions, but rarely do they realize how theory can apply in real life situations. The teachers who engage in teaching these subjects have routinized this approach of teaching the theory and setting typical questions that will take the student through a journey of learning from grade 01 to grade 13. This has created a stereotype mindset in people to think within silos of those subjects. They hardly realize that silo-based thinking does not solve real life situations. The subject knowledge should be used in combination to produce real life solutions. It can only arise when students think differently. This is the integration of the mindset contained in several different silos (Figure 1). This means to enable the student to use the sciences and mathematics learnt to evolve solutions producing technologies using the designs that are emotionally appealing to people. The designing of the solution is the engineering aspect. It will involve mechanical, electrical, and civil engineering aspects when large projects such as bridges, powerplants and high-rise buildings are in need. This is possible only with the STEAM mindset. We are fortunate to have some people who have got the gist of STEAM in their mind and are not foreign to thinking in an integrated frame of mind. This is the concept of STEAM orientation.

4. Discovery – Science in History

In the history of evolution of humankind, STEAM has been the mainstay of livelihoods from very primitive levels to more advanced levels of today. This must be understood not literally but metaphorically since there was no such analysis or knowledge in the early days to associate what people have recently labeled as STEAM. The acronym STEM was used in 2001 by scientific administrators at the U.S. National Science Foundation (NSF). The organization previously used the acronym SMET when referring to the career fields in those disciplines or a curriculum that integrated knowledge and skills from those fields. On December 15, 2015, US enacted a law "Every Student Succeeds". The law includes mandates, and funding, to provide STEAM education in schools.

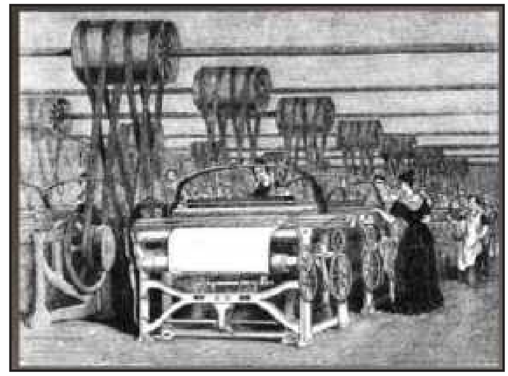

Fig 02 : Steam power used to run cotton fabric mill – 1st Industrial Revolution

5. Geological Evolution

Quite apart from the usage of the acronyms STEM and STEAM, science has made the difference to the world towards economic development. History of evolution gives us a very effective learning tool on how STEAM came to be adopted and how it made a huge social impact eventually making better standards of living for people. Let's take a brief look at the geological evolution of earth, and then the cultural evolution of humankind to get a better perspective of STEAM entry into the world. Scientists have estimated that geological evolution started 14.7 billion years ago with the formation of the universe, and the formation of the earth 4.5 billion years ago . It appears to have taken ten billion years for the formation of the earth after the formation of the universe. The first apes (early Miocene period), having an enlarged brain appeared 25 million years ago. The primitive tools came to be used 2.5 million years ago with the start of Quaternary ice-age. This appears to be the first use of technology in the world. Evidence of first stone tools

Fig 03 : Automobile manufacturing factory - 2nd Industrial Revolution

Fig 04 : Automobile Manufacturing – 3rd Industrial Revolution

appeared in Ethiopia. First human *(Homo habilis)* using hand axes appeared in Africa 2 million years ago. The renowned Neanderthals *(H. sapiens neanderthalis)* lived in Europe and Asia 130,000 years ago. About 34,000 years back Cro-magnons in Europe using bone tools and using full language to communicate replaced Neanderthals. This era was very primitive and slow in the evolution of technology.

6. Cultural Evolution of Mankind

Evidently people progressed rapidly with the cultural evolution that started from this point. Hunter gatherer nomads lived from 32,400 years up till about 10,000 years when humans started domesticating animals such as goats and pigs. Agricultural farming and settlements developed from 9,500 years ago with the cultivation of wheat and barley (Mesopotamia, modern Iraq). Naturally the people of that era had found the use of primitive technology using knowledge gained by trial and error. Writing began in various forms in the last 5,000 years as seen in hieroglyphics (Egypt), and cuneiform (Mesopotamia, Egypt). The iron age started 2,700 years ago signaling the transformation of industrial activity. Technologies such as the use of abacus by Romans, use of magnetic compass (China), first block printing (China), invention of astronomical clock (China), invention of porcelain (China), explosives (China) were witnessed. Quite in recent history the rise of individuality, imagination, innovation, first moveable-type printing (Europe), exploration of America and India by Europeans using sailing ships, theory of earth revolving around sun (Copernicus, Poland, 1543AD), discovery of laws of gravity (Newton, UK, Principia 1687AD), birth of modern physics, rapid colonization of America and India by Europeans, cataloguing of organisms by genera and species (Linnaeus, Sweden, Systema Naturae 1735), and invention of steam powered engine 250 years ago (Watt, Scotland, 1769) were the hallmarks of success in discovery.

7. Industrial Revolutions

The First Industrial Revolution – the 1st STEAM Revolution
Having seen the evolution of humankind up to this point we now step into the industrial age with the 1st industrial revolution which started with the invention of steam driven machines using coal power. This is the start of the STEAM revolution that made quantum leaps

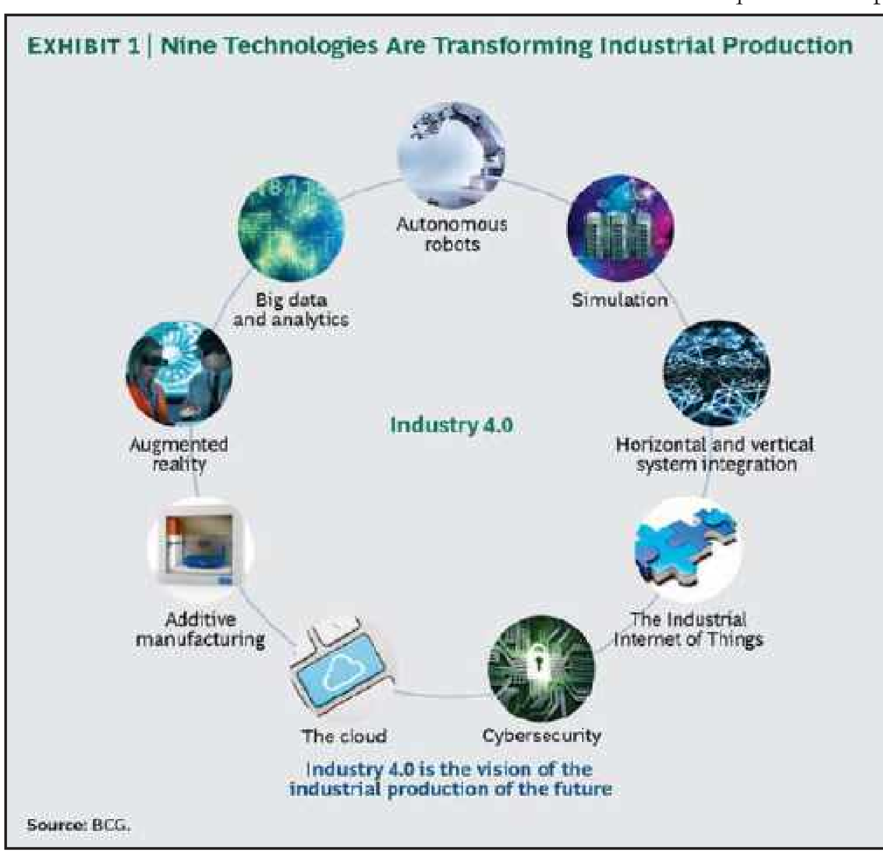

Fig 05 : The Digitally Connected World - 4th Industrial Revolutions.

Fig 06 : Both the pilot and the cameraman replaced but more jobs created on ground to manage the new operation

in economic development. The 1st industrial revolution followed a slow period of industrialization, from the beginning of the 18th century to the beginning of the 19th century. (Figure 2)

During this period the emergence of mechanization started replacing manual work with machines. An impact was agriculture taking a lesser place compared with industry as the driver of production economy. Mass extraction of coal started to fuel mechanization using the steam engine. Inventions such as forging and new skills in metal shaping helped evolve the mechanized factories.

By the 19th century, stationary steam engines powered the factories of the Industrial Revolution. Steam engines replaced the sail for ships. The factory production of textiles, and iron and steel started in UK. Reciprocating engine, the piston and cylinder type of steam engines were the main source of power until the early 20th century.

The Second Industrial Revolution – the 2nd STEAM Revolution

The 2nd industrial revolution is generally dated between 1870 and 1914 (the beginning of World War I) (Figure 3). It was a period when advances in steel production, electricity and petroleum with a series of innovations that changed life and livelihoods. Steel production became cost effective and railroad transportation revolutionized the movement of goods and people. Electricity was developed from breakthroughs in basic physics (Universities in UK) which led to the telegraph (communication system). Then came the telephone which has a long history of evolution with many inventors and finally Antonio Meucci and Alexander Graham Bell shared credit. Electrification of cities and homes was driven by Thomas Edison in the USA. The expansion of telegraph lines facilitated transportation causing unprecedented movement of people and ideas, which gave rise to a new wave of globalization. Chemical synthesis also developed to produce synthetic fabric, dyes and fertilizer. Gas and water supply systems, and sewage removal systems evolved in many cities. Electrical power and telephones systems were introduced. Factory electrification and production line technology came to be used. Fossil oil replaced coal. Daimler and Benz in Germany developed the internal combustion engine using oil and electricity. Highways and the transport systems developed.

