RENEWING MATHEMATICAL AND DIGITAL EDUCATION INITIATIVES IN THE ASIAN COUNTRIES: A REVIEW

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ABSTRACT

This review report presents an overview of the mathematical and digital education initiatives taken by eight different Asian countries. In this report, we have discussed that how different Asian countries are developing their mathematical and digital education to provide quality education to their populations and preparing them to meet future challenges posed by advancement in new technologies. Our paper included eight Asian countries (China, japan, South Korea, Singapore, Pakistan, India, Nepal, and Bangladesh).

KEYWORDS

Mathematics education, digital education, PISA, OECD, Asian countries, economic development, future workforce

1. INTRODUCTION

Programme of International student assessment (PISA) publishes after every three-year results of participant countries on the bases of their student`s performance in mathematics, reading and science literacy. PISA defines mathematical literacy as an individual's capacity to reason mathematically and to formulate, employ and interpret mathematics to solve problems in a variety of real-world contexts" [1]. It includes concepts, procedures, facts, and tools to describe, explain and predict phenomena. It helps individuals know the role that mathematics plays in the world and make the well-founded judgments and decisions needed by constructive, engaged, and reflective 21st Century citizens. Mathematical and digital skills are the key tools to solve critical real-life problems and are utilized in all other applied sciences to demonstrate and solve real world problems and create innovative ideas. PISA has published the 2021 mathematics framework as shown in the figure 1 below [1]. In addition to mathematical literacy, digital literacy and science education plays a key role in the economic development of a country. Data gathered by different organizations like world Economic forum, OECD, and PISA reveals that the countries with quality education provision have sustained and

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developed stronger economies.

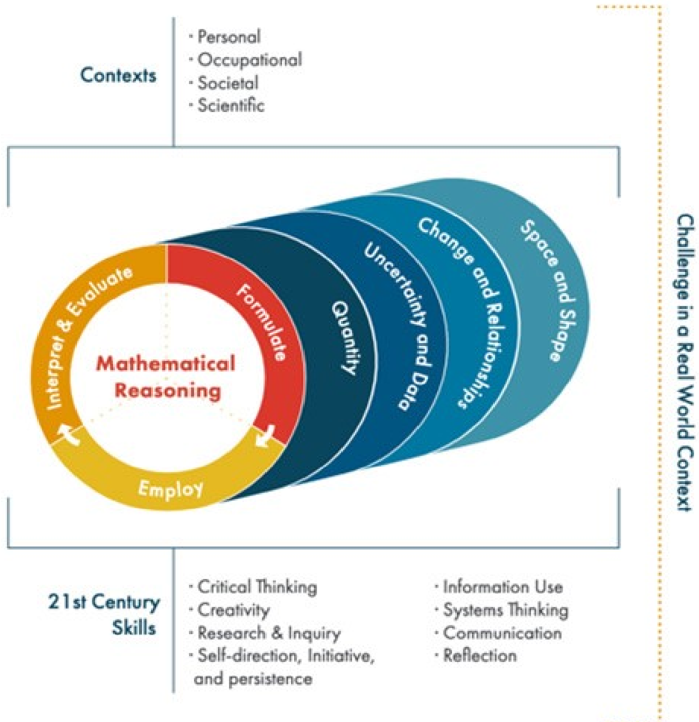

Figure 1. Mathematical framework 2021 adapted from PISA

A research finding has suggested that realistic mathematical education and learning through games is fruitful in developing learner`s capability of thinking and solving real life problems [2]. Therefore, mathematical, and digital literacy has a vital role to play in the development of future workforce and economic growth of a country in sustainable way.

2. AIM OF THE REPORT

In this review paper we aim to showcase the efforts of different Asian countries in renewing mathematical education and digital initiatives. We take four developed and four developing countries from Asia and find how they are developing their mathematical and digital education. This report firstly aims to highlight state of the art initiatives taken by different Asian countries in renewing mathematical and digital education. Secondly, our report aims to show a correlation of good scientific and digital education practices with the development of the economy. The report focuses on four developed Asian countries (China, South Korea, Singapore, Japan) and four developing Asian countries (Pakistan, India, Nepal, Bangladesh) and draws relation between their economic development and

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quality education provision. Advanced Asian countries have done well in their PISA results [3]. Therefore, the main purpose of the review report is to see what kind of mathematical and digital initiatives have been taken by different Asian countries and how economic development is linked to the advancement in mathematical/scientific and digital literacy?

2.1. Methodology

The nature of the research done in preparing this report is qualitative. We have gathered related information from scholarly research articles. We also collected state of the art information from official websites of the respective countries (China, Japan, Singapore, South Korea, Pakistan, India, Bangladesh, and Nepal). Additionally, we gathered data from open sources like OECD, PISA, UNICEF, World Economic Forum. In tabular form we presented the comparison of the countries in terms of mathematical initiatives, digital initiatives, latest PISA ranking if applied and inclusive development index IDI ranking.

