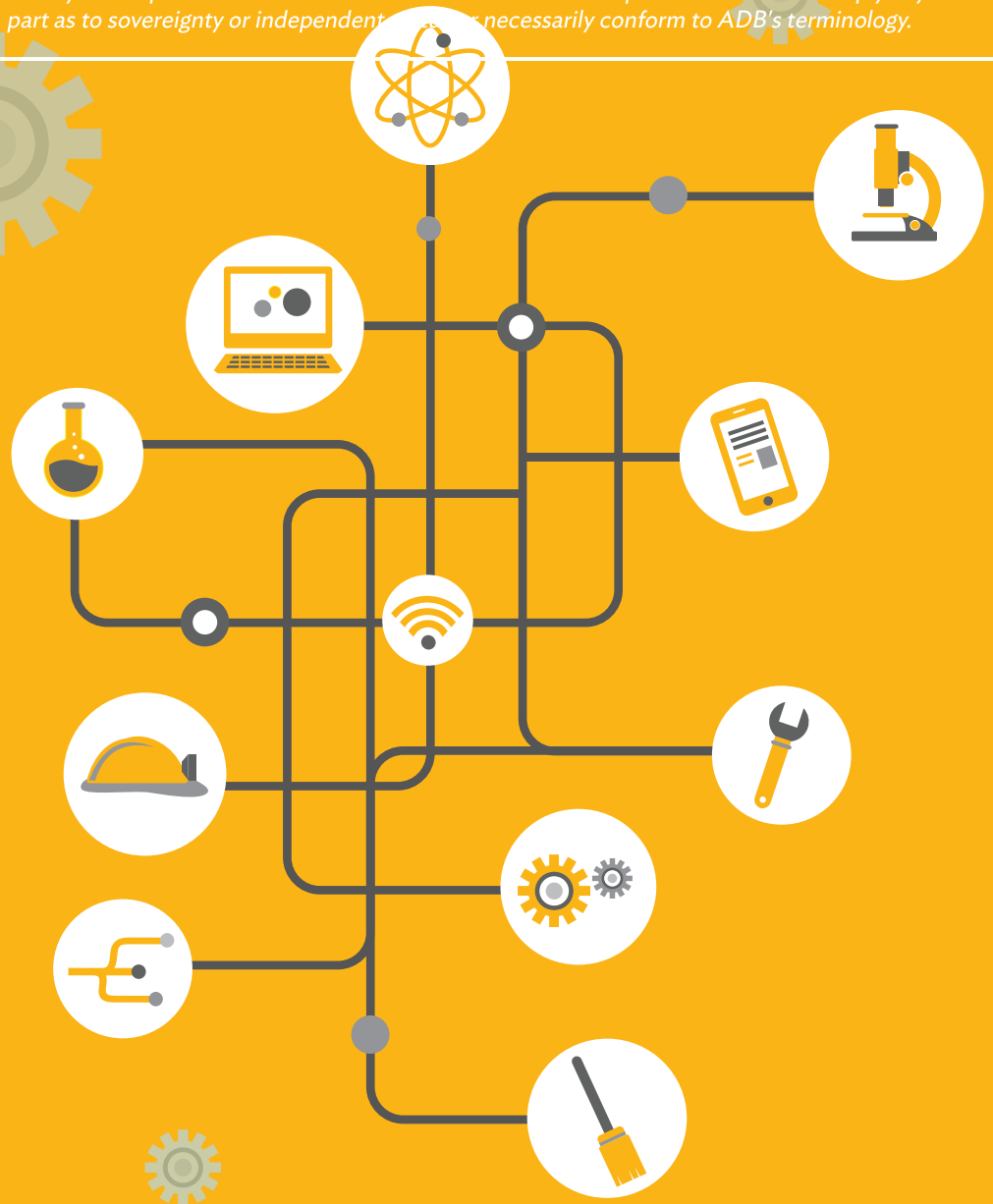

ADB

9th International Skills Forum

Reimagining Education and Skills Development for a New Normal

23 August 2021 • 1–5 p.m. (Manila time)
24 to 27 August 2021 • 2–6 p.m. (Manila time)

STEM Education: (1)Some best practices in developed countries, and (2)Findings from ADB study on four developing member countries