The Third Industrial Revolution – the 3rd STEAM Revolution

The 3rd Industrial Revolution started in the second half of the 20th century, with the emergence of nuclear energy. The 3rd industrial revolution saw the rise of electronics with the introduction of the transistor and then replacing it with the microprocessor. Telecommunications also revolutionized, and computers came to be used. With the new introduction of microprocessors, the production of miniaturized material started. This technology was the key to space research and biotechnology. In industry the era of high-level automation in production started. Automation was made possible with the programmable logic controllers (PLCs) and robots. Thus the hallmark of the third industrial revolution used electronics and information technology to automate production (Figure 4). The first industrial revolution used water and steam to mechanize

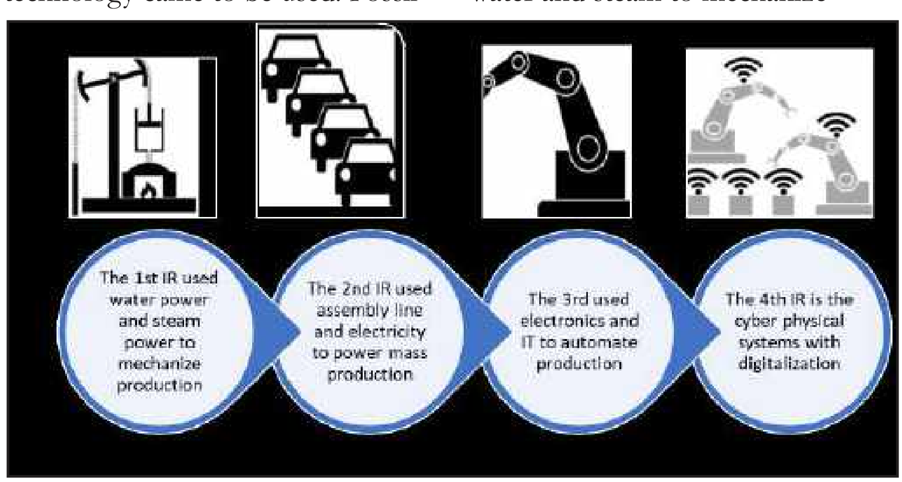

Fig 07 : The Four Industrial Revolutions at a glance – These were clearly STEAM revolutions

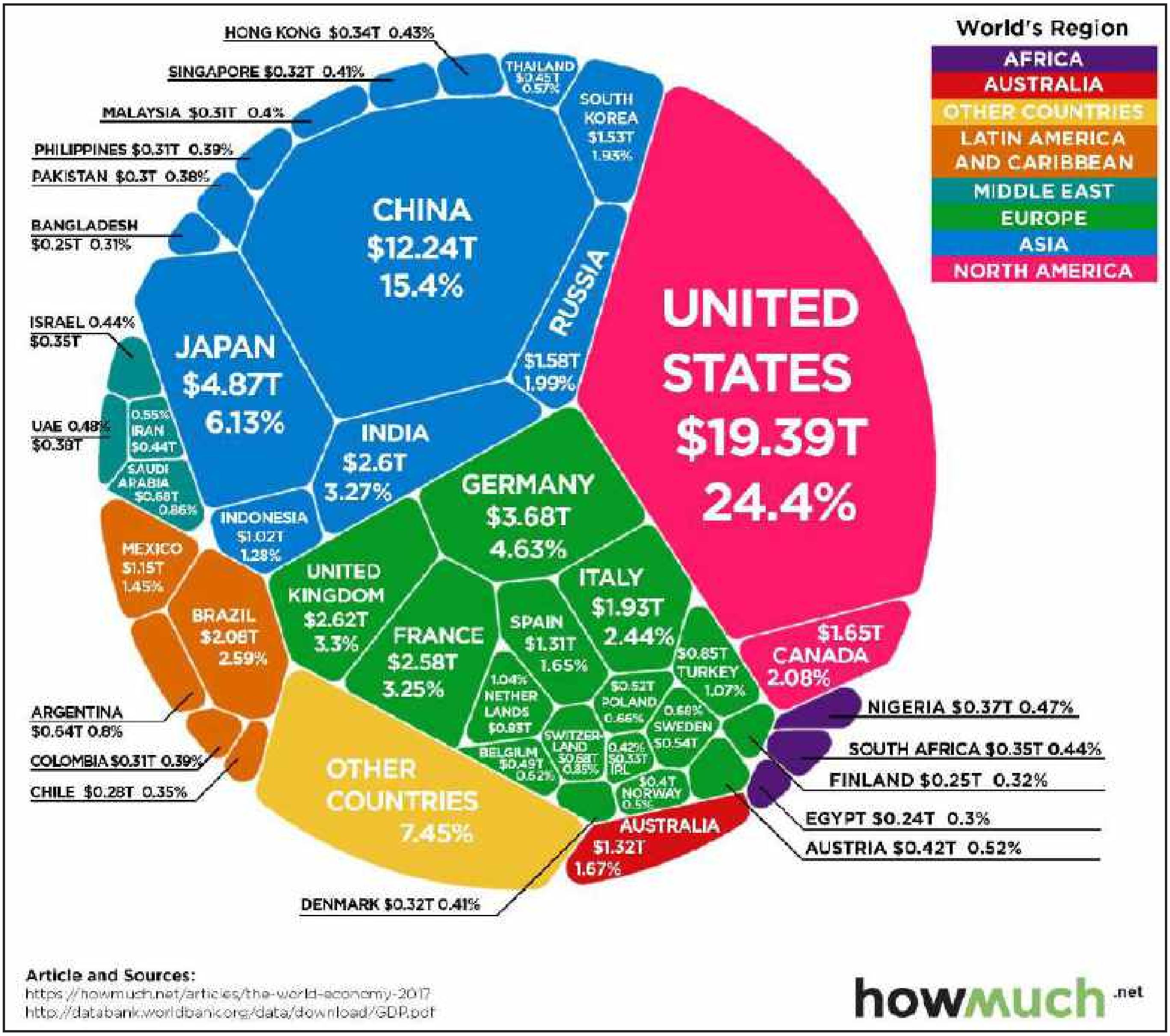

Fig 08 : World GDP - All Countries who are in this picture have STEAM oriented economic development

production, the second used electric energy to create mass production and the third used the microprocessors and information technology.

The Fourth Industrial Revolution – the 1st Digitization Revolution

Now we are facing the 4th industrial revolution which is labeled 'Industry 4', 'I4' or '4IR'. The hallmark of the 4IR is digitization. Its creation is founded on the Internet. All three previous revolutions took advantage of new type of energy while this revolution took advantage of the internet and the digitization. This digitalization helps in the creation of a virtual world to run the real physical world.

In the previous revolutions we collected data from history while the 4IR enables real time connections with the fast gathering of data on the internet (Figure 5). Thus, production facilities enable their interaction in real time to get the best results. It makes communication among different people and connected machines in a production line possible using technology such as Cloud, Big Data, Analytics and the Industrial Internet of Things (IoT). This makes more robots to come into the production lines replacing the human interventions. Maintenance of sophisticated machines can be done more effectively before failures occur.

Big data and analytics make real time decisions, effective inventory management, goods delivered to homes from the factory, and real time movement of people between jobs easier. The machines keep learning and improving technology with machine learning. One of the advantages of 4IR is that it is based on greater intelligence gathering using real time data. It can economize on energy using wind, sun and geothermal energy. It is also anticipated to create new jobs while most of the jobs that we know today will disappear to give way to machines.

8. Opportunity for Sri Lankan Students'

It is easy to realize that people who invented the technologies and innovated them further during the past three centuries did so with the application of science, technology, engineering, aesthetics and mathematics. This indicates that STEAM has been the driver of development that gave rise to the living standards today. The current position of the developed STEAM countries can be seen in Figure 8. All other countries are left with only 7.4% of the world GDP. This means that Sri Lanka needs full commitment of our students to rise with STEAM to help develop the economy.

The 4IR is a different challenge. The reason is because while it took three centuries from the beginning of the 16th century to travel through three industry revolutions, the fourth industry revolution is happening much faster (Figure 7). It is changing the technologies around us within months. Therefore, it is imperative for our students to get ready to face the future armed with relevant knowledge. This gives you the best reason to adopt STEAM learning process.

The STEAM Journal quotes, "In China, they are grasping all the expertise they can concerning STEAM education because they believe it will allow the labels of the future to say "invented in China" rather than "made in China." It is a cash cow, having your citizenry. A more interesting way to look at, or justify building STEAM programs in schools is that STEAM modes of learning make students more creative, and more empathetic. Creativity, and empathy, lead to happiness, trained via STEAM!". This is a truly inspiring statement for wanting to make STEAM a new learning experience in Sri Lanka for our students. It confirms our belief that STEAM is the path to innovations which generates economic development, and on the other hand, it makes it fun learning. One cannot seek a better way to get children into learning for a greater purpose than passing a mere school test.

Sri Lanka requires a complete transformation of the students' mindset to adopt value creation. This is about economic value creation. First, they must understand the meaning of value since many of the services in Sri Lanka are provided as a free service, and now taken for granted as a right of citizens. This has led to the loss of intrinsic economic value, and the fact that the service provider, the government, must raise these monies from others who create wealth by taxing. The next thing is, once they enter society how should their efforts be transformed from receiving free gifts to earning by creating wealth. How does one create wealth? This is the most valued question that teachers should provide answers for the students to develop a transformative mindset. Creating wealth comes with an idea that is marketable which can be either a product or service. Since children leave school either to join the higher learning ladder or develop vocational skills or to work in an institution, the idea of wealth creation is about entrepreneurship. That means to be working with the knowledge that one is helping value addition within the institution.

Be it the university, vocational training institution or the paid workplace, it is necessary to carry the thought that one must be contributing positively to value than behaving negatively to bring down the value.

The solutions to real life problems are found by bringing several disciplines together integrated within the solution. As such for a student to be able to see that they need to look outside the framework of the silos of subjects and draw from other subjects to have such an integrated activity is the right approach. This is the teachers' responsibility to create such a mindset in a student.

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Implementation of STEM Education in Schools

Prof. Sunethra Karunarathne

Introduction

We are living in the 21st century. The world is changing rapidly with the advances of science and technology. We cannot continue the practices that we have used in the past to be successful at present and in future. It is our responsibility to prepare the present generation to meet the challenges of the future. UNESCO has introduced four major skills that are required to be successful in the 21st century. They are:

- Collaboration
- Communication
- Creative thinking and
- Critical thinking

Attle and Baker (2007) have shown that 80% of all employees work in group settings. Employment in modern day require transferable multidisciplinary knowledge and skills. Employers value effective oral and written communication skills as well as the ability to work effectively within diverse groups (Finelli et al. 2011). They have found that new recruits find it hard to get adapted to working situations in their institutions due to a lack of critical-thinking skills, and the ability to communicate effectively, solve problems creatively, work collaboratively and adapt to changing priorities. In addition, they have not developed "soft skills" and also "hard skills" related to specific jobs. Most countries such as USA, UK, Australia, Singapore, Malaysia, and Canada have identified this gap during the last few decades. They have identified that by improving the knowledge and skills in mathematics and science will immensely contribute to improve creative and analytical skills of persons. They have consequently planned to deviate from the conventional way of teaching mathematics and science, and have aimed to provide a broader understanding that may help to integrate these disciplines with technology and engineering. Thus they have stepped out from the conventional box of education, and tried to improve creative and analytical thinking among students and youth by introducing fun learning methods. Many countries plan to improve achievement in STEM (Science, Technology, Engineering and Mathematics) education to bring about a workforce leading towards improving economy and sustainable development, by preparing children to meet global challenges of the modern world such as energy, health and the environment.

