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# BUILDING STEM LITERACY IN CAMBODIAN HIGHER EDUCATION

*Technology alone is not enough. It's technology married with liberal arts, married with the humanities, that yields us the results that make our heart sing.*

Steve Jobs 2011


*Cambodian youth is now very interested in STEM professions: 14th Cambodia STEM Festival, Phnom Penh, November 2018*

## Introduction

STEM – the acronym for science, technology, engineering and mathematics – has become a dominant education discourse, and already a buzz word for many, around the globe. Policymakers view STEM skills as a means for a country to build a truly competitive economy. Similarly, STEM-qualified workers hold a comparative advantage in the job market. This importance has resulted in the promotion of students' interest in STEM subjects and selection of STEM majors at degree level, as well as government capital investment in STEM-related courses, at both general and higher education levels.

As in other countries, efforts to promote STEM education and professions in Cambodia have been largely linked to the increasingly vital role of science and technology in society, as set out in key national plans, strategies and policies. One such pivotal policy document is Industrial Development Policy 2015–25, launched in 2015, which aims to transform Cambodia from a low-skilled labour-intensive economy into a highly skilled and higher value-added competitive economy by 2025 (Council of Ministers 2015).[1] Policy to promote and strengthen STEM education and learning was introduced a year later with a focus on improving the ability of higher education institutions (HEIs) to produce multi-competent graduates in related disciplines with the personal, practical and technical skills needed to support Cambodia's economic capacity. The importance of STEM cannot be emphasised enough. The prime minister recently reaffirmed the government's commitment to

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1 Other key national science, technology and innovation-related policies include the 2013 Cambodia National Science and Technology Master Plan 2014–20 and the 2014 Cambodia ICT Master Plan 2020. The government also established the National Science and Technology Council and its general secretariat in 2014 and 2015, respectively.

## In this Issue

promoting the development of science, technology and innovation, stating that the "Development of science and technology will enhance productivity, growth, knowledge and technological capacity, which will help Cambodia build a knowledge-based society" (CDRI 2018, 1).

Despite strong commitment, STEM is still a relatively new term in Cambodia, carrying different meanings for different people. Although the term is widely used, policy documents rarely give a definition of STEM; and when they do, there is no clear elaboration. Both STEM Policy and the Higher Education Vision 2030 still treat STEM as siloed disciplines taught in a classroom setting. The Education Strategic Plan 2014–18 and the Higher Education Roadmap 2030 refer to STEAM, simply highlighting the equal importance of arts-related majors. None of the policy documents discuss STEM or STEAM as an emerging integrative paradigm, with STEM literacy as a goal, suggesting the lack of a clear definition of STEM and related concepts. This raises the question of the true meaning of the term and how, without regard for context-specific understanding, Cambodia can improve the quality of STEM graduates to meet the challenges of the fast-changing national and global landscape.

The paper draws on a study conducted by the Cambodia Development Resource Institute (CDRI) to review modern STEM programs in Cambodian HEIs. The paper begins with a brief overview of the study. It then describes the conceptual framework for integrative STEM education used to explore the current teaching and learning of STEM subjects in Cambodian HEIs, focusing on progress made towards achieving STEM literacy. The final section offers some recommendations for future studies.

