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De-framing STEM discourses in Cambodia

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Summary

This qualitative study examines the development of STEM programs in Cambodian higher education, using as its theoretical framework Chesky and Wolfmeyer's (2015) concept of an integrative STEM education, which highlights the intersections between purpose, pedagogy and content. The teaching of STEM in Cambodia remains discipline-based, dominated by teacher-centred approaches and lacking real-world experience. Outdated course content and uncritical adoption of foreign curricula with little consideration for local context have resulted in a disconnection between pedagogy, content and mission. Cambodia needs to develop its own STEM education model, moving beyond the utilitarian policy discourse to embrace broader dimensions of human development.

Keywords: STEM; STEAM, Cambodia; higher education; interdisciplinary approach; liberal arts, paradigm, ASEAN

1. Introduction

Cambodia's steady economic transformation in the past 30 years has been aligned with a rapidly expanding industrial sector dominated by manufacturing and construction, moving beyond the subsistence agriculture that sustained the economy following the civil war and subsequent rebuilding. Such transformation has been supported by "structural reform, a sound and stable financial system, and well-timed and well-targeted policy stimuli" (Chhair and Ung 2016, 9). Such policies include a focus on industrial development, education (including higher education), science, technology and innovation.

This transformation has not occurred in isolation from other Southeast Asian countries. In 1999, Cambodia became the 10th member state of the Association of Southeast Asian Nations (ASEAN) and this has provided additional impetus for development with active collaborative support in areas such as economics, education, technology and science.

The Cambodia Industry Development Policy (IDP) 2015–25 espouses a vision of transformation and modernisation of the country's industrial structure from a low-skilled labour intensive economy into a high-skill economy that is technology driven and knowledge based (Council of Ministers 2015). Highlighted in the IDP is the development of highly qualified human resources in science and technology and it is within this policy context that science, technology, engineering and mathematics (STEM) became a priority for government development agendas to promote economic and societal development of the country. The Ministry of Education, Youth and Sport (MOEYS) developed its STEM policy with a vision to develop general and higher education students with strong competence in STEM subjects to meet the labour market needs of Cambodia and the wider ASEAN community.

This paper examines STEM in the context of Cambodian higher education. It positions STEM as a "taken–for-granted" object of practice to be questioned, analysed, classified and regulated around notions of purpose, pedagogy and content; in essence, how it is problematised.

2. Literature review

This section discusses two bodies of literature: (1) the policy discourse of STEM reform at the global level which the authors argue has been shaped primarily by economic agendas, and (2) the discipline-based approaches to STEM teaching and learning, partly driven by such utilitarian STEM policy discourse.

2.1. Utilitarian STEM policy discourse

STEM education is seen as a global reform paradigm. This drive for STEM reform is largely centred on the individualistic maintenance of economic competitiveness through the cultivation of human capital; that is, skilled, qualified and innovative employees. This research is situated in the context of economics, industry, higher education, and the STEM reform agendas in Cambodia and more broadly across ASEAN countries.

At the 2017 ASEAN Manila Summit, member states reaffirmed the importance of science, technology and innovation (STI) in the *ASEAN Declaration on Innovation* (ASEAN 2017). The declaration reiterated the importance of STI in fostering economic growth, job creation and regional competitiveness through the continuous development of a STEM and ICT skilled workforce through education and training policies attuned to economic needs.

The *Global Competitiveness Index* (World Economic Forum 2018) ranked Cambodia at the lower end of ASEAN country rankings in 2018, with Singapore leading and Laos trailing behind. The Index is determined by diverse factors, including institutions, infrastructure, health and primary education, higher education and training, and innovation. Cambodia is ranked below the average for the region in the pillars of higher education and training in such aspects as quality of the education system, and quality of mathematics and science education. Innovation is also below the regional average in aspects including capacity to innovate, quality of scientific research institutions, and availability of scientists and engineers.