3. CHINA

People`s republic of China is an East Asian country, with 1.4 billion of population. Mandarin is China`s official language. Primary school education starts at the age 6 or 7. China`s basic school education includes 9 years of education, 6 years of primary school education and 3 years of Junior Secondary School education. Basic school education is mandatory of every child according to Chinese law. China has performed well on PISA [3] and OECD test scores. Shanghai has developed its own assessment system on the bases of PISA's state-of-the-art methods and ideas of assessment and evaluation. [4]. Therefore, PISA acts as an assessment tool to help countries make their education systems better.

In March 2011, the Shanghai developed a set of green indicators for the comprehensive evaluation of academic quality. The set of green indicators considers 10 different aspects [4]. 1.Education level of student 2, student`s eager to learn, 3. Study load 4. Teacher`s relationship and engagement with student, 5. teaching methodology, 6. the curriculum management,7. the effect of students' socioeconomic backgrounds on their learning and development achievements, 8. students' general behavior and moral ethics, 9. Overall health (Physical, mental) of the student, and 10. Academic progress of the student over a certain period. Green indicators help in understanding students' academic situation at the regional and school levels. Green indicators provide educators an insight into education management and helps them to evaluate student`s performance, therefore provides schools and teachers with detailed, and targeted teaching recommendations. The evaluation information is then applied to the teaching improvement. This makes a cycle of standards, teaching evaluation and on the base of its improvement for the provision of quality education.

3.1. Mathematical Thinking (MT)

Mathematical thinking (MT) support sustainable mathematics learning and is one of the key objective of mathematics education. Mathematical thinking has emerged as an important feature of Chinese mathematics education. Mathematical thinking helps to nurture critical thinking and problem-solving skills in learners. Mathematical thought is

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also recommended by Chinese researchers recommended mathematical thinking as a thought process to help students understand scientific concepts and develop reasoning [5].

3.2. Artificial Intelligence (AI) in basic education

In China, the development of AI human resources has become a national education strategy, and Chinese curriculum is making its way to include artificial intelligence-related education at the elementary, middle, and high school stages.

SenseTime is a leading company and is building the largest artificial intelligence computer center in the Asian area [6]. SenseTime in collaboration with Huadong Normal University in Shanghai is to create basic artificial intelligence educational materials for high school students in China. This teaching material would be used at 40 top-level high schools nationwide, including Tsinghua University High School, Huadong Normal University Second High School, and Shanghai Jiao Tong University High School. SenseTime would provide these schools with artificial intelligence labs that will produce focusing on building new teaching models.

China is investing its resources in taking strong mathematical and digital initiatives and reforming its education vanquish future challenges.

3. JAPAN

Japan an island country in East Asia with comprising of 126.3 million of population. The current Japanese education system includes six years of elementary school, three years of Lower secondary school education, three years of upper secondary school and, finally, four years of higher education [7]. Japanese students spend many hours per week in mathematics learning. They are facilitated by parents at home with private mathematics lessons as well [8]. In Japan, the mathematics curriculum taught privately is complimented with public school´s teachings. Chinese mathematics has played a key role in the development process of Japanese mathematics. Japanese algebra oriented from Chinese mathematics [8].

3.2. Japanese Mathematics Curriculum

Japanese mathematics curriculum consists of three parts: 1. Curriculum for the basic school education includes mathematical learning objectives for primary, lower secondary, and upper secondary school levels, 2. Curriculum with objectives targeted to different grades, and 3. Plan of the recommended syllabus. In Japan, all educational institutes follow a particular syllabus for mathematics which includes aims, objectives, pedagogical approaches for mathematics teaching, tasks and activities, outcomes, and assessment of the student`s learning [9].

3.3. Common core standards for teaching mathematics

Japanese teachers use a technique called jugyokenkyu (lesson study). It is an invaluable way for teachers to improve their instruction. In this technique, teacher prepares a demonstration lesson and delivers his/her lesson in the class in the presence of other teachers and a university professor. Later participants and the teacher reflect on the demo

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teaching lesson. This kind of Lesson Study helps teachers to get a feedback for their improvement and future teaching lessons. During this process, the teacher selects a mathematical topic, create a problem question, and finally implement the study plan. In this way teachers improve their mathematical teaching with feedbacks and reflections, and therefore engage students in effective learning [10].

3.4. Mathematical Innovation

Japan`s Ministry of Education, Culture, Sports, Science and Technology outlined document for mathematical innovation. According to which various social issues can be solved fundamentally through mathematics innovation, which is difficult in problem-solving research in individual fields [11]. Mathematical innovation can be achieved by [11,12];

1. Activities that connect the discovery of needs for mathematics to collaboration between mathematics and various sciences and industries

2. A common meeting or discussion place can provide a one roof for people from research and industry to sit together and find innovative ideas for solving different real- life problems while utilizing mathematical approaches.

3. "Mathematics Collaboration Program" initiated by the Ministry of Education, Culture, Sports, Science and Technology offers workshops, events and meetings to students and researchers in the field of mathematics.