**The study**

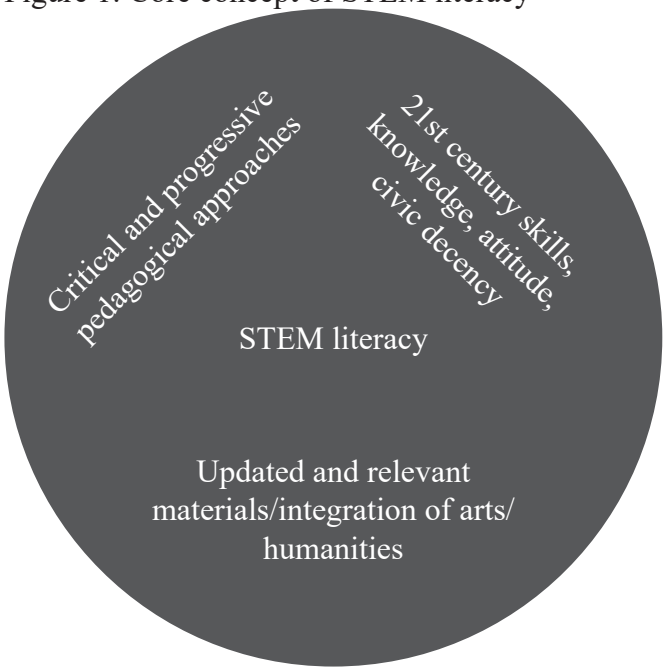
This paper supplements a large-scale study of Cambodian STEM higher education, conducted by CDRI's Education Unit from May to November 2017 at 15 selected HEIs. Data was collected from documents and over 100 semi-structured interviews with Cambodian policymakers, educators, students and employers. STEM programs across different disciplines were examined including agricultural science, information technology, biology, chemistry, maths, medicine, environmental science and engineering.

**STEM literacy as a paradigm**

STEM education, restricted to the teaching of science, technology, engineering and mathematics as individual subjects (silos), has a long history. However, as a paradigm, STEM only entered into public discourse in the 1990s. Initially the term was used to simply refer to the importance of these individual disciplines, with utilitarian aims of building national economic competitiveness and employability skills and attributes (Chesky and Wolfmeyer 2015). Such aims have in many ways restricted how STEM programs have been delivered, not only reinforcing traditional teacher-centred instruction, but also overlooking the interconnectedness or interdisciplinarity of these subjects in a real-world situation. The result has been the privileging of certain hard skills over the acquisition of soft skills such as collaborative teamwork, critical thinking and creativity and the development of values and virtues such as compassion and ethical responsibility. Not surprisingly, STEM graduates are commonly cited as ill-equipped with intellectual development, personal values and social responsibility, beyond their technical expertise.

In efforts to imbue students with a healthy balance of soft and hard skills, STEM education has gradually developed into an integrative paradigm, where the purpose is to produce graduates with 21st century skills, knowledge, personal values and virtues. Also referred to as STEM literacy (Bybee 2013), this paradigm requires interdisciplinary STEM curricula that "explore teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects" (Sanders 2009, 21). At the higher education level, integrative STEM emphasises the inclusion of social sciences and humanities/arts. Pedagogical approaches have to be critical and progressive, encompassing the interaction between the learner and the instructor. Problem-solving or project-based learning is also key to providing students a real-world experience beyond learning theoretical concepts in the classroom. Overall, building STEM literacy requires a strong connection between vision and mission statements and practices on the ground, particularly the pedagogical approaches used and the curriculum content taught, as summarised in Figure 1.

Figure 1: Core concept of STEM literacy




## Findings

### Purpose of STEM programs

The mission of Cambodian higher education is "To build a quality higher education system that develops human resource [sic] with excellent knowledge, skills and moral values in order to work and live within the era of globalization and knowledge-based society" (MOEYS 2014, 3). Two key national policy interventions reflect this intention. One is the Foundation Year Program, introduced in the mid-2000s, which is arguably rooted in liberal arts philosophy and requires that first-year undergraduates take a variety of basic courses in sciences, social sciences, humanities and foreign languages before progressing to their specialisation. The other is the Cambodian Qualifications Framework (CQF), introduced in 2012, which provides guidance for the development of education at all levels. At the higher education level, the CQF highlights the development of graduates with knowledge, interpersonal skills, digital and ITC literacy, numerical skills, and a sense of civic responsibility.