STEM: Country Comparisons (Marginson et al. 2013) acknowledges many countries, including Finland, Germany, China, Korea and Singapore, as being "STEM-strong". These countries emphasise national development, strategic national policy frameworks around science and technology in industry, higher education, high technology development and scientific research. The report stresses that STEM-strong countries have an "unbreakable commitment to disciplinary contents" as "STEM teachers are expected to be fully qualified in their discipline and to teach in that field and not others" (Marginson et al. 2013, 15). Overall, STEM policy discourse has privileged STEM disciplines for economic growth and national competitiveness.

The situation in Cambodia is no different, with government ministries stating the importance of STEM for the country's economic future through a series of policy statements, including IDP 2015–25 (Council of Ministers 2015), STEM Policy (MOEYS 2016) and Rectangular Strategy Phase IV (Royal Government of Cambodia 2018). In sum, to master the economic future, Cambodia needs a systematic and coordinated program of knowledge, skills and technological development that increases the added value of existing and new industries for a positive economic future.

The above statements would seem to be intended to develop specific coding orientations and practices for both education and industry sectors: the "taken-for-granted" relationship between STEM and the economic future. Yet, what is missing from this neoliberalist agenda of capitalism is a clear definition of what STEM is, or is not. This is a problem of meaning for education in Cambodia, if not the world, dealing specifically with notions of pedagogical practice and instructional and regulative contexts. The instructional context refers to relations between the discursive rules of selection, sequence, pacing and evaluation related to the transmission and acquisition of knowledge and skills, while regulative contexts focus on the values, attitudes and norms of social conduct (Bernstein 2000).

2.2. Discipline-based STEM

STEM pedagogical practice in the international contemporary literature is often focused on separate discipline-based subjects, where there is little modification of the instructional and regulative contexts. Such practice suggests little or no connection between STEM disciplines or inclusion of arts and humanities (Chesky and Wolfmeyer 2015). Such a pedagogical practice does not recognise the place of the processes of inquiry, where student engagement enables the application of STEM knowledge and skills in critical and creative problem-solving contexts. Such practice raises the question of the meaning and purpose of STEM and how using the same pedagogical practice relates to the science, technology and innovation agenda for developing a positive economic future.

A recent trend advocates a shift from traditional disconnected STEM to a problem-based integrative STEM approach – a pedagogical practice that "explores 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). This suggests STEM education cannot be simply utilitarian-oriented and detached from human sociocultural values, what Tuana (2016, 242) called "the complex linkages between science literacy and ethical literacy". Steve Jobs understood this and said of his business strategy that, "It is in Apple's DNA that technology alone is not enough – that it's technology married with liberal arts, married with humanities, that yields us the results that make our heart sing" (Zakaria 2015, para. 2).

The rote-based and teacher-centred nature of Cambodian higher education limits teachers' opportunities to enhance their skills, and the introduction of a problem-based inquiry curriculum would fundamentally change the instructional and regulatory context of any faculty or department in science, mathematics, technology and engineering; in short, a fundamental change in beliefs and identity of individuals across Cambodian higher education. The six-year Cambodia Higher Education Improvement Project (World Bank 2018b), introduced in 2018, has the objective of improving the quality and relevance of education, research, and teaching and learning capacity in STEM and agriculture.