4. Promotion of mathematical research through collaboration between mathematics researchers and various sciences and industries

5. Development of human resources necessary for mathematical innovation

6. Dissemination of information and development of results

7. Improvement in statistical education

3.5. Artificial intelligence strategy 2019- Educational reform

Japan has made Artificial Intelligence utilization strategy for an AI ready society 5.0. Education for AI is proposed for all. Mathematics is the backbone of AI. Therefore, Japanese education system is stressing hard on developing good mathematical education practices to support AI literacy in Japan [13].

Japan`s idea of Globalization of knowledge explains the promotion of science, technology, and engineering (STI) for SGD`s. Under this initiative, Japan has given its 2019 plan for AI. The globalization of knowledge initiative stresses on the promotion and teaching of science, technology, and engineering to make their nation global citizens. Japan has introduced AI and mathematical education compulsory at all levels [14].

4. SINGAPORE

Republic of Singapore is an island city-state in Southeast Asia with 5.704 million inhabitants. Singapore performed exceptionally well for science, reading and mathematics

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in the 2009 and 2012 Program for International Student Assessment (PISA). Singapore stands number one position in the global school ranking for its performance in mathematics and science and secure second position in 2018 [3]. Education system in Singapore has improved consistently over the past years. McKinsey report published in 2010 named Singapore's education system as "Great" because of its consistent improvement [15].

Singapore's education system has a 6+2+2 school system which includes 6 years of primary education, 2 years of lower secondary and 2 years of higher secondary education. After this basic school education students may continue 2-3 years of pre university education at Junior colleges or other centralized institutes. Students may also join polytechnic institutes for professional education or may join the workforce [16]. Three very important and successful features of Singapore education system are [17];

1. **An ability driven system:** The ability driven education system based upon an Integrated Program (IP) where students skip the GCE 'O' level exam and join directly the GCE 'A' level exam or the International Baccalaureate (IB) diploma. Ability driven education system emphasizes on the mental, physical, and educational development of learners in the field of. science, sports, arts and mathematics.
2. **Customized and interdisciplinary curriculum:** focus on the future skill development. Students are given free hand in subject selection and they are free to choose different combinations of subjects.
3. **Teach less learn more strategy (TLLM):** focus on the teacher`s role as a facilitator of learning, who support, facilitate, and engage students in student centered learning environments. Ministry of education has given teachers more freedom by reducing the content of the curriculum. In that way teachers are less pressurized and more encouraged to engage students in more interactive ways of learnings.

4.1. Mathematics philosophy

In 1982, Singaporean Minister of Education initiated a math program named as Primary Mathematics Series years [16], taught in Singapore`s schools for twenty years. Singapore math became a registered trademark under the name of Singaporemath.Com Inc in 1998 and has been applied to US schools and got attention worldwide. In 2003, Trends in International Mathematics and Science Study (TIMSS) scores revealed Singapore's fourth graders and eighth graders were the top math performers in the world, public education started taking a closer look at the method. Singapore remained at the top as of the 2015 TIMSS [9].

The Singapore math method implements CPA (Concrete, Pictorial, Abstract) approach, mental math strategy, bar modeling, and number bonds. This kind of math methodology helps students to think mathematically [18].

4.2. Computational thinking (CT)

Computational Thinking (CT) is one of the 21st century skills that should be taught at the primary and secondary school levels. Global digitalization, industrial

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automation and advancing computing technologies demand new set of computational skills from future workforce.

Singapore has initiated many educational programs focusing on developing computational thinking in their students, from early education. Such programs include the Code for Fun and Applied Learning Program. Computing courses are added in O-level and A-level curriculum [19]. In Singapore, the importance of computational thinking development and education is understood on all levels. Government, educational institutions, parents, and private institutions, all are working together.

4.3. Strengthening digital and mathematical literacy: Initiative 2020

In the wake of digitalization, it is inevitable for economies to survive without digital literacy. Future workforce will be more skilled based and digitally literate. To join the pace with the increasingly digital world Singapore`s Ministry of Education has given a National Digital Literacy Program 2020 [20]. Strengthening Digital Literacy Program focuses four components for the digital age that is, Find, Think, Apply, and Create framework.

At Primary level:

The focus is to engage students in developing computational thinking and learning simple coding through the 'Code for Fun' program.

At Secondary and pre-University level:

1. Use of personal learning devices (PLD) will be rolled out to develop digital literacy of students by 2028. Students will use their personal learning devices with Singapore Student learning space (SLS).
2. The computing subjects will be offered by O-Level and A-Level schools.
3. Mathematics curriculum will be tailored to induce computational thinking in students.
4. Syllabus for Lower Secondary Science will be revised/updated and rolled out in 2021 that will develop interest and basic understanding of advanced technologies like Artificial Intelligence (AI) and other computation technologies.