Across all Cambodian HEIs, the integration of the foundation year and credit transfer system into their undergraduate programs, in principle, suggests their alignment with the national education goal, which is to produce competent graduates who can actively contribute to the country's socioeconomic and political development. Hence, we can conclude that the goals of STEM programs across the 15 surveyed universities have embraced the national higher education vision.

However, STEM Policy, introduced in 2015, is narrowly oriented, mainly supporting a national plan for the economic transformation of Cambodia, as set out in IDP 2015–25. This emphasis on a utilitarian approach means the goal of STEM policy overlooks the sociocultural dimensions of education, as highlighted in the national vision for Cambodian higher education and the missions and objectives of the 15 studied HEIs.

### STEM pedagogy and curriculum content

Although the goals of Cambodian higher education at both national and institutional levels are in many ways aligned with the goal of STEM literacy, there is a clear discrepancy between the vision and mission inherent in STEM literacy and the pedagogical approaches and the curriculum materials used in STEM education. In reality, STEM teaching and learning remain constricted by a silo mentality. The implementation of the CQF and the credit system has yielded mixed results, with most HEIs offering courses based on prescriptive curricula with few options or little flexibility for learners. The implementation of integrative STEM education in Cambodia faces several challenges, as elaborated below:

#### *Traditional teacher-centred approach*

One-way face-to-face classroom lectures still dominate Cambodian higher education, with teachers regarded as the sole repositories and dispensers of knowledge. There is little interaction between students or between students and teachers at many HEIs, generating a submissive graduate workforce rather than one with the key competencies for the 21st century – collaboration, creativity, critical thinking and communication (the "Four Cs"). A constraint on STEM graduates' creativity and innovation is their lack of exposure to the arts and humanities – a consequence of the rigidity of the curriculum and limited interdisciplinarity. Relatively few universities have successfully adopted the academic credit system, which is aimed at providing options and flexibility for students in both core and elective courses. Course selection at most HEIs therefore remains prescriptive by nature. Even the foundation year programs are seen simply

as a bridge between high school and university, rather than the added value of interdisciplinarity between science and arts/humanities. Indeed, many employers complained about graduates' lack of soft skills, including team spirit and communication. According to some, it usually takes graduates at least three to six months to adjust to the workplace.

Another issue highlighted by the study is the scant professional development opportunities for academics across Cambodian HEIs. As a result, few instructors have adopted new approaches such as project-based learning or internship in their programs, even though such learning pathways are made explicit in the CQF. Also, many instructors were locally and traditionally educated and therefore had little to no experience of student-centred approaches themselves. On becoming instructors, they simply adopted the same conventional teaching-learning approaches.

***Little integration of information and communication technology***

While the world is becoming increasingly digitalised, with Industry 4.0 and artificial intelligence looming large, information and communication technology (ICT) remains on the margins in curricula and in the operations of HEIs. In addition to insufficient resources, many faculty members had no prior training in using digital teaching platforms. This is concerning because digital illiteracy is preventing faculty members and students from accessing a wealth of online resources. It is also undermining Cambodia's efforts to widen access to higher education for the general public, 70 percent of whom are under the age of 30, even though half of the population owned smartphones as of 2016 (Phong, Lihol and Sola 2016).

***Obsolete and discipline-based content***

The contents of STEM majors in Cambodia are very much discipline-based, with students mainly oriented towards acquiring the technical skills required in their career field. The contents of a number of majors, including mathematics, physics, biology and chemistry, were outdated. In almost every discipline, the instructors used only locally produced textbooks compiled by adapting materials and contents designed for use in a foreign teaching environment, supplemented by imported foreign-language textbooks. This is a root cause of the irrelevance of curriculum content to the fast-changing labour market and to society at large. In addition, many faculty members who participated in the study had limited exposure to research, and therefore had limited capacity for engaging in curriculum renovation. Even those with research experience had barely updated their courses, largely due to their teaching workload either at one or many HEIs – a persistent issue omnipresent in developing countries.