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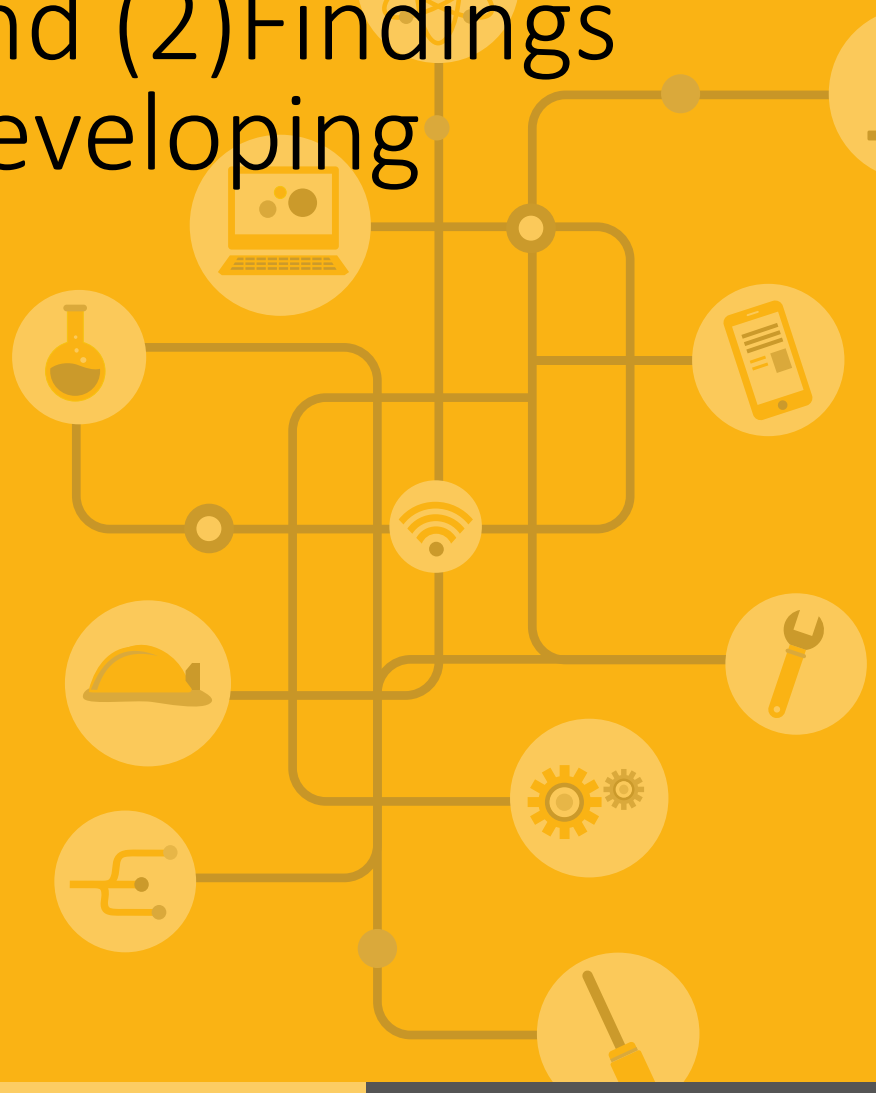

STEM

- STEM stands for Science, Technology, Engineering & Mathematics
- Science and Mathematics are school subjects in mainstream schools in the world
- Technology and Engineering are not yet school subjects in most schools
- Technology, however, is embedded in school subjects such as Design & Technology and Informatics. Also, it is common for teachers to make use of ICT-based resources when teaching Science and Mathematics.

STEM (cont'd)

- It is common for educators to talk about STEM when what they mean are, in fact, Science and Mathematics subjects as well as those related to ICT.
- Integrated STEM, where Science, Technology, Engineering and Mathematics are combined together, is a worthwhile goal to aspire for as students need to recognize that the modern economy is mainly driven by STEM and that the natural world is interdisciplinary in nature.