Fig 01 : Use of robotics in learning

Knowledge structures of STEM education

Although there were massive STEM education reforms in USA, Kelly and Knowles (2016) state that implementation has not been successful in integrating STEM subjects in an authentic context, because of the lack of

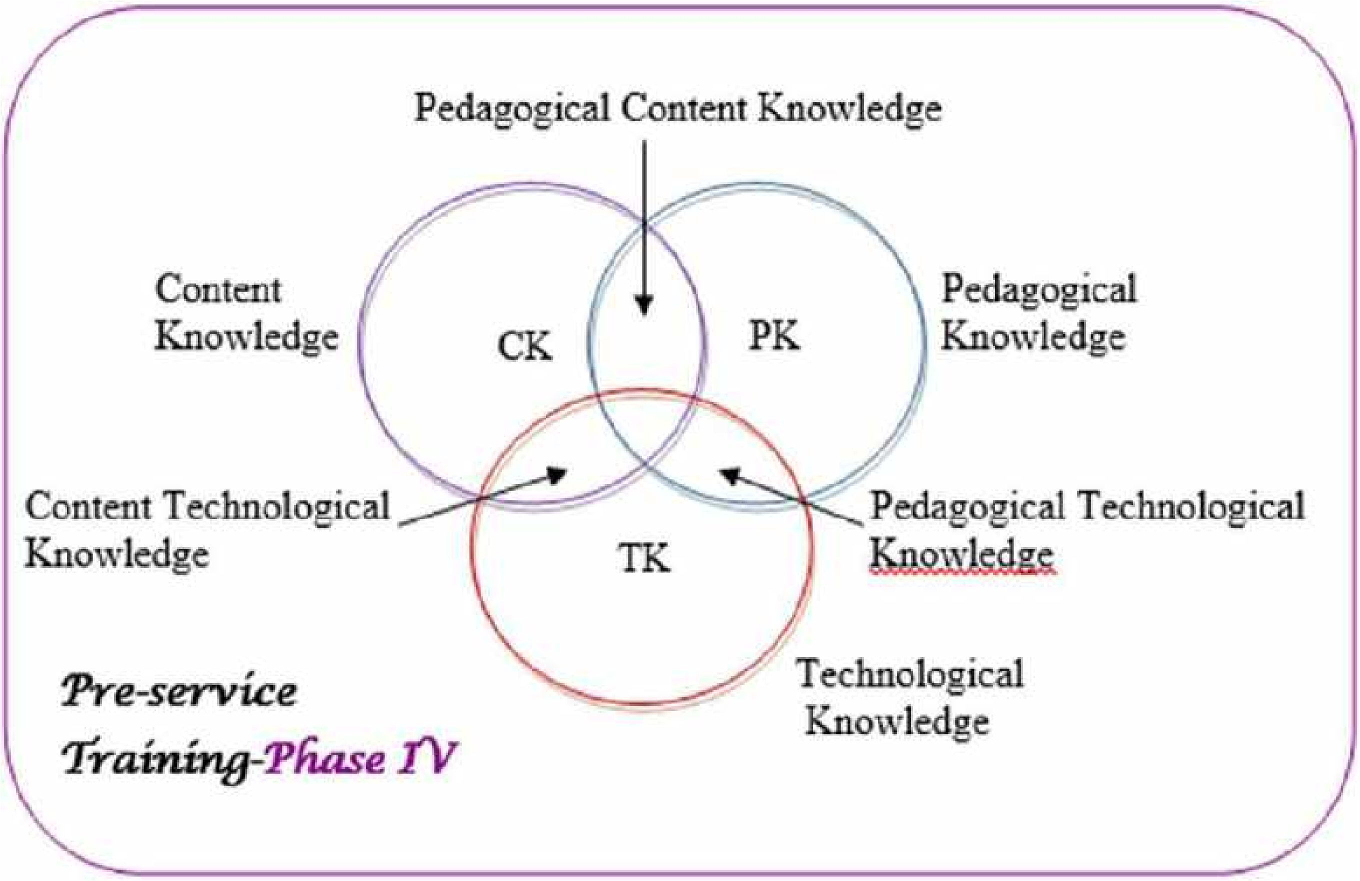

Fig 02 : Integration of content knowledge, pedagogical knowledge and technological knowledge

cohesive understanding of STEM education among educators, and have suggested the need for the formulation of a STEM conceptual framework. This framework needs to be based on learning theories and pedagogies that will lead to achieve key learning outcomes. Integration of STEM requires a strong conceptual and professional foundation on how students learn and apply the STEM content.

To help understanding science meaningfully, the learner should place the science concept in a broader and a deeper context to see how science is linked with other disciplines, not only with technology, engineering and, mathematics but also with other disciplines such as Aesthetics (STEAM), language, social studies and, with the use of Robotics (STREAM).

Teachers need to possess a very good understanding of scientific concepts (content knowledge.) They should also possess a sound knowledge on how to teach for a better understanding (pedagogical knowledge). There should be a blend of these two knowledge structures (Pedagogical Content Knowledge, PCK) to help students build up science concepts without misconceptions. In addition they need technological knowledge to craft challengeable activities to arouse curiosity and creative thinking of students to search for solutions. Figure 02 shows how the integration of knowledge structures overlap in the engagement of different activities. In classroom situations, especially in building models, students have to integrate content knowledge with technological knowledge.

Learning becomes interesting if students can see some relevance to what they experience in day-to-day life. Then they can make sense of what they learn, and also they will be able to make connections. Solutions to real life problems are found by bringing several disciplines together and integrating these within the solution. The knowledge gained by studying one subject is not enough to find a solution to a real world problem. As Nadelson et al. (2012) state STEM education teachers require a pedagogical content knowledge (PCK) to help students to make sense of what they are learning, and to apply these to real world contexts.

Table 01 : Energy lessons from Grade 1 to Grade 11

Grade	Subject Area
Grade 11	▸ Energy and energy generation ▸ Power ▸ Heat ▸ Electricity ▸ Magnetism
Grade 10	▸ Work ▸ Energy ▸ Power ▸ Energy transformation ▸ Energy uses in daily life
Grade 9	▸ Simple machines ▸ Power input ▸ Power output ▸ Efficiency ▸ Levers
Grade 8	▸ Electricity ▸ Electric circuits ▸ Efficiency ▸ Sound waves ▸ Magnetism
Grade 7	▸ Energy forms ▸ Measuring energy ▸ Efficiency ▸ Practical uses of energy
Grade 6	▸ Energy ▸ Energy forms ▸ Practical uses of energy ▸ Energy saving
Grade 5	▸ Force ▸ Work
Grade 4	▸ Simple machines
Grade 3	▸ Work
Grade 2	▸ Magnetic forces
Grade 1	▸ Pull ▸ Push ▸ Light

Role of teachers in implementing STEM education

To bring about a skillful generation, teachers have to play a bigger role. In order to do proper planning, teachers need to understand how concepts are included in the school curriculum, and how these are connected from the previous grade to the current grade and to the next grade. They will be able to organize the content under several themes, so that students will build up concepts related to the theme in a progressive way from grade 1 to grade 11. This is vertical integration. In a STEM education workshop for teachers held in the Central Province, in collaboration with the Central Province Education office and the Postgraduate Institute of Science (PGIS) (December 14-15, 2019 at PGIS) they were asked to identify how the content is organized in the current syllabus. Table 1 shows how a group of participants drew up vertical integration for the "Energy" theme. In the oral presentation they suggested how to revise it to get a deeper understanding of the concepts as the students go from grade one to eleven. They showed how mathematics, technology and, engineering could be linked in teaching.

It is also necessary to have horizontal integration with other disciplines. In STEM education practices it is the key factor. Successful implementation would be possible if parallel grade teachers plan lessons together. It is also necessary that the other teachers who teach language and social studies to participate in this discussion. By sharing their

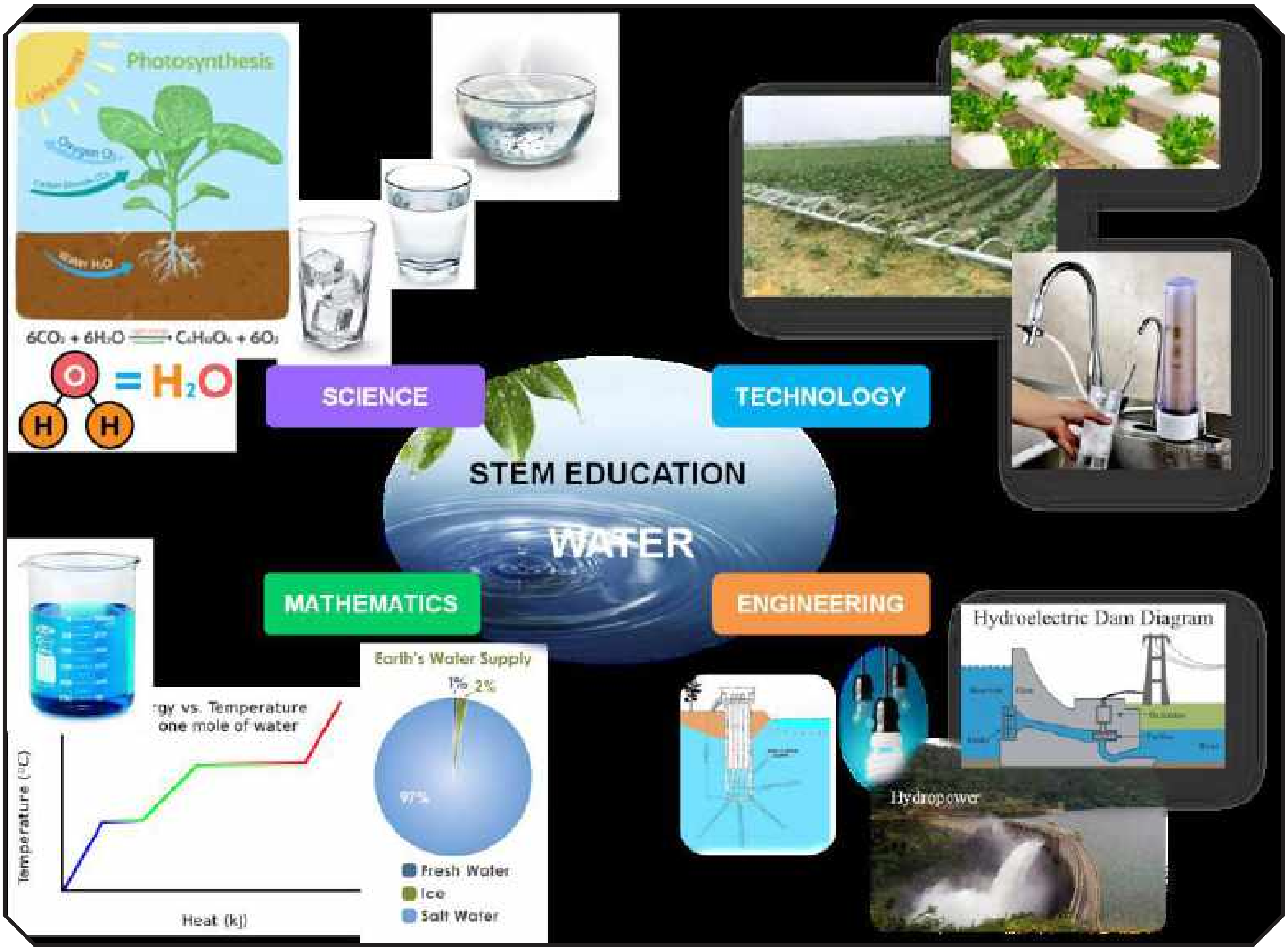

Fig 03 : Horizontal integration in teaching "Water"

experiences so many bright ideas will emerge in linking examples from other disciplines. Figure 3 shows a possible horizontal integration in teaching "Water." For science we generally present the properties of water, chemical formula and the reaction to represent formation of water and the uses of water. We need mathematics to present, size, capacity of water bodies and relationships of variables graphically. Technology has been used to design several efficient ways of applications of water in agriculture, health and purification. Use of engineering demonstrates the construction of massive projects such as power plants, dams and hydroelectricity.