At Institutes of higher learning level

5. The new curriculum applied to all educational institutes by 2021 is focused on nurturing 21st century skills like digital competencies, computational thinking, problem -based thinking and reasoning.
6. Artificial intelligence (AI) related topics will be taught to higher institutes. As in future there will be demand of AI competencies in sectors, such as transport and logistics, health, and finance [20].

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5. SOUTH KOREA

South Korea is a growing economy in East Asia with a huge population of 25 million people. Korean language is commonly spoken language of the country. In the South Korean education system Pre-school is optional and is offered from the age of three. Compulsory schooling starts from the age of 5 or 6 referred to as middle school (Jung Haggyo), and then High School (Godeung Haggyo). The Korean public education structure is divided into three parts: six years of primary school, followed by three years of middle school and then three years of high school. Korea's educational progress is characterized as a sequential bottom-up process. During 1950, Korea implemented its low-cost approach and achieved its universal elementary education. Then, during the 1960s and 1970s, it implemented the equalization policy to reduce competition and inequalities in access to secondary education. From 1980-1990, South Korea improved the quality of higher education. As a result of South Korea`s sequential bottom-up approach, the country developed economically. South Korea's low-cost approach, policy of equity, and implementation of plans and policies are the key instruments of South Korea`s economic growth [21].

5.1 South Korea's smart education

Korean education is introducing a new educational paradigm called "Smart Learning" in South Korea. Korea is adopting highly advanced Information Technology (IT) in education and therefore Korea`s smart education is a convergence concept of Ubiquitous Learning (u-Learning) and Social Learning [22]. South Korea has initiated its smart learning plan along with the concept of digital textbooks focusing on the idea of no more heavy backpacks. South Korea has invested $2 billion to develop digital textbooks for all schools by 2015. A research study highlighted the challenges of Korean digital textbook projects. Korean digital book pilot project is a major step in smart learning, but there are certain issues of weak internet connectivity and cyber security [23].

5.2 Korean mathematics

South Korea revised its middle school mathematics curriculum in August 2012 [24]. The focus of revision was to develop students' mathematical creativity and sound personalities. The revised mathematical curriculum emphasizes on 1. contextual learning for developing mathematical concepts and making connections with everyday lives situations; 2. manipulation activities through which students may create and innovate; and 3. ability to justify results based on their learning and experience.

South Korea has performed well and improved in last years in mathematical performance. According to a comparative study [25] done by comparing OECD countries with South Korea in terms of digital literacy and usage in schools, the results show Improvements in 2018 over 2015 in ' access of ICT at school', 'access of ICT at home', and usability of digital devices outside of school for non-learning purposes. The study has shown that the national index of digital literacy is low as compared to other OECD countries. Therefore, South Korea requires more efforts in developing mathematical and digital literacy prior to the fourth industrial revolution.

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6. PAKISTAN

Pakistan is one of the Asian countries who is seeking educational reforms for the development of its economy and meeting the challenges posed by the global digitalization and industrial automation in future. Unlike the above mentioned four Asian countries, Pakistan is lagging in providing basic education with equity and quality. Lack of effective reforms, lack of finances, poverty, corruption, and inconsistency in policies are the main factors contributing to this incapability. New Pakistani Government in 2018, initiated many plans for the educational reforms focusing on introducing digitalization and ICT education in basic education [26].

6.1. Pakistan`s educational system

Pakistan`s education system is divided into six levels [27]:

1. Preschool (for the age from 3 to 5 years)
2. Primary (grades one through five)
3. Middle (grades six through eight)
4. High (grades nine and ten, leading to the Secondary School Certificate or SSC)
5. Higher Secondary grades eleven and twelve, leading to a Higher Secondary School Certificate or HSSC
6. University programs leading to undergraduate and graduate degree and post graduate studies leading to PhD.

6.2. Digital Pakistan Initiative

Pakistan ministry of Information technology along with Pakistan ministry of education has initiated Digital Pakistan initiative, under which the idea of Digital education is initiated. Around 423 Federal Government educational institutions in ICT are providing educational services to 220,000 students from kindergarten level to postgraduate level [28]. Ministry of education is now focusing on digitalizing the educational management systems and introducing systems such as.

- Online admission systems
- Online learning courses
- Blended learning system: Project for implementation of Blended Learning System in 200 classrooms is initiated
- Online monitoring system
- Smart Board system in 75 female institutions by the collaboration with JAZZ and Smart learn Pakistan companies. This system will be extended to more institutions in future [28].

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6.3. National education policy framework

The government launched National Education Policy Framework 2018 [29, 30] envisaging;

- Enrolling 25 million out of school children
- Provision of quality education
- Skill development
- Uniformed syllabus across the country
- Education volunteers' program would also be launched soon to make educators available to far flung areas.
- Establishment of National Skill University
- 27,300 out of school children in capital city of Islamabad will be brought back to school [29].
- Future skill development programs
- Uniformed syllabus across the country
- Smart schools to fulfil teacher`s shortage in different part of country

6.4. Pakistan educational policy 2021

The Ministry of Federal Education and Professional Training is working on Pakistan National Education Policy 2021 through a widespread consultative process. Pakistan Education Policy 2021[29] focuses on national harmony, unity among different religious and ethnic communities. PEP 2021 aims to develop educational standards by paying special attention to education management systems, teaching standards and teacher training systems, examination and admission management systems, digital literacy and provision of basic education for all children.