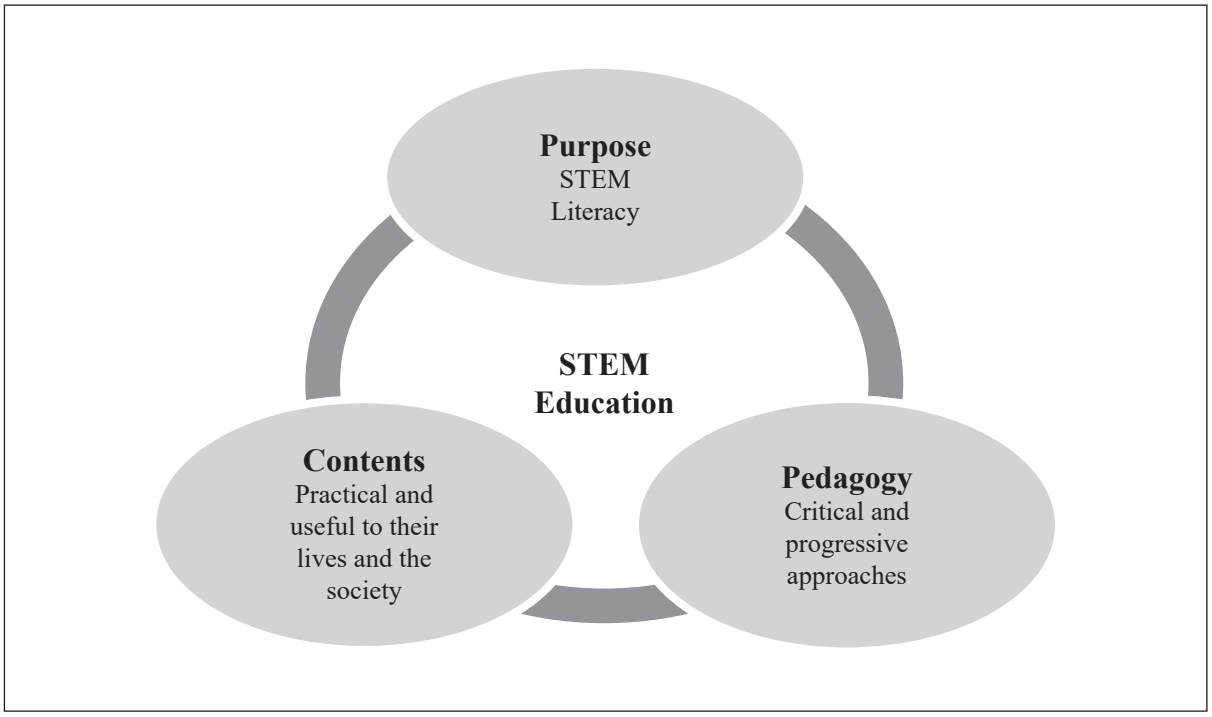
The ASEAN Economic Community 2015 and the Cambodia Industrial Development Policy set clear goals for increasing the number of graduates in STEM programs. It follows that "the STEM in the national interest" rhetoric emphasises a need for greater student enrolment in STEM subjects. In practice, however, low STEM enrolment rates in both K-12 and higher education institutions persist in Cambodia and in other parts of the world (Boe and Henriksen 2015; Eng and Szmodis 2016; Mak 2015; Peou 2015; Un 2014). Also, the intensification of STEM rhetoric across ASEAN countries has subtly coerced the governments to increasingly adopt STEM higher education policies from around the world. As an object, STEM has its principles of power and social control through policies particularly in education. Such policies are "central to how we are governed because they have all sorts of effects on the way we live our lives-both directly and indirectly through the norms they install" (Bacchi 2012, 2). Teachers and students (human) and disciplinary expectations and traditions, policies, resources and employer expectations (non-human) create non-linear outcomes. Without such de-framing, the adoption of STEM in higher education could easily take the form of uncritical knowledge and policy transfer – an approach that Crossley and Watson (2003) argued has occurred across the developing world since 1945.

This study investigates the current STEM teaching and learning practices in Cambodian higher education institutions. Such an understanding will not only assist the Cambodian government to improve the development and implementation of STEM programs, but will also help avoid the uncritical acceptance and wholesale adoption of foreign education concepts.

3. Theoretical framework

The theoretical framework draws heavily on Chesky and Wolfmeyer's (2015) constructed philosophical standpoints of ontology, epistemology and axiology within STEM. The study asks three questions: What is the main purpose of STEM education? What are the pedagogical approaches for STEM education? What are the contents of STEM teaching and learning materials? These questions provide a space to ask critical questions about the aims, assumptions and possible implications for the higher education system in Cambodia.