Fig 04 : Students working in groups to solve a problem

Groupwork

In STEM education practices assigning groupwork is essential. Sharing the benefits of groupwork with the students in a transparent manner helps them understand how learning could be improved and prepare them for life experiences (Taylor 2011). Creating facilitated opportunities for groupwork allows students to enhance their skills in working effectively with others (Bennett & Gadlin 2012). Groupwork gives students the opportunity to engage in process skills critical for processing information, and

Fig 05 : Students' engagement in groupwork

evaluating and solving problems, as well as management skills through the use of roles within groups, and assessment skills involved in assessing options to make decisions about their group's final answer.

Johnson and Smith (2014) found that students learning in a collaborative situation have greater knowledge acquisition, retention of material, and a higher-order of problem solving and reasoning abilities than students working alone. There are several reasons for this difference. Students' interactions and discussions with others allow the group to construct new knowledge, place it within a conceptual framework of existing knowledge, and then refine and assess what they know and what they do not know. This group dialogue helps them to make sense of what they are learning and what they still need to understand or learn (Ambrose et al. 2010).

In solving a problem, group members need to share their experiences and propose ways of solving. The collaboration and communication among the members help in thinking creatively and critically to arrive at a solution with consensus.

Groups can tackle more complex problems than individuals and thus have the potential to gain more expertise and become more engaged in a discipline (Qin et al 1995). Groupwork creates more opportunities for critical thinking and can promote student learning and achievement.

Conclusion

At the initial level teachers might find it difficult to use different teaching methods and strategies, but with collaborative lesson planning, it is easy to make links with other subjects by using the following methods in the teaching learning process, such as:

- Problem-based learning
- Project-based learning
- Role play
- Drama
- Posters
- Panel discussion
- Debate
- Quiz programmes
- Computer programming
- Developing models

All these methods could be used as groupwork to enhance skills of collaboration, communication, cooperation, creative thinking, critical thinking, problem solving, innovative and designing, social responsibility and ethics, leadership and, adaptability to live in a multicultural society. Students are required to gather information from home, community and other institutions and, through surfing internet to complete the given task, to solve the problem in an effective way and to share with the whole class. Teachers are required to assess students continually based on the engagement of work. The entire methodology of teaching is student-centred and based on a constructivist approach.

Education reforms are geared towards economic development. Although economic development is important, ever increasing GDP without any care to other aspects of life and nature is unsustainable and can inadvertently sabotage happiness. The Gross National Happiness (GNH) philosophy in Bhutan is development guided by human values (National Education Framework, 2012). The educational initiative, "Educating for GNH" is a teaching learning process functioning in all schools to develop critical thinking, teamwork, values and many other skills such as peace. Another key priority is the implementation of "Transformative pedagogy or 21^{st} century pedagogy." It is a comprehensive set of teaching strategies and skills. STEM could be implemented successfully in Sri Lankan schools by paying attention to develop 21^{st} century skills in students with the use of 21^{st} century pedagogy by teachers.

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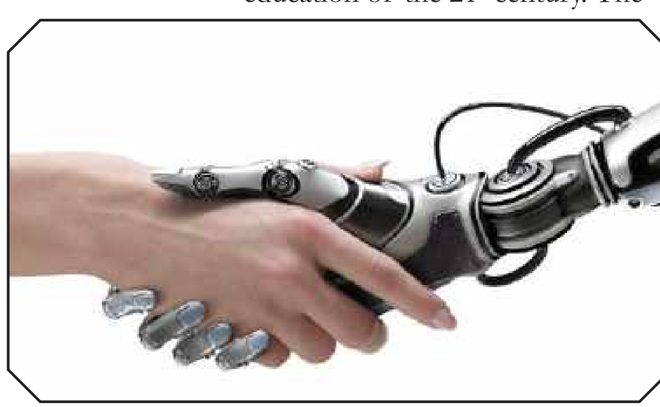
Identify STEM Education and Activities for Information Technology

Vipula Kulathunga

The most significant set of events that impacted the social, economic and cultural changes in human society began with the start of the industrial revolution. The industrial revolution that fashioned the present and that of the 21^{st} century began with the first industrial revolution of the 18^{th} century. The first industrial revolution began with steam power and its mechanization process. It was followed by the second industrial revolution in the 19^{th} century. The second industrial revolution marked the invention of electricity, and the assembly line manufacturing process. Third industrial revolution which began around the 1970s continues into the present. The third industrial revolution refers to the digital revolution which is the shift from mechanical and analogue electronic technology to digital electronics. The digital revolution marked the beginning of the information age. It is the era of rapid knowledge expansion. Knowledge of the world doubles within less than two year periods at present. The third industrial revolution is expected to transit into fourth industrial revolution by as early as 2030. The fourth industrial revolution refers to the technology revolution. A technological revolution is a period in which one or more technologies are replaced by another technology in a short period of time. It is an era of accelerated technological progress characterized by new innovations whose rapid application and diffusion can cause an abrupt change in society. Artificial intelligence and automation are the key driving forces of the future world. Some of the present jobs will disappear, or the shape of the present jobs will be changed. It will create many unique facilities driven on technology as well as many unpredictable challenges to human society. Thus, the technology-driven world in which we live is a world filled with not only promise, but also challenges. Creating a suitable work force for future requirement will be a real challenge to the education sector. The key factors for all the industrial revolutions from the first industrial revolution are innovation and creativity. It is predicted that according to thus current pattern, the future society will be based on innovation and creativity in the fields of Science, Technology, Engineering and Mathematics. The 21^{st} century skills are mainly identified under three headings. These are 1. Career and Life Skills 2. Innovation and Learning Skills, and 3. Digital Literacy. Innovation and creativity, logical thinking and critical thinking, are identified as some of the key skills under the innovation and learning skills category. Thus, the need for students to acquire these skills is more than ever needed in education of the 21^{st} century. The



logic of the concept of STEM education, as a consequence of the social discourse, is a reasonable argument as to how well traditional present education contributes to these skills. By 2030 with more than 60% of the future work force has been prepared, the world economy will be built on innovations and creativity in the fields of Science, Technology, Engineering and Mathematics. According to this basic assumption, STEM education approach is needed for changes to be made in the fields of Science, Technology and Mathematics education. STEM education is a strategic educational approach to carry on teaching and learning process to the extreme, which inter and intra learning disciplinary manner in the fields of Science, Technology, Engineering and Mathematics will aim at empowering innovation, creativity, critical thinking and logical thinking. However, it should be noted that STEM education has been interpreted with different objectives, and hence the creation of a commercial market. Often a group of activities, or a set of challenges or both, appear to be considered STEM education. But these two are just two of the essential tools in STEM education. Therefore, reading the real need of STEM education and introducing educational reforms should aim at achieving the relevant objectives and become a timely national requirement.

Expected skills in the twenty- first century that includes the skills of innovation and creativity, as well as critical thinking and logical thinking, cannot be directly taught. Engaging in an educational process in creating the environment and opportunities relevant to the child is the only way out. Some of the basic practices that need to be developed from a preschool age can be identified in the report "Next Generation Science Standard" published by the National Research Council of the United States of America. In providing practices and opportunities in the right environment and circumstances, will enable them to adapt to the fields of science, technology, engineering and mathematics to

Table 01 : Competency Levels of Traning that should be provided in terms of age

		Highest level expected in terms of age			
	Ability to practice	**Age 4- 7**	**Age 8- 10**	**Age 11- 13**	**Age 14 and above**
1	Asking questioning and defining problems	Perception and Readiness to act	Guided responses and Basic proficiency	Guided responses, Basic proficiency and Complex overt response	Guided responses, Basic proficiency, Complex overt response, Adaptation and origination
2	Developing and using models				
3	Planning and carrying out investigations				
4	Analyzing and interpreting data				
5	Mathematical thinking and patterns				
6	Constructing explanations and designing solutions				
7	Engaging in argument from evidence (based on cause and effect)				
8	Obtaining, evaluating, and communicating information				

suit the intellectual skills such as innovation, creativity, critical thinking and logical thinking. Such identified core competencies include the ability to, 1. Asking questions and defining problems 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and interpreting data 5. Mathematical thinking and perceiveing patterns 6. Constructing explanations and designing solutions 7. Engaging in arguments from evidence, and 8. Obtaining, evaluating, and communicating information. Their innovation, creativity, critical thinking and logical thinking skills will grow in the fields of science, technology, engineering and mathematics, depending on how well, how often and to what depth they are integrated with the fields. Depending on the quality of STEM education, the twenty first century human is being created. Activities and challenges can be used appropriately in practicing these skills. It is anticipated that each STEM learning opportunity will provide experiences and opportunities for the child to master one or more of these practices. In 1972 Simpson, presented some of the essential steps to follow when practicing the psychomotor domain. These steps are, 1. Perception (awareness) 2. Readiness to act 3. Guided response 4. Basic proficiency 5. Complex overt response 6. Adaptation, and 7. Origination. Such a model is suitable for use in a STEM educational setting, as they can be identified as innovative, creative, critical thinking and logical thinking, as necessary steps for a child to be a character. Therefore, it is important to recognize that STEM education is not a solitary activity, or a few but a strategic approaches to education. Here are some examples of STEM education activities.