Some best practices in developed countries

- Teaching of science & mathematics are given pronounced emphasis in schools.
- High standard of pre-service teacher education in the sciences & mathematics
- Emphasis on teacher professional development in the sciences & mathematics.
- Pronounced research activity levels of teacher education institutes in STEM education subjects
- Presence of science centers, with linkages to schools.

Some best practices in developed countries (cont'd)

- Long history of NGO-based scientific academies and scientific societies as well as other associations for the cause of science promotion.
- Providers of STEM education from also outside school system.
- High bandwidth access to Internet in schools.
- Pervasiveness of ICT in lesson delivery.
- Integrated STEM education activities for students from a few sources - school-based enrichment programs, offerings from science centers or from external vendors.

ADB study on four developing member countries

- Asian Development Bank has funded a study to map the state of STEM education in four developing member countries.
- Bangladesh, Cambodia, Kyrgyz Republic and Uzbekistan are the four countries where the studies were carried out
- Findings from these studies have provided useful perspectives on the state of STEM education in each country.
- Findings can also provide useful pointers on areas for improvement.

Methodology for study

- Information avalable in public domain
- Interviews of stakeholders
- Desk work
- Design, development and administration of two surveys:

(a) STEM subjects teachers' views of STEM education

(b) School leaders' views of education

Surveys of STEM subjects teachers

Generated findings on 12 subscales:

- Syllabus in STEM teaching subject
- Assessment in STEM subject
- Textbooks in STEM subject
- Own pre-service teacher training program
- ICT in STEM education
- Students' interest in STEM subjects
- Professional development programs in STEM education
- Pedagogy in STEM subjects
- Project work in STEM subjects
- Innovations in STEM education
- Laboratory
- Design & Technology workshop

General findings from STEM subjects teachers

- They feel that their students are less likely to take up careers in STEM in the future.
- They feel that their students' interest levels in STEM subjects are not up to the desired levels.
- More effort needs to be put into exciting students about STEM.
- Inadequate professional development programs or, where teachers have attended these, quality was not up to expectations.
- Pre-service teacher training programs in STEM subjects that they have attended need improvement.
- Laboratories are not adequate and also are not well resourced for teaching science subjects.
- Internet connectivity in schools is rather slow.
- Their perception of state of STEM education in their school and country is not high.
- Their overall attitude towards STEM education is not high.

Surveys of school leaders

Generated findings on 5 subscales:

- School leadership
- School improvement
- Relationship with national education authorities
- Relationships with other stakeholders
- Professional development of teachers

General findings from school leaders

- Educational polices need some improvement.
- They feel that there could be some improvement in the quality of teachers in their schools.
- Teachers need more support for professional development.
- Universities and teacher education institutes need to provide more support to schools.
- Their perception of the effectiveness of education in their school and in the country is not high.
- Their overall attitude towards education is not high.

Recommendations

- 6 major recommendations are provided.
- More recommendations have been provided in the reports for each country.

Recommendation 1: Improve interest levels of students in Science and Mathematics

Evidence

Survey findings indicate that students' interest levels in science and mathematics are not high in most of the DMCs.

Short term action

Expose students regularly to enrichment programs, of which there are so many that can be conducted in schools using commonly available materials.

Medium term action

Need to ensure that lessons are delivered in an interesting and well-resourced manner. This is also dependent on the quality of the teaching workforce and the resources allocated for teaching subjects in STEM. So, a policy decision on teacher recruitment, upskilling of existing teachers' competencies through professional development, and resourcing the schools are important.

Recommendation 2: More professional development courses for teachers

Evidence: Both teachers of STEM subjects and school leaders have flagged off the need for more teacher professional development.

Short term action

Some of the courses, which take on board recent developments in the science and mathematics education literature, can be on the following:

- Innovative approaches to teach Physics, Chemistry, Biology, Mathematics and Primary Science.
- New ways of assessing students' learning.
- Developing low cost science and mathematics teaching aids.
- Design and development of science enrichment programs – there are so much that can be done for the various topics in the sciences.
- Using low cost materials to conduct integrated STEM activities.
- How to identify misconceptions in the sciences?
- How to address students' misconceptions in the sciences through conceptual change interventions?