***Poorly equipped libraries and laboratories***

Most HEI libraries are under-resourced, with books mainly donated by development partners and charitable organisations. The irrelevance of such study materials to the local reality is one of the main challenges besetting national efforts to promote reading and research culture. This is not to mention the lack of reading culture in Cambodian society in general and among students in particular. The students interviewed for the study reported using the library just once or twice a week, particularly when their regular classes were cancelled. Furthermore, the teaching and learning of science is severely handicapped by the lack of modern and state-of-the-art laboratories, with serious implications for the country's socioeconomic development.

***Compromised quality of STEM programs***

Access to STEM education is a complex issue. Government efforts to promote student interest in these disciplines have compromised education quality, particularly in the private sector. At high school, the majority of students opt for the science stream but, when it comes to higher education, the opposite holds true. At university, the majority of high school graduates, including talented maths and science students, select social science majors. To expand access to higher education and address enrolment issues, many HEIs have lowered their entry requirements, attracting both highly qualified and poorly prepared students. To accommodate the wide range of abilities, HEIs have to modify their STEM programs and curriculum contents, which can compromise the quality of STEM education.

**Recommendations**

The discussion has highlighted the complex issues relating to the development of STEM literacy in Cambodia and pinpointed the crux of the matter: how Cambodia can in the short term provide quality

education and in the long run, produce well-rounded graduates as responsible citizens and key enablers to realise its vision of becoming an upper-middle-income country by 2030 and a high-income country by 2050. From our findings, we propose five key recommendations for Cambodia to achieve STEM literacy:

***STEM literacy for Cambodia.*** STEM policy has to be revised to incorporate sociocultural dimensions into its vision. Innovative and progressive pedagogy, with the support of ICT, needs to be integrated into STEM programs, but with adaptation and adjustment to ensure the right fit with the Cambodian social system. The review of STEM content has to be conducted by all HEIs and should engage faculty members, employers, students and their parents.

***Centres for excellence***. Each HEI has to develop a centre for teaching and research excellence, with its mandate to support faculty members and administrators in integrating innovation, ICT and critical pedagogy in teaching and learning STEM. Not only will international best practices and lessons be shared among them but also research on the practical challenges facing teachers in the classroom will be conducted. These centres will play a role in initiating outreach programs that provide students opportunities to apply their knowledge in a real-world setting, bridging the gap between school and workplace.

***Science park***. This will provide a space for collaboration between the government, industry and HEIs in the promotion of science and innovation in Cambodia. It will manage the flow of knowledge and ideas emanating from university research to the private sector for commercialising research and developing products. Properly managed, the science park will allow Cambodia to develop high-tech industry, as demonstrated in many developed and emerging economies.

***A supportive ecosystem***. STEM needs a healthy and supportive higher education ecosystem. To enable cross-disciplinary STEM teaching and learning, HEIs and the government have to strengthen such programs as the foundation year and provide more courses in arts and humanities for STEM students. New courses need to be created and integrated into existing programs, including entrepreneurship, so that STEM graduates become job creators, not just job seekers. Taking this a step further, certain non-STEM courses should be compulsory for STEM students before they can graduate.

Professional development training for support and teaching staff has to be initiated and institutionalised. Such approaches as project-based learning would not be possible without support from open-minded and well-informed administrators, through motivating instructors, establishing a system of collaboration and providing them with necessary resources. Student support services of all kinds are needed, including libraries, dormitories, counselling, employment and careers advice. This means HEIs should begin to look at the development of students as whole human beings, rather than just consumers of skills.

***STEM for the bright mind***. Although student interest in STEM should be promoted, STEM has to be for the best and the brightest, with strong science and maths backgrounds as prerequisite. Poor doctors can cause needless deaths just as mediocre engineers can cause buildings to collapse. Various measures to attract bright students to STEM majors need to be established by HEIs in collaboration with high schools. These range from regular talks by successful scientists (role models) to national science and innovation competitions.

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