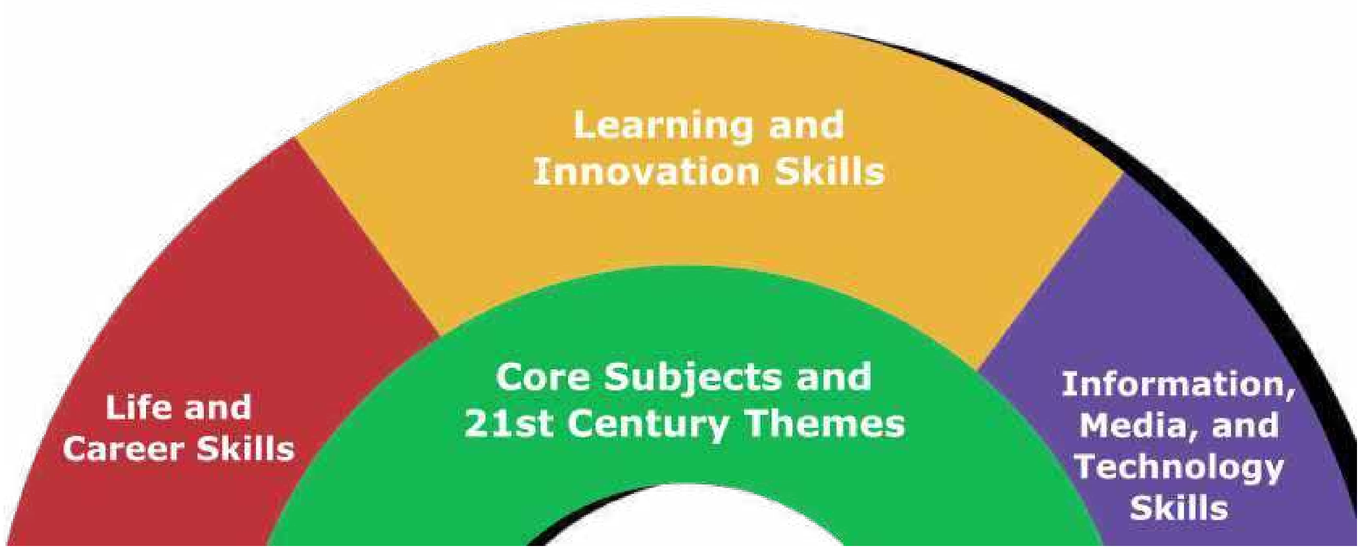
Example 01. This can be applied to children of ages 4 to 7 years. At this stage, activities or challenges should be organized to help children to reach that level of perception and readiness to act.

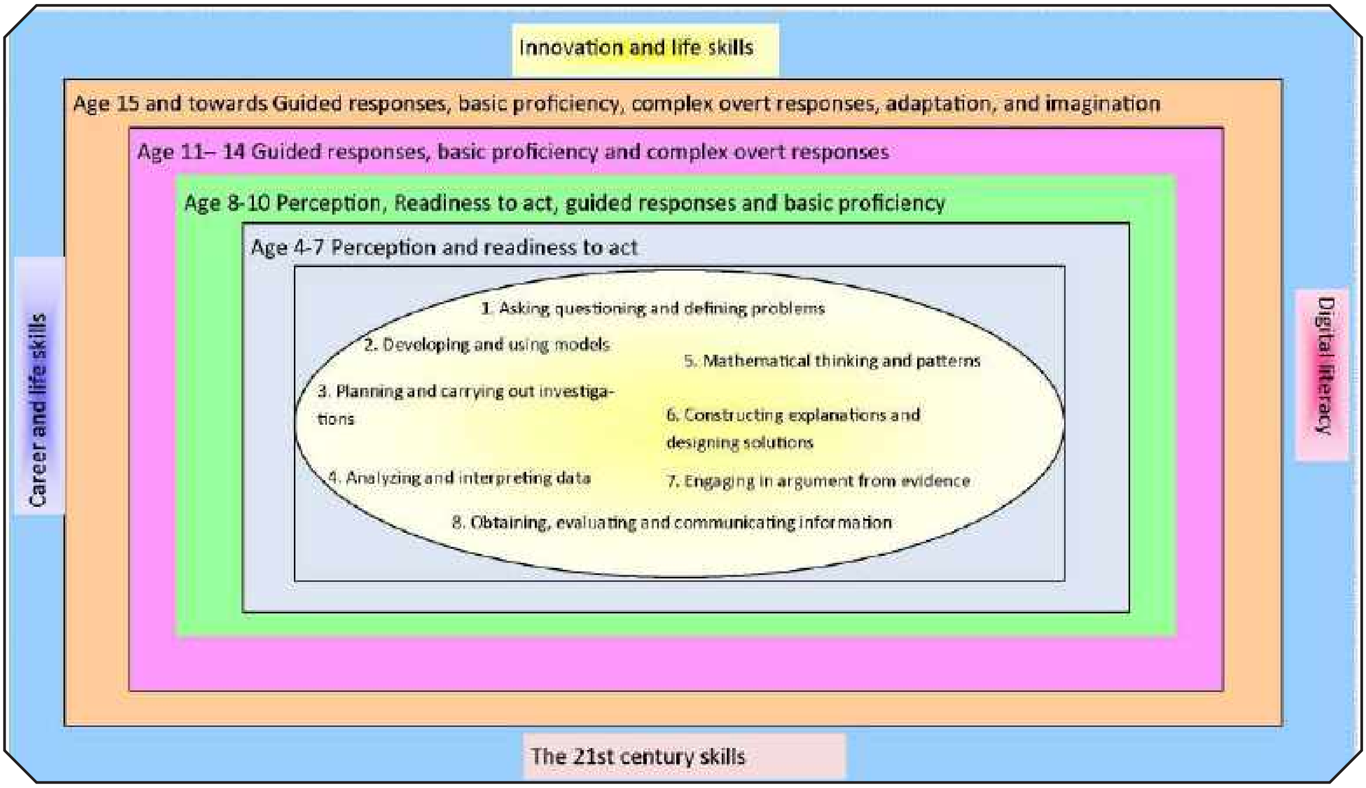
Asking questions and defining problems

Request children to watch a soccer game at the playground or on television. Accordingly, children should be motivated to ask questions, and observe the different movements as well as to stop the ball. Questioning should be done between child and teacher, between teacher and child, and between child and child too.

Further, make it an opportunity to play a soccer game. The children then push the ball back and forth, and the movement of the ball changes as it moves. The speed of the ball moves slowly, and the movement of the ball slowly changes with the direction of the ball, as well as with the position of the ball, so that the child has the ability to question it, and develop the ability to question.

This will enable the child to ask questions, perceive, and be ready to act. Accordingly, it should guide the child to understand how the movement is triggered and to prepare the child to define the problem. It is necessary to understand how the development of the internal mental thought process is carried out.





Developing and using models

Models that can trigger movements, such as a toy bow or a catapult, should be used for guidance, or allowing for further experience. Provide things like cardboard, double tape, plastic pearls, etc. Make it a challenge to create a model for a game based on movement. Children should be able to work in a group under the guidance of their teacher, based on their observations and prior knowledge. The child will experience perception and readiness to act for creating models at the level of learning. It will develop the child's intellectual processes as well as psychomotor skills.

Planning and carrying out investigations

Give two balls and a little bat and tell them what to do to make the ball to move. Instruct children to plan and implement a simple test that will show them when a push comes into play, and when it does not push, the movement does not start. Guide in both cases how the observations received are reported. The child begins to experience planning and carrying out investigations. It is the level of perception and readiness to act in planning and carrying out investigations.

Analyzing and interpreting data

The observations should be interpreted in different ways. They should be taught to interpret these situations as they observe, and feel comparatively and individually. In such cases, the teacher should be able to identify the patterns of interpretations positively with the intervention of the teacher. The goal should be to enable the child's thinking ability and be ready to be interpreted as data.

Constructing explanations and designing solutions

This should allow for a constructing explanation such as how the motion can be triggered. Similarly, children should be given the opportunity to propose a solution to a problem such as how to get rid the country of not reviving a stalled car. You can also give children the opportunity to propose a solution to a problem by asking them how to make the way of throwing something away. In this case, it is the teacher's job to disturb the intelligence of the children.

For this ability, perception and readiness to act must be planned. It also aims at developing the child's intrinsic thinking ability.

Engaging in an argument from evidence (based on cause and effect)

Various evidence regarding motions should be directed to gather whatever form. Evidence must be assigned to the pulling and pushing of the school, playground, home, street, market place or any other child's environment. They should then be presented to the class as group, arguing about different motions such as pushing, pulling, speeding and slowing. Here, too the child should practice arguing on the basis of evidence to achieve the level of perception and readiness to act.

Mathematical thinking

The size of the push or pull should be thought comparatively in terms of the magnitude of the movement qualitatively, such as the larger, the smaller, etc. It is a possible mathematical thinking practice in this age group. Here, the child will be able to qualitatively and mathematically perceive the meaning of motion, and thus be in readiness to act to think mathematically.

Obtaining, evaluating, and communicating information

The information obtained should motivate the child to make different judgments about the motions. The child will come to the judgment, such as a big push or a big speed. It has to be guided. Ask the child to communicate in various ways with other children, school community and their family members. It will be more creative if you ask children to draw a picture, telling them to do word expressions, or portraying characters. Here, too, the practice must be designed for perception and readiness to act. There will also be a development of intellectual skills as well as psychomotor skills to obtain, evaluate and communicate information.

Identifying patterns

In this way, the pattern of movements should be allowed to predict the motion of a given situation. To do that, you can do some activity in video, such as stopping somewhere and guessing what happens next, as well as describing a situation and asking what happens next. This will help the child to perceive patterns and readiness to act in the internal thinking process.

As mentioned above, STEM activity can be correctly identified as combining of one or more of learning practices in the fields of science, technology, engineering and mathematics based on child's development stages to make opportunities for developments of an innovative mind, creative thinking, logical thinking and critical thinking. STEM mainly target logical and mathematical intelligence and creativity from basic intelligence instances identified in Howard Gardner's multiple intelligence theory, but by correctly organizing these activities, the child will practice in the field of the intelligence such as interpersonal, intrapersonal, verbal – linguistic, visual-spatial, musical, kinesthetic and naturalistic. In the STEM approach, practicing and setting an inquisitive mind set is the most recognizable characteristic.

While none of the above scenarios should be done in a sequential or all-encompassing way, this education must be carried out from the early childhood stages to meet the necessary skills for facing challenges of the 21^{st} century. Their depth should be determined by the developmental stages of the child. Accordingly, the table given above can be used as a guide in designing and building STEM activities.

As in the example above, the child should be able to practice and develop activities that will deepen in the next age group. In all these cases, it is necessary to make use of computer thinking. Accordingly, well designed STEM approaches can stimulate 21^{st} century skills by stimulating the child's innovations, creativity and critical thinking as well as collaborative and communication skills, life and career skills and digital literacy. Thus, through proper STEM education it is possible to create a human generation that can overcome the challenging era of creating beyond 2030.