6.5. Pakistan mathematical society

The Pakistan Mathematical Society (PMS) is the most engaged scientific society of Pakistan in mathematical education and research. PMS organizes seminars, conferences and meetings for the promotion and development of mathematical knowledge on national and international levels[31].

The educational reforms in Pakistan are focusing on the provision of basic education to the masses and means to bring out of school children back to school. Pakistan is not having special initiatives regarding mathematical education. Mathematics is taught as the basic subject from grade 1 to grade 10. After that, it is up to the choice of the student to take mathematics as a subject to further study. For engineering study, mathematics is a compulsory subject.

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Pakistan is the world's second country with highest number of out-of-school children (OOSC) with 22.8 million children aged 5-16 not attending school. It represents representing 44 per cent of the total population in this age group. In the 5-9 age group, 5 million children are not enrolled in schools and after primary-school age, the number of OOSC doubles, with 11.4 million adolescents between the ages of 10-14 not receiving formal education. Disparities based on gender, socio-economic status, and geography are significant; in Sindh, 52 percent of the poorest children (58 percent girls) are out of school, and in Balochistan,78 percent of girls are out of school [32]. As a result of this, the literacy rate of the country is not growing sufficiently. To keep pace with economic development and global digitalization, skillful education is the steppingstone.

7. INDIA

India is the second largest country, situated in south Asia with population of about 1.3 billion. After getting independence from Britain in 1947, India inherited British education system and tried to seek reforms in past years. Indian and Pakistani education system has its roots from the colonial times. Different languages are spoken in different Indian regions, but Hindi is the most common language. The education system in India is a "10 + 2 + 3" system. Lower primary school education lasts from the age 6-10, upper primary school education from the age 11-13, secondary 14-16, and upper secondary school education from the age 17-18 [33]. First ten years of basic education is mandatory for all children. This means that the first decade of a child's education is mandatory. Most students begin their schooling at age five, in the form of preschool. Primary school education begins at the age of 6. Students are obligated to attend school up to age 14, after that they can join the workforce.

7.1. Digital India Program

Technologically driven 21st century has equipped everyone with digital devices. One such technology Mobile Applications (M-App). Digital India program is using this technology to change the future of India and its citizens. Government of India is initiating many digital programs for learning and governance, such as M learning apps for digital India [34]. Indian Government has initiated 28 digital initiatives under the digital education program. Some of the main initiatives are [35];

- Availability of MOOC courses
- Virtual labs
- Digital libraries
- Mobile apps for mathematical education
- SOS tools
- Text Transcription of video content etc.

Online learning has become more common phenomenon in schools to facilitate learners in learning different courses. Majority of the schools are offering online and digital learning programs [36].

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7.2. National education policy 2020

India`s National Education Policy 2020 [37] has paved the way forward for educational reforms both at School level (Kindergarten to 12th- Senior Secondary Education) and in Higher Education.

1. The national education policy focuses on equity, access, use of technology effectively and importance to teacher development and professional training.
2. Teaching of basic coding would start from Grade 6 and students would be exposed to basic computer skills. Also, internships for Grade 6-8th with local and indigenous craftsmen would be a part of the opportunities.
3. The Govt of India has created Atal Tinkering Labs program which focused on applied science and problem-solving funding tinkering labs at the Schools.
4. Government will be funding innovative ideas to spark entrepreneurship at the campuses.
5. The govt is enabling teacher training through MOOCs, bringing in flexibility on transfer of credits, interdisciplinary approach, giving similar credit to Fine Arts and sports as well.
6. All India Council for Education- regulatory body for Technical Education in India has made decision that from 2021, for entrance to Engineering Education in India, Maths and Physics would not be a compulsory subject.

7.3. Mathematical initiatives

No separate initiatives for mathematical education are taken. Mathematics is taught as the basic subject from 1-10 grade. After that student can continue to study if he/she likes to study mathematics as a subject. There are approximately six million out of school children in India. Drop -out rates are higher in India as out of 100 students, 29 percent of girls and boys drop out of school before completing their basic elementary education [38]. Challenges remain because most of the children who are in school are not learning at grade appropriate levels. Most common reasons for high number of drop out are poverty, early marriage, child labor, violence or abuse, and poor teaching practices. Other factors include seasonal migration, and lack of access and awareness of social protection measures [38]. India`s National education policy 2020 is aimed to address the drop out problem and paving way to equity and inclusive education [37].

8. BANGLADESH

Bangladesh is a South Asian country with 163 million people. Bengali is the common language of Bangladesh. In Bangladesh, twelve years of basic education is mandatory for all children. Mandatory education consists of eight years of primary school level education and four years of high school level education. School system in Bangladesh consist of three pathways: General Education, Madrasah (religious) Education, and Technical/Vocational Education [39].