Long term action

Education authorities needs to ensure that each teacher attends x hours of training annually

Teacher education institutes need to enhance the range and quality of their professional development programs

Recommendation 3: Improve pre-service teacher education in STEM subjects

Evidence

Feedback has been given that in most of the DMCs, the training programs in STEM subjects that teachers attended during their teacher preparation program need some improvement.

Short term action

Content in curriculum studies courses needs some improvement. These must also be informed by recent research developments. Also, assessment needs to be more robust.

Medium term action

Revise curriculum courses in STEM subjects at pre-service level and ensure that their enactment in the class is also in sync with the revisions.

Need more PhDs in STEM subjects education among teacher educators .

Recommendation 4: Introduce integrated STEM activities via low cost initiatives

Evidence: Teacher are not clear on how to conduct integrated STEM activities

Short term action

Contrary to popular notion, integrated STEM activities can be conducted using low cost materials and other resources.

School teachers need training on this.

Recommendation 5: Improve assessment of student learning

Evidence: Survey findings show that in most of the DMCs, assessment of learning in STEM subjects during examinations need to be more rigorous.

Short term action

Difficulty level of the questions in examinations need to be enhanced so that there is more robust appraisal of students' understanding Teachers also need more training on how to set thinking questions

Long term action

A policy change by the Education authorities is needed if students' learning are to be more rigorously assessed during examinations.

Recommendation 6: Set up science centers

- Evidence: It is noted that there are no (classical) science centers in all the four DMCs.
- Short term action: If the state can provide land and premises for free, and recruit a core team of scientific, technical and management staff, a small science center can be set up in the capital city. Quite a lot of exhibits can be fabricated using workshop facilities in tertiary and technical institutes using cookbooks produced by the Exploratorium. Science enrichment programs on STEM subjects can be produced and offered for schools. This science center can grow organically over time.
- Long term action: A science center in every major city in the DMC.

Recommendation 6: Set up science centers (cont'd)

- Contrary to popular notion, setting up a science center is not that expensive for a developing country, and it can be done using indigenous expertise and resources (Tan & Subramaniam, 1998, 2003).

Tan, W.H.L. & Subramaniam, R. (1998). Developing countries need to popularise science. *New Scientist*, 2139, 52.

Tan, W.H.L. & Subramaniam, R. (2003). Science and technology centres as agents for promoting science culture in developing nations. *International Journal of Technology Management*, 25(5), 413-426.

Summary

- The four DMCs are well positioned to ramp up STEM subjects education in schools.
- School leaders, STEM subjects teachers and policy makers recognize the need for the country to be strong in STEM education.
- There is a need to recognize areas identified for improvement in this study and work towards addressing these.

Summary (cont'd)

- It is first necessary to enhance science/mathematics teaching and learning as well as assessment in schools.
- STEM education in a country cannot just be the responsibility of schools - other stakeholders need to come in or be incentivized to come in.
- Integrated STEM education is best promoted via informal science education – either by schools or by institutions dedicated to science popularization.

Thank you

What is next? – linking STEM and EdTech to competency based teaching and learning

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ADB

Norton (1987) - five essential elements of a CBT system:

1. Competencies to be achieved are carefully identified, verified and made public in advance.
2. Criteria to be used in assessing achievement and the conditions under which achievement will be assessed are explicitly stated and made public in advance.
3. The instructional program provides for the individual development and evaluation of each of the competencies specified.
4. Assessment of competency takes the participant's knowledge and attitudes into account but requires actual performance of the competency as the primary source of evidence.
5. Participants progress through the instructional program at their own rate by demonstrating the attainment of the specified competencies.

Imagining a shift to competency based education

1. Requires revisioning/reimagining education systems to focus on **outcomes** instead of inputs
2. Move from content driven to **skills** driven
3. From credit/time based system to **performance** demonstration – focus on practice and mastery
4. Move away from lessons and towards **experiences** – 21st century skills – communication, collaboration, critical thinking, creativity, tech, etc…
5. Assessment methods revision - strict grading to feedback based on performance and **mastery**

STEM/EdTech connection

A. **Practice** – learning by doing

B. **Problem** – ability to solve real world challenges

C. **Performance** – focus on mastery not hierarchy in grading

D. **Personalization** – encouraging learners to become empowered in learning decisions

Thank you