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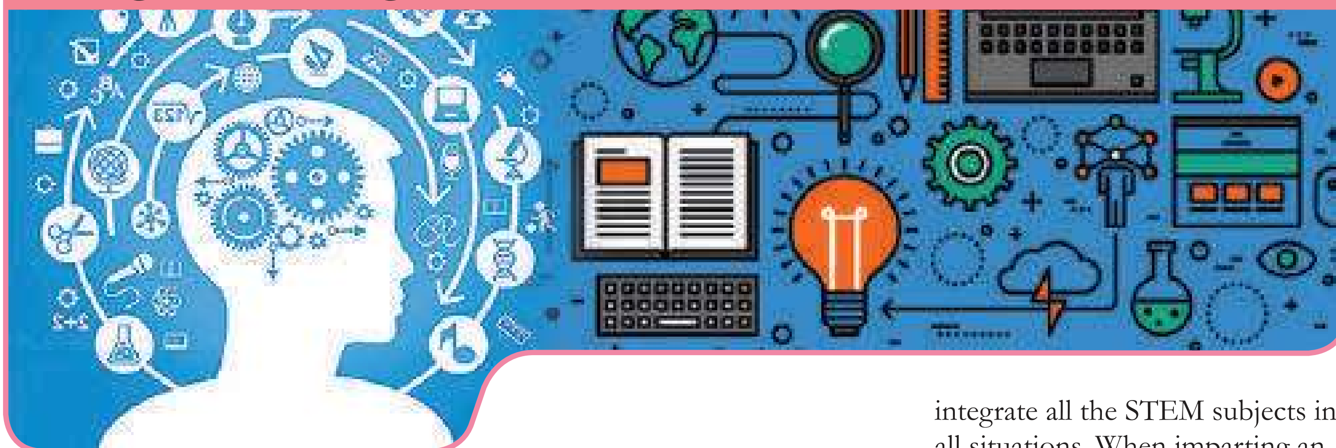
How could STEM Educational Experiences be Achieved through the Existing Science Curriculum

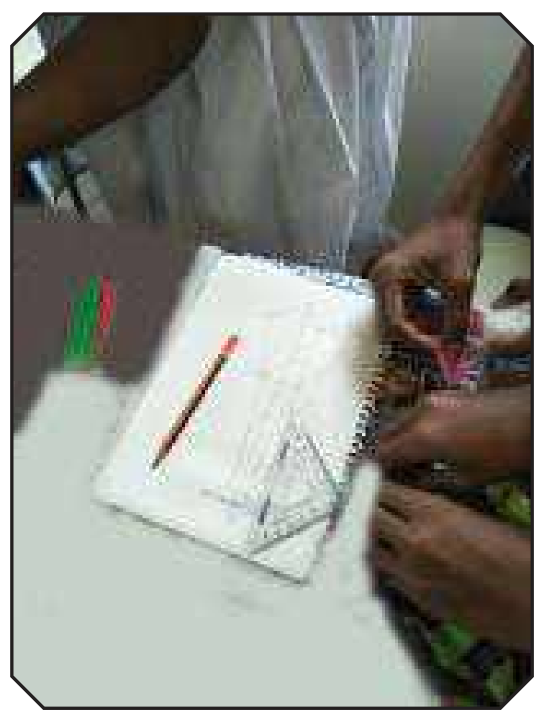
Dr Asoka De Silva



Even though education associated with the subjects of science (S) Technology (T) Engineering (E) and Mathematics (M), had existed for quite sometime, STEM education had received special attention only in the decade beginning with the year 1990. The emphasis during this early period was focused on improving and developing each of these subjects independently of each other.

Although action was taken to develop these subjects individually to higher standards in separate compartments, the result especially in the western world was for the student population to gradually move away from STEM education. There was also a continuous breakdown or decline of their motivation to study these subjects. But in actual fact it was predicted that in the near future there will be a shortage of the STEM workforce, and many nations believed and expected that economic development of a country can be achieved by overcoming this shortage. Most educational researchers in the world have shown that it is necessary to provide the students with STEM Education experiences in an integrated form in order to realize this expectation more efficiently and successfully. Presently it has become a debatable issue as to how this integration should be carried out so that the students get STEM education experiences of a high standard. Many scientists have indicated that in order to solve the above problem related to STEM education, the method should be that the subject curriculum has to be presented as a way of solving the real problems in the world. When presented on this basis the content of the subject curriculum now presented in a compartmentalized manner, the students invanably tend to suitably integrate and adapt the subject content to find solutions to problems as relevant. In other words, through STEM education it is possible to provide oportunities to the students to find solutions to problems in the real world by integrating the compartmentalized subject curricula or content. However it is essential to overcome the misconception that it is possible or compulsory to integrate all the STEM subjects in all situations. When imparting an integrated education, integration of a minimum of any two or more STEM subjects, or integration of any other subject or few other subjects with STEM subjects is possible.

In developed countries as well as in developing countries in the world, subject curricula have been already developed leading to STEM education. Simultaneously action is being taken to bring these experiences to the students through various techniques. In Sri Lanka, the manner of taking



STEM experiences to the students through the normal education process is still at the discussion stage. However, Sri Lanka which is dreaming of a knowledge based economy, should not postpone action to create opportunities to bring STEM education experiences to the students through the existing general education process.

Therefore a quick way of bringing the STEM education experiences to the students is to identify the suitable subject content in the existing secondary grades in the school, based on the basic concepts referred to earlier of the integrated STEM education, and to plan integrated activities for the STEM subject content. To understand the various concepts, basic principles, and theories many activities have been proposed. However such activities have been limited to understand specifically the scientific concepts only, and mostly confined within the school. Therefore if the teachers choose a few of the selected items of the proposed activities and decide to conduct them in a STEM education "manner", then two advantages can be achieved. The first is that because it is proposed to introduce the STEM education approach to the school curriculum in the near future, it will help to orientate the school system as relevant. Secondly, it will create an opportunity to a large section of students who have to leave the school system, to get the STEM education experiences at least to some extent.

Given below are a few suggestions presented to the teachers who are bent on imparting a STEM approach to the proposed activities in the existing science curriculum. This series of suggestions are a set of practices that should be incorporated into the scheduled activities to be carried out in the school so as to give them a STEM approach. In these suggestions, the term practices is used instead of the term skills so as to emphasis

that in a scientific investigation it is not only the skills that are essential but also the knowledge relevant to each of the practices.

Practice 1 - Questioning and defining the problem

Students in any grade should ask questions about anything they read, any phenomenon they observe, any conclusion reached based on a certain model or a scientific investigation. Also they should ask questions about the problem they have to solve. They should define more specifically the problem they have to solve by asking questions regarding the obstacles that arise, the limitations encountered when trying to find solutions by following the methods planned by them. Opportunities should be created for the students to ask questions of the type as stated above when the activities suggested in the teachers hand books and text books are under taken.

Practice 2 - Designing and using models

In science, models are employed to illustrate a system or part of a system, as an aid to provide explanations, when collecting data for various predictions and to communicate information to others. In engineering, models are used to visualize a design, to improve a design and to determine or test the strength and weaknesses of a design. The above mentioned opportunities should be provided to the students who attempt to find solutions to practical problems, by leading them to develop models and use them. It would be possible to give successful STEM education experiences to the students if the teachers pay special attention to provide the necessary facilities to develop models and use them in a more meaningful way instead of trying to make them understand the concepts using the models.

Practice 3 – Designing investigations and carrying them out

Investigations are conducted to

explain a scientific phenomenon, or to examine a theory or a design. In the science of engineering, investigations are carried out in order to improve a technical system, or to rectify an error or to select the most suitable solution to solve a problem, from among optional solutions. It is possible to impart the STEM education experiences to students by introducing the scientific or engineering approach as stated above to the scientific activities proposed in the existing school text books or teachers guide. It is extremely important to provide the facilities to lead the students to techniques to collect stronger evidence for whatever investigation they are engaged in, in order to state the targets or aims of the investigation, to predict the result and come to conclusions. Also opportunities should be created for the students in the higher grades, so that the students are able to identify the independent, dependent and controlled variables associated with the investigation and design the plan and carry it out.

Practice 4 – Data analysis and stating definitions

It is easy and convenient to communicate to others the data collected by planning and carrying out investigations through presenting the data to bring out some pattern or relationship. Since the basic data collected provide only limited information, it is extremely important to analyze the data by presenting them as tables, or graphs or by statistical methods. It is essential that students should be guided to analyze and state definitions with the aim of proving the conclusions associated with the problem. For this purpose opportunity is available to the students to suitably apply the mathematical knowledge acquired by them by this stage. Accordingly students get an opportunity to integrate science and mathematics.

Practice 5 – Applying mathematical and numerical thinking

Using mathematics to illustrate physical variables and the relationships between them, and also to make quantitative predictions are practices that should be developed in science students. Besides the practices mentioned above mathematical applications such as logic, geometry and calculus in the higher grades can be seen in the fields of science and engineering. Using mathematics is a more forceful and efficient manner to solve the problems in the fields of science and engineering. There are many opportunities suitable in the modern world for the use of computers and other digital components to solve the problems in the fields of science and engineering. Accordingly teachers should take steps without delay to make available to the students computers and other digital components in order to make observations, to take measurements, to record data and to process the data not only when carrying out scientific activities in the school but also when solving real life problems.

Practice 6 – Presenting explanation and designing solutions

In science stating the causative factors or suggesting explanations for various phenomena is constantly taking place. Therefore students should be led wherever possible not only to give their own explanations, but also to forward accepted explanations they have acquired through learning the subject. Attention of the teachers should be directed to encourage the students to carry out activities aimed at giving experience to them to arrive at conclusions, after collecting data and interpreting them, subsequent to investigating a particular problem using scientific concepts, principles, laws and theories.

In engineering more attention is placed to find solutions rather than to put forward explanations. Here emphasis is specially to point out the constraints associated with the solution, and indicate the criteria regarding the expected quality of the solution or the product made; develop a design/plan of the solution; examine models and improve the design or model to an optimum level. Thus when students are engaged in finding solutions to a problem teachers should be specially cautious to provide the opportunities to improve the afore mentioned qualities. Thereby it will be possible to impart more meaningful STEM education experiences through the science subject.

Practice 7 – Debating giving evidence

Providing an explanation to a problem or supporting a planned solution giving reasons, or arriving at a consensus through argument and reasoning is an anticipated practice that should be cultivated in students through STEM education. Thereby it is possible to arrive at the best explanation or a planned solution. This also trains the students to engage in comparisons and evaluation of opposing views to the best of their ability.

Practice 8 – Acquisition of information, evaluation and communication

Practices such as obtaining information from various sources such as books, magazines, internet and media without limiting oneself to one source; being able to identify the clearly outstanding views and possibility for the existence of errors according to the methodology; making inferences from observations; using different views to provide explanations and the ability to differentiate, are essential when handling information related to science and engineering. Understanding and knowledge of language style, vocabulary and the use of technical terms specific to each field of subjects is also extremely important. This understanding is equally important not only for the acquisition of information, but also for evaluation and communication purposes. It is necessary to identify the opportunities existing in the science curriculum so as to guide the students to develop their capabilities in the usage of language in the STEM subject areas. This may be practiced through writing essays, taking part in debates, delivering lectures and making presentations. These help to develop meaningful STEM experiences among the students. By enhancing the proposed activities in the existing science curriculum through the integration of science, technology, engineering and mathematics, through the development of relevant practices in the fields of science and engineering, and by taking the afore mentioned purposes into consideration student performance would be enriched. They would be motivated to engage in their subjects; they would be successful in finding more suitable meaningful and efficient solutions for day to day problems encountered in the world of work. Therefore one should not wait for the day when educational reforms

with the STEM education label are introduced into the school system, but play an active role to incorporate the STEM experiences into the existing curriculum so that the present student population would enter the world of work armed with better skills, and would be able to face the problems in the real world more successfully.