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8.1 Digital Bangladesh

Government of Bangladesh has taken initiative called Digital Bangladesh. Under this initiative, Bangladesh is preparing to provide digital health, digital education and digital commerce and automation to industrial level [40].

Bangladesh is thriving to increase the literacy levels throughout the country. Through Digital Bangladesh is making it possible for its pupils to access education everywhere. Digital materials, online courses, and mobile applications are helping country in improving its digital and overall literacy. Use of digital white boards, tablet devices and learning apps are helping to integrate digital learning in conventional learning. Bangladesh is reforming education with digitalization, the digital initiatives include;

1. Providing virtual classrooms [41].
2. Online courses
3. Digital libraries
4. Learning mobile applications
5. Digital devices and equipment usage

Although general education on a basic level is improving in Bangladesh but the country is still facing a drop out challenge. According to UNICEF the increase in dropout rate remains is due to children's need to help with farming, child labour, poor teaching practices, poverty, and crowded classrooms[42].

9. NEPAL

Nepal became a republic in 2008. The country has population consisting of approximately 28 million inhabitants. Official language of Nepal is Nepalese. Nepal`s education system consists of 10+4+2 system. It includes ten years of basic school education, four years of college level studies (two years of intermediate and two years of bachelor program), and two years of the master's program at the university [43].

9.1 Digital education

In Nepal, the initiative of introducing ICT in school education is progressing. Nepal`s education Master Plan executes the implementation of the Information and Communication Technology Education Master Plan [44] which has increased the access to computers, internet, and digital learning materials in schools, therefore developing digital literacy at basic school education level.

9.2 School sector development plan (2016-2023)

The recent national educational plan that is School Sector Development Plan (2016–2023) integrates and focuses on use of ICT in government schools. This demonstrates the commitment on the part of the government. E-textbooks are in process of development and adoption [45].

According to UNICEF [46], Nepal has number of challenges posed by poor quality and inequity, geographical remoteness, gender, and socioeconomic and ethnic differences.

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10. DISCUSSION

From the table below we can find a correlation of educational development in terms of mathematical and digital education and the economic development of a country. However, the impact of their educational strategies on the growth process of economies can be seen after 5-10 years. Digital initiatives are taken by almost all countries however their pace and affectivity are different to different countries and their resources. Strong mathematical initiatives are taken by China, Japan, Singapore, and South Korea. There are no separate initiatives for mathematical education are taken by Pakistan, India, Bangladesh, and Nepal.

China being at first place and Singapore at second place took the top ranks in PISA 2018 ranking. South Korea retained its place among top ten countries with rank 9 and Japan places at rank 15. PISA is not applied to Pakistan, India, Bangladesh, and Nepal as these countries are not participated in PISA [3]. Although, PISA ranking is not a precise tool for measuring the educational performance of a country. However, in recent years it has been observed that PISA has emerged as a performance evaluator and help countries to evaluate and develop their educational systems more effectively. PISA provides a feedback also to check and correct any shortcomings or make improvements in the educational systems if required.

Table. Comparison of eight Asian countries in digital literacy initiatives, mathematical literacy initiatives, ranks in mathematics and science in PISA results 2018, and ranks in inclusive development index IDI 2018 [47]

Countries	**Mathematical initiatives**	**Digital initiatives**	**Ranks in mathematics and science education in PISA/OECD 2018 Out of 70 country participated**	**Ranks In inclusive development index IDI 2018 Out of 189 countries participated**
China	√	√	1	26 out of 74 emerging economies (Emerging economy)
Japan	√	√	15	24 out of 29 advanced countries (Advanced economy)
Singapore	√	√	2	NA

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South Korea	√	√	9	16 out of 29 advanced countries (Advanced Economy)
Pakistan		√	Not Applied	47 out of 74 emerging economies (Advancing economy)
India		√	Not Applied	62 out of 74 emerging economies (Advancing economy)
Bangladesh		√	Not Applied	34 out of 74 emerging economies (Slowly advancing economy)
Nepal		√	Not Applied	22 out of 74 emerging economies (Advancing economy)

Inclusive Development Index (IDI) reflects more closely the criteria by which people evaluate their countries' economic progress [47]. In IDI index countries are classified as advancing countries (emerging economies) or advanced countries (advanced economies). Table below shows that China, Japan, Singapore, and South Korea are performing well in IDI index. China is fast emerging economy, while Japan, Singapore and South Korea are advanced countries. Pakistan, India, Bangladesh, and Nepal are emerging/advancing economies according to the inclusive development index.

It is noted that all the above Asian countries are driving towards the digital literacy. Advanced countries (China, Japan, South Korea, and Singapore) are well ahead in digital education focusing on Artificial intelligence, computational sciences, coding and mathematical literacy and developing mathematical thinking, mathematical innovation and computational thinking in their core curriculums. On contrary, developing Asian countries are behind on taking initiatives for mathematical education but well on track in terms of taking initiatives for digital literacy and digitalization. Digital education initiatives are taken by Pakistan, India, Bangladesh, and Nepal. However, there are factors related to limited resources, huge populations, poor teaching methods and lack of planning and implementation which hinders the process of development.

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3. Conclusions

Fast economic growth requires human development. Human development can be achieved with the provision of quality education, modern skills, digital and mathematical literacy. We have presented here a case of four highly emerging/developed countries (China, Japan, South Korea, and Singapore). The developing or advancing countries can follow the path to fast economic growth and development by learning lessons from developed countries. New emerging technologies are posing challenges to the future workforce. Therefore, to meet those future challenges and achieving economic growth and development on a faster and stable pace, the progress in mathematical and digital education is inevitable. No nation can earn economic development without their human development. Future industrial change due to automation and digitalization will create a big economical gape between developing and developed countries, if skillful workforce will be unavailable in developing countries due to the lack of the provision of digital and scientific education to their youth. Therefore, digital and mathematical/scientific literacy is a key to the future industrial skill development and economic stability.

References

[1] OECDMcClure, L., (2019), “A PISA work on mathematical literacy”, [Online] Available:https://www.cambridgemaths.org/blogs/a-pisa-work-on-mathematical-literacy/

[2] Laurens, T., Batlolona, F. A., Batlolona, J. R., & Leasa, M, (2018) “How Does Realistic Mathematics Education (RME) Improve Students’ Mathematics Cognitive Achievement?”, Eurasia Journal of Mathematics, science and technology education.

[3] OECD, PISA 2018 Database. Online Available:https://doi.org/10.1787/888934028254

PISA https://www.oecd.org/pisa/

[4] Wenjie, Y. & Guorui, F, (2019) “Post-PISA Education Reforms in China: Policy Response Beyond the Digital Governance of PISA”, ECNU Review of education, Vol. 2(3) 297–310.

[5] Li, N., Mok, I., & Cao, Y, (2019) “The Evolution of Mathematical Thinking in Chinese Mathematics Education. Mathematics”, 7(3), 297. doi:10.3390/math7030297.

[6] Sensetime China, [Online] Available:

https://www.sensetime.com/me-en

[7] Education in Japan, [Online] Available:

Japanese Educational System | Education in Japan (in-japan.education)

[8] Schumer, G, (2010) “Mathematics education in Japan”, Journal of Curriculum Studies, 31. 399-427. 10.1080/002202799183061.

[9] TIMSS, 2015 “Trends in International Mathematics and Science Study”, [Online] Available: https://nces.ed.gov/timss/

[10] Isoda, M, (2007) “Japanese lesson study in mathematics”, [Online] Available: https://doi.org/10.1142/6339 | February 2007

[11] METI and MEXT report, 2019, [Online] Available:

DOI: 10.5121/ije.2021.01601

https://www.meti.go.jp/english/press/2019/0326_004.html

[12] MEXT, "Ministry of education, culture, sports, science and technology, Japan" [Online] Available:

https://www.mext.go.jp/en/

[13] AI utilization strategy, 2019 [Online] Available:

http://www.keidanren.or.jp/en/policy/2019/013_outline.pd

[14] Integrated Innovation Strategy, (2017), [Online] Available:

https://www8.cao.go.jp/cstp/english/doc/integrated_outline.pdf

[15] Snart, F, (2011) " 2010 McKinsey & Company report: How the world's most improved school systems keep getting better", Journal of Educational Change. 12. 10.1007/s10833-011-9176-8.

[16] Wong, K.Y., Lee, P.Y., Berinderjeet, K., Foong, P.Y. & Ng, S.F, (2009) "Mathematics Education: The Singapore Journey",Series on mathematics education, vol 2.

[17] Tan, C., & Koh, K. & Choy, W. (2016). The education system Singapore. *In Juszczyk, S. (Ed.Asian Education Systems (pp. 129-148).*

[18] What is Singapore Math? Singapore Math Inc.[Online] Available:

https://www.singaporemath.com/what-is-singapore-math/

[19] NIE, National Institute of Education, (2019-2021), Singapore, " How to Bring Computational

Thinking (CT) Into Mathematics Classrooms: Designing for Disciplinary-specific CT": a project, [Online] Available:

https://www.nie.edu.sg/research/projects/project/oer-10-18-lck

[20] National digital literacy program initiative, 2020, Singapore, [Online] Available:

Press Releases (moe.gov.sg)

[21] Chong, J.L., Yong, K. & Soo-Yong, B, (2012) "The rise of Korean education from the ashes of the Korean War" PROSPECTS. 42. 10.1007/s11125-012-9239-5.

[22] Zhu, Z.T. & Yu, M.H, 2016 "A research framework of smart education" , Smart Learning Environments 3:4, DOI 10.1186/s40561-016-0026-2.