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STEM Education through the Finland Experience

B.W.G. Dilhani


Finland occupies a prominent place amongst the countries in which the best educational methods are practiced. Their system of education is very unique because the teachers are well trained and the children receive equal opportunities for education. Also the schools in Finland are allowed the freedom to prepare and adapt the subject content (curricula) that suit the particular school while keeping within the national curriculum. Adapting the curriculum to suit the region and the school is carried out with the participation of the school teachers, parents and the students. The Finland school curriculum which has been prepared with the objective of producing citizens suitable for the nation, has identified the investigational approach as an essential component of education. Eventhough no specific reference has been made to STEM, it can be identified as a part of the Finland school curriculum. Another specific feature of the Finland education system is that they believe the children who received primary education, by who carrying out activities freely received a better education (learnt better) than those who learnt using books. Their concepts were :-

• The less hours of instruction will permit more hours for rest and for more favorable breaks.
• Less testing means more learning.
• Less topics in the curricula means more indepth learning.
• Less homework means more free time.
• Less students in a class room means more care and individual attention.

In Finland primary school children do not have to face tests. They do not have to cover an extensive curriculum. They do not have homework. They do not get assignments from their teachers which they have to do at home, and take back to school the next day. Therefore children play freely, indulge in various activities and enrich their lives with varied


Fig 01 & Fig 02 : Equipment for children to play with Aeroplanes

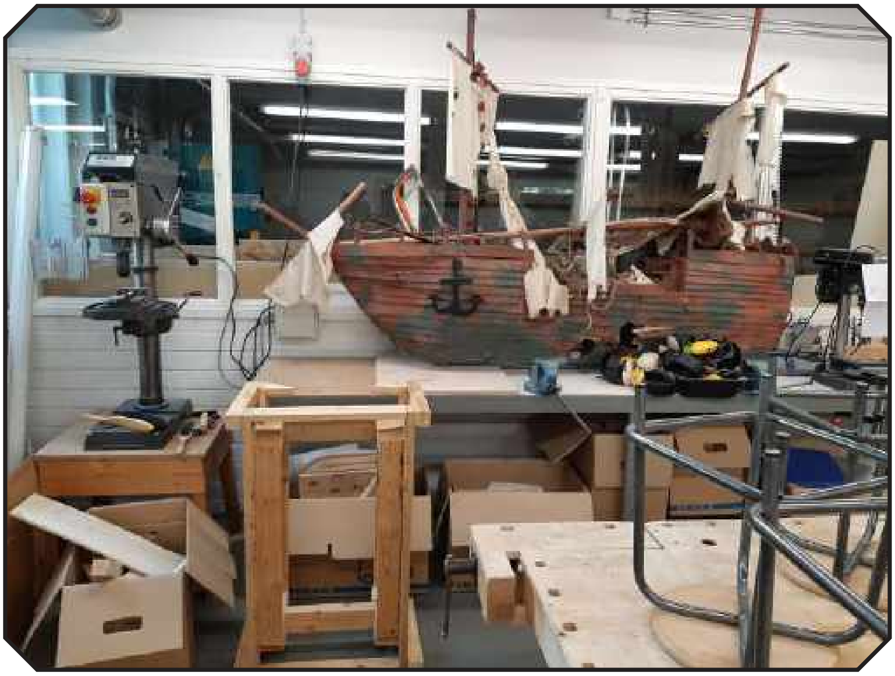

Fig 03 : The ship that can be floated in water

experiences. The school play ground has been organized in such a manner that it is conducive to provide varied experiences to the children. Similarly the school corridors have been organized to provide various suitable learning opportunities. Unlike in Sri Lanka, the schools in Finland use technology to the maximum for the learning process. The children in the primary classes also use mobile phones, laptops, tab computers etc. for the learning processes. Equipment for sports and various activities for the students have been placed in different locations within the school building itself. These activities are related to STEM activities.

Fig 04 : The workroom for the students

It was observed that there were various creations of the primary school children done with the assistance of the teachers. The students had a workroom to turnout these creations. Their work room had various modern equipment. Because it is dangerous for students to operate certain types of equipment by themselves the teachers assist them. An aeroplane and a ship which could be floated in water, and turned out of wood, were among some creations the primary school students had turned out. When they are making these creations, the plan for the creation is also thoughout by the student itself. They get an opportunity to make their creation a success after carrying out a few trials.

The teachers will assist them only when required. When planning the creations the students will have to use their knowledge of all subjects such as science, mathematics technology and engineering. They have also used their aesthetic talents or skills to make their creations aesthetically attractive or appealing. Although making these creations provide a very good opportunity

Fig 05 : The proposed location for the students to suitably organize their assignment

to employ STEM, the term STEM is never used by them to describe these activities. What is expected through these activities is to helps the students to be able to face challenges, to improve their creativity, to find solutions to problems, to engage in teamwork with patience, and to strengthen their ability to face difficult situations, thereby facilitating them to become balanced individuals with a fine personality. This is how STEM is employed in the education method of Finland.

Opportunities have been provided to students to gain STEM experiences through various activities organized by the school outside the curricula. As an example when changes have to be made in the school premises/ environment, ideas and suggestions from students are encouraged, and the students are assigned the responsibilities associated with the suggestions they have made. The principal would organize a suitable small location out doors in the school for the students to leisurely spend the time during the autumn. He would also supply some wood furniture for this purpose. His idea is to assign this activity to the students to plan and organize this location to suit the purpose. Through this type of activity too the students get an opportunity to incorporate the various subject curricula they have learnt and to test it out. When a child gets such opportunities to actually use the knowledge they have gained, it is very fruitful to their learning process. Through this process the students get the opportunity to gain a better understanding and knowledge than what they would gain using books alone or answering examination papers. In Finland it is possible for the teachers to engage the children in these activities, and students very willingly carryout these activities because the curricula are not extensive and not a burden.

Eventhough during primary education more emphasis has been placed on such activities, in the higher grades, there is more emphasis on projects, investigations and experimentation. These have been planned and introduced so as to engage the students in these activities collectively as well as individually. Forty seven percent of the students who have completed the compulsory basic education tend to enter vocational education. Here the aim is to produce an individual possessing specialized vocational training. Students who enter the vocational education stream may enter the normal academic educational stream when

Fig 06 : Children engaged in STEM activities

necessary. Accordingly in the Finland education method/system there is no obstacle for students to do as they desire or wish, in their education.

In Finland the Eureka Science Centre at Vantac which is located to the North of Helsenki, is an effective place from which everybody irrespective of whether they are small or big (young or old) can gain experience. There opportunities are available for anybody to learn scientific concepts and test them out individually. Most of the STEM activities presently much talked about in Sri Lanka, may be tried out at this Centre. For this purpose maximum use of Technology is employed. Here it was possible to observe the way in which small children who are accompanied by their parents try out the various activities with great enthusiasm. In this manner it is possible for the students to gain a great deal of knowledge in addition to the experiences they obtain from schools.

In a country such as ours which tries to “market” STEM calling each and everything STEM, there are many lessons we can learn from Finland. On the whole even though the educational method in Finland is based to provide the STEM experiences, they define it not as STEM but as a method providing life experiences to students. Therefore the students do not try to determine whether they apply science or mathematics in the activities they carry out. Instead they apply the knowledge or experience they have gained for the relevant instances as required to carryout their work and for creations. They try out the knowledge they have gained for practical purposes. They experiment with it and thereby gain skills suitable for their future. This is why Finland is included as one of the countries practicing the best method of education in the world. Finland practices STEM while not actually calling it as such.

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Nobel Prize Winners of 2019

Apeksha Herath

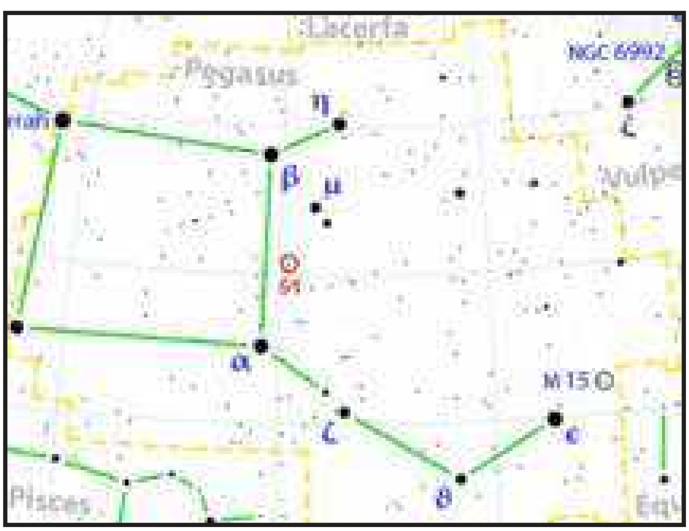
Nobel Prize is the most prestigious award given for extraordinary contributions and achievements in the world. It is an annual international prize awarded from a fund bestowed for the purpose by the Swedish inventor and industrialist Alfred Nobel. He owned 355 different patents, and his most famous discovery was dynamite. The Fund for the Nobel Prizes was established through a donation offered under the last will of Alfred Nobel. He signed his last will at the Swedish-Norwegian Club in Paris on 27th November 1895. The Nobel Foundation was set up to carry out the provisions of his will. The Nobel Prizes were awarded for the first time in December 1901 during the fifth anniversary of the death of Alfred Nobel. The prize was awarded in recognition of outstanding academic, cultural, or scientific advances. Each Nobel Prize comprised three elements, a gold medal, a diploma bearing a citation, and a sum of money. Prizes were awarded in respect of Literature, Physics, Chemistry, Peace, Physiology or Medicine for the first time in 1901. Later, in the year 1968 the Prize for the Economics was introduced. The Nobel Prize is awarded either for one person, or divided equally among two or three persons. The Nobel Prize was not awarded for some years specially during the period of World War I (1914-1918) and World War II (1939-1945). The prizes for physics, chemistry, and physiology or medicine have been the least controversial. However, the Prizes awarded for Literature and Peace have on occasions led to controversion mainly due to the broad and unspecified nature of these field and as a consequent the peace prize has been the most frequently withheld prize. This article presents a brief account on the Nobel Prize winners of 2019.

John B.Goodenough, M.Stanley Whittingham & Akira Yoshino

Michel Mayor, Didier Queloz & Phillip James Edwin Peebles

Chemistry

The Nobel Prize for Chemistry was awarded to three scientists, namely John Goodenough, M. Stanley Whittingham, and Akira Yoshino for their contribution



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to the development of Lithium-ion batteries during 1970-1980. These batteries are frequently used in portable electronics and electric vehicles. Nowadays they are popular in military and aerospace applications. Lithium-ion batteries were cornerstones of the technological revolution of the last few decades. Lithium-ion batteries are powered by flows of Lithium ions, crossing from one material to another. They are lighter and more compact than earlier types of rechargeable batteries, and were able to hold charge for a longer period of time.

Physics

The Prize for Physics was awarded for contributions made for the understanding of the evolution of the universe, and the Earth's place in the cosmos. The prize was shared among three Nobel Laureates, namely James Peebles for theoretical discoveries in physical cosmology, and the other half jointly to Michel Mayor and Didier Queloz for the discovery of an exoplanet orbiting a solar-type star.

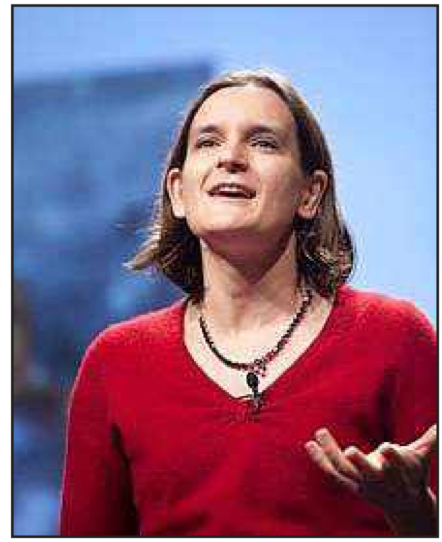
Phillip James Edwin Peebles is a Canadian-American astrophysicist, astronomer. He is one of the leading theoretical cosmologists with a significant involvement in the field of primordial nucelosynthesis, dark matter, the cosmic microwave background, and structure formation. Many of his contributions are dedicated to the field of physical cosmology for determining the origin of the universe.

Peter Handke

Physiology or Medicine

William G. Kaelin, Sir Peter J. Ratcliffe, and Gregg l. Semenza were awarded the Nobel Prize in the category of Physiology or Medicine appreciating their contribution for the discoveries of how cells sense and adapt to oxygen availability. Their combined work has revealed the molecular machinery which regulates the activity of genes in the presence of varying levels of oxygen. They established the basis for the understanding of the effect of varying oxygen concentrations for cellular metabolism and physiological function. Their discovery is useful for the development of new medical interventions to fight against anaemia, cancer and many other diseases.

Abhijit Banerjee



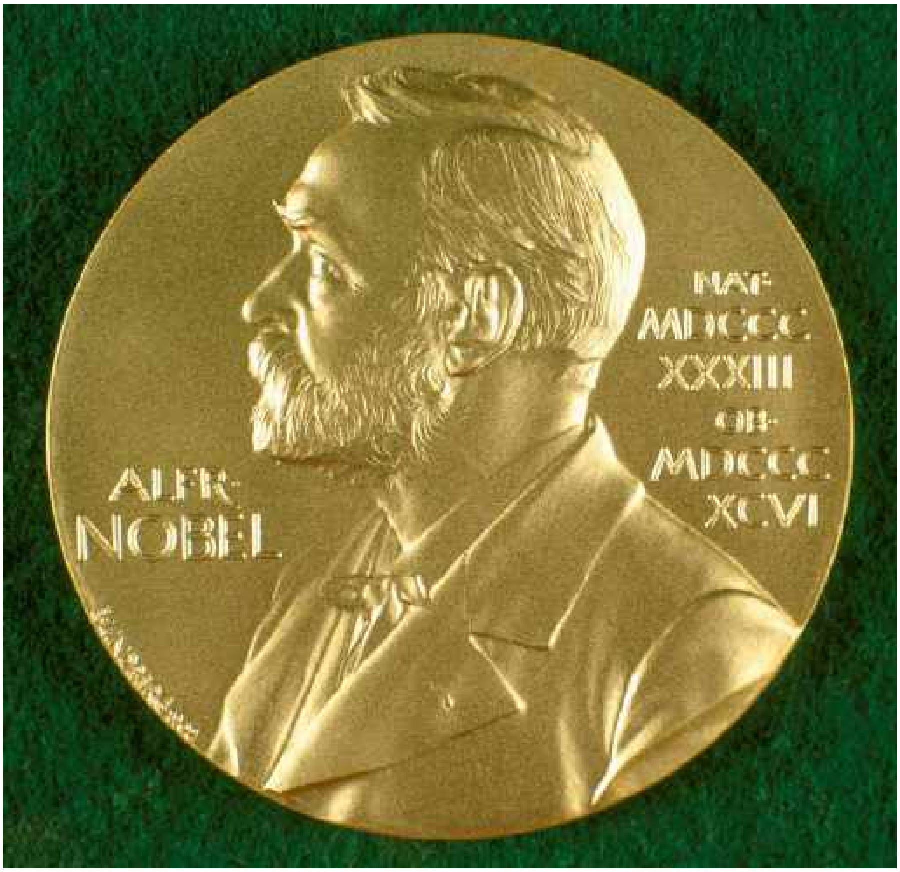
Esther Duflo

Michael Kremer

Abiy Ahmed Ali

Literature

Peter Handke was recognized as the Nobel Laureate in the field of literature for his influential contribution to explore the boundaries and the specificity of the human experience, with his linguistic ingenuity. Peter Handke was well known as a novelist, playwright, translator, poet, film director and screenwriter in the second half of the 20th century. The dominant themes of his writing are the usage of ordinary language, and addressing the reality of life and human mental conditions. "Goalie's Anxiety at the Penalty Kick" is identified as his best-known novel which describes about a former football (soccer) player who commits a pointless murder, and then waits for the police to take him into custody. 'The Left-Handed Woman' is a dispassionate description of a young mother coping with the disorientation she feels after she had separated from her husband. 'A Sorrow Beyond Dreams' is a semi-autobiographical novel



that brought back to memory his deceased mother. 'Repetition', 'Slow Homecoming', 'Shortletter', 'Long Farewell', 'The Moravian Night', 'A Journey to Rivers' are some of his novels. His films included 'Wings of Desire', The Wrong Move, 'The Absence', 'City of Angels', The 'Wings of the Doves', The 'Goalie's Anxiety' at the 'Penalty Kick', and The 'Left-handed Women'. 'Kasper', The 'Hour We Knew Nothing of Each Other', 'Offending the Audience', 'Storm Still' are the popular plays authored by him.

Peace

Abiy Ahmed Ali won the Nobel Prize for his contribution for the achievement of peace and international cooperation. He had made a decisive initiative to resolve the border conflict with neighboring Eritrea. He is an Ethiopian Politician serving as the fourth Prime Minister of the Federal Democratic Republic of Ethiopia since 2nd April, 2018. He contributed for the promotion of reconciliation, solidarity and social justice. Further, he had been engaged in many other peace and reconciliation processes in East and Northeast Africa.

Economics

The prize for economics was awarded to three economists including Michael Kremer, Esther Duflo and Abhijit Banerjee for their experimental approach for the alleviation of global poverty. The research areas of Michael Kremer focused on the poverty reduction, education economics and health economics. He contributed towards establishing the effectiveness of the proposed antipoverty measures.

The research areas of Esther Duflo were microeconomic issues in developing countries addressing household behavior, education, access to finance and health. The work of Abhijit Banerjee was focused on development economics, and was the author of many books related to economics. The combined work of the three of them led to the discovery of the causal relationships related to economics.

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What have you learnt from the Vidurava 2020 January - March Q1 Issue? Scan your own memory!

Identify STEM Education and Activities for Information Technology

True or False?

1. The Third Industrial Revolution refers to the digital revolution, which is the shifty from mechanical and analogue electronic technology to digital electronics.
2. It is predicted that according to this current pattern, the future society will be based on innovations and creativity in the fields of science, technology, engineering and mathematics.
3. Engaging in an educational process in creating the environment and opportunities relevant to the child is not the only way out.
4. Models that can trigger movements, such as a toy or a catapult, should not be used for guidance, or allowing for further experiences.
5. It will be more creative if you ask children to draw a picture, telling them to do word expressions, or portraying characters.

STEM Education Through the Finland Experience

True or False?

1 Adapting the curriculum to suit the region and the school is carried out with the participation of the teachers, parents, and students.
2. In Finland primary school children have to face tests and they have to cover an extensive curriculum.
3. When students are making the creations, the plan for the creation is also thought out by the student itself.
4. Opportunities have been provided to students to gain STEM experiences through various activities organized by the school outside the curricula.
5. Even though during primary education more emphasis has been placed on various activities, in the higher grades, there is no emphasis on projects, investigations and experimentation.

STEM (STEAM) Evolution – Understanding the Foundations of World Economic Development

True or False?

1. The sciences cannot stand the test of emotional recognition without humanities, social sciences and arts.
2. In the history of evolution of humankind, STEAM has not been the mainstay of livelihoods from very primitive levels to more advanced levels of today.
3. Quite apart from the usage of the acronyms STEM and STEAM, science has made the difference to the world towards economic development.
4. One of the disadvantages of the Fourth Industrial Revolution, is that it is based on greater intelligence gathering using real time data.

5. STEAM has been the driver of development that gave rise to the living standards today.

Implementation of STEM Education in Schools

True or False?

1. Employment in modern day requires transferable multidisciplinary knowledge and skills.
2. To help understanding science meaningfully, the learner should place the science concepts in a broader and a deeper context to see how science is linked with other disciplines.
3. Learning becomes interesting if students could see some irrelevance to what they experience in day to day life.
4. In STEM education practices, assigning group work is not essential.
5. Group dialogue helps students to make sense of what they are learning and what they still need to understand or learn.

How could STEM Educational Experiences be Achieved Through the Existing Science Curriculum

True or False?

1. Through STEM education it is possible to provide opportunities to the students to find solutions to problems in the real world by integrating the compartmentalized subject curricula.
2. Students in any grade should ask questions about anything they need, and phenomena they observe, any conclusions reached based on a certain model or scientific investigation.
3. Since the basic data collected provide only limited information, it is not important to analyze the data by presenting them as tables.
4. In science, stating the causative factors or suggesting explanations for various phenomena is not constantly taking place.
5. In engineering more attention is placed

Nobel Prize Winners of 2019

True or False?

1. Alfred Nobel owned 355 different patents and his most famous discovery was dynamite.
2. The prizes for physics, chemistry and physiology or medicine have been the most controversial.
3. Peter Handke was recognized as the Nobel Laureate in the field of literature for his influential contribution to explore the boundaries and the specificity of the human experience, with his linguistic ingenuity.
4. Abiy Ahmed Ali won the Nobel Prize for Peace, for his contribution for the achievement of peace and international cooperation.
5. The prizes awarded for Literature and Peace have on accasions led to controversies mainly due to the narrow and specified nature of these fields.

Answers

01) 1. True, 2. True, 3. False, 4. False, 5. True
02) 1. True, 2. False, 3. True, 4. True, 5. False
03) 1. True, 2. False, 3. True, 4. False, 5. True
04) 1. True, 2. True, 3. False, 4. False, 5. True
05) 1. True, 2. True, 3. False, 4. False, 5. True
06) 1. True, 2. False, 3. True, 4. True, 5. False

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