[23] Jeong, H. & Kim, A,(2015) "The Digital Textbook in South Korea: Opportunities and Challenges", doi:10.1007/978-981-287-326-2_6.

[24] Lew, H.C., Cho, W. & Koh, Y.l,(2012) "New challenges in the 2011 revised middle school curriculum of South Korea: mathematical process and mathematical attitude", ZDM Mathematics Education 44, 109–119.

[25] Kim, K., & Min, M, (2020) "Comparative Analysis of ICT Accessibility and Usability of Korean Students Based on PISA 2015 and 2018 Data" , International Journal of Internet, Broadcastingand Communication, 12(1), 73–80. https://doi.org/10.7236/IJIBC.2020.12.1.73.

[26] Ghulam, R.M. (2007), "Education in Pakistan: The Key Issues, Problems and the New Challenges", Journal of Management and Social Sciences.Vol. 3, No. 1,(Spring 2007) 47-55.

[27] Education system in Pakistan, [Online] Available:

DOI: 10.5121/ije.2021.01601

https://www.scholaro.com/pro/Countries/Pakistan/Education-System#:~:text=Education%20System%20in%20Pakistan%201%20Primary%20Education.%20In,4%20Vocational%20Education.%20...%205%20Tertiary%20Education.%20

[28] Digital Pakistan Initiative, (2020), [Online] Available:http://mofept.gov.pk/ProjectDetail/ZDZjYzY3ZDAtZTQ2OS00NGRhLTliNmItMzJmMzdiYTY3ZDE0

[29] Ministry of Federal Education and Professional Training Pakistan, (2018) “National education policy”, [Online] Available: http://www.mofept.gov.pk/SiteImage/Policy/National%20Eductaion%20Policy%20Framework%202018%20Final.pdf

[30] Burke, L. (2019) “Pakistan`s 2018 national education policy: The nationalization of the private education sector? Proceedings of INTCESS 2019- 6th International Conference on Education and Social Sciences,4-6 February 2019- Dubai, U.A.E.

[31] PMS. Pakistan Mathematical Society, [Online] Available:

http://pakms.org.pk/history.htm

[32] UNICEF Pakistan, [Online] Available:

https://www.unicef.org/pakistan/education

[33] Indian education system, (2015), “An overview of the anchient Indian education” [Online] Available:

https://www.semanticscholar.org/paper/Indian-Educational-System-:-An-Overview-of-the/efd3370cb7cdad525bf81f688f42a3490bb93506

[34] Joshi, D. & Bansal, T, (2017) “M learning apps for digital India”, Computing Conference,

London, 2017, pp. 1136-1142, doi: 10.1109/SAI.2017.8252233

[35] Digital Initiative of Government of India in Higher Education. (2019), [Online] Available:

https://www.lisportal.com/en/lis-result/3720-digital-initiative-of-govt-of-india-in-higher-education

[36] Gemin, B. & Pape, L.& Vashaw, L.& Watson, J., (2015) “Keeping Pace with K-12 Digital Learning: An Annual Review of Policy and Practice”,Twelfth Edition. ERIC Number: ED570125

[37] NEP, (2020) “National Education policy Ministry of Human Resource development. Government of India”, [Online] Available:https://mail.google.com/mail/u/0/?hl=enGB#inbox/FMfcgxwLswHJJnTVTRgnxwgDlXJvbWJM?projector=1&messagePartId=0.1

[38] UNICEF India, [Online] Available: https://www.unicef.org/india/what-we-do/education

[39] Mohit, P. & Ranada, P.S, (2016) “The education system in Bangladesh and the scope of Improvement”,Journal of International Social issues.

[40] Digital Bangladesg, a concept note, [Online] Available:http://btri.portal.gov.bd/sites/default/files/files/btri.portal.gov.bd/page/a556434c_e9c9_4269_9f4e_df75d712604d/Digital%20Bangladesh%20Concept%20Note_Final.pdf

DOI: 10.5121/ije.2021.01601

[41] Faieza, C., (2020) "Virtual Classroom: To Create a Digital Education System in Bangladesh", International Journal of Higher Education, v9 n3 p129-138 2020.

[42] UNICEF Bangladesh, [Online] Available:https://www.unicef.org/bangladesh/en

[43] Education System Nepal, (2014), Nuffic, 1st edition., [Online] Available:

Education system Nepal (nuffic.nl)

[44] Silja, B., Soumitra, D., & Bruno L., (2016) "Global Information Technology Report", World Economic Forum.

[45] Chandan, R., (2019) "Design and Development of Multimedia E-Textbooks for School Education in Nepal", [Online] Available

http://urn.fi/URN:NBN:fi-fe2019111237822

[46] UNICEF Nepal, [Online] Available:

http://urn.fi/URN:NBN:fi-fe2019111237822

[47] IDI, (2018), "Inclusive development index", [Online] Available:

WEF_Forum_IncGrwth_2018.pdf (weforum.org)

DOI: 10.5121/ije.2021.01601