Figure 1: Core concept of STEM education



Source: Authors (modifications made from Chesky and Wolfmeyer 2015)

Chesky and Wolfmeyer (2015, 38) posited that "STEM is deeply entrenched with societal values and concerns"; they categorised the aims of STEM education as utilitarian, cognitive and democratic. Simply put, the purpose of STEM education goes beyond graduate employability to the development of informed citizens with a sense of social and environmental responsibility.

STEM pedagogy for responsible citizenship has to be critical and progressive, including through all interactions that teachers and students have concerning assessment, study and practical work (Bybee 2013, 6). The methods for teaching and learning STEM subjects should equip students with problem-solving, communication and critical-thinking skills (Nielsen 2011). In sum, STEM pedagogy is rooted in constructivist theory that emphasises a student's role as an active manager of learning and constructor of knowledge.

In examining STEM ontology, Chesky and Wolfmeyer (2015) referred to the post-modern standpoint of multiplicity postulated by Badio (2008), about subject selection and the knowledge students should acquire in order to grow as individuals. STEM content should be broad and comprehensive, with lessons being useful for students and relevant to context and local needs. Overall, the successful implementation of STEM programs demands strong connections between purpose, pedagogy and content.

4. Methodology

This study adopts a qualitative research approach that seeks to understand phenomenon through interpretive inquiry to best explore the weight given to social issues by people or groups (Creswell 2014). The methodology is guided by the philosophical assumptions of constructivism – the subjectivity that people attribute to experiences within their societal, cultural and historical understanding, and the interplay between researcher and researched (Winston 2012, 113). As such, interpretive inquiry fits particularly well with the study's theoretical framework and

issues of interest in an integrative approach. These both stress the important role of context and human agency in understanding STEM higher education in Cambodia.

The study draws on qualitative data, collected between May and November 2017, at 15 higher education institutions in Phnom Penh and the provinces. More than 100 interviews and conversations were completed with a range of participants, including senior administrators, academic staff, private sector employers and students' parents. In-depth interviews and focus group discussions were also conducted with 69 students and alumni. Interviews were conducted and recorded in Khmer and/or English depending on the participant's preference, then translated to English for analysis. Participants came from a variety of STEM-related disciplines, including agriculture, information technology, biology, chemistry, mathematics, medicine and engineering. Primary data was supplemented by policy documents, annual reports and course syllabi of the participating higher education institutions. Qualitative data analysis was performed using Chesky and Wolfmeyer's (2015) STEM philosophical framework. The analysis was also informed by the experience of the authors who, as insiders, are familiar with the development of Cambodian higher education. Pseudonyms are used to ensure the anonymity of participants.

5. Findings: Purpose, pedagogy and content of STEM in Cambodia

In the early 1990s, Cambodia started to transition from a centrally planned economic and political system to embrace a free market economy with multiple-party politics. With the introduction of the privatisation policy in the mid-1990s, higher education provision began to expand, from just eight public institutions in 1997 to 125 (48 public and 77 private) by 2018. Gross enrolment in higher education increased from 13,465 students in 1996 – around 1 percent of the higher education-aged cohort – to 217,840 in 2016, or 12 percent. However, the majority of students continue to gravitate towards non-STEM majors, with Business Administration being the most popular (Mak 2015). The quality of teaching and learning at the higher education level, including in STEM disciplines, has also been a concern as Cambodia's economy has undergone significant structural change away from subsistence agriculture towards more technical industry, namely the important garment and footwear sector. It is within this context that the government and stakeholders have sought to improve and promote STEM subjects – a relatively new term in Cambodia and still often misunderstood – throughout the education system. The following discussion focuses on purpose, pedagogy and content of STEM teaching and learning in Cambodian higher education.

5.1. Purpose

A review of key policy documents suggests that the main purpose of Cambodian higher education is to produce graduates with technical knowledge, skills and abilities, and who are capable of working in both national and international settings. This is aligned with the current paradigm of STEM literacy and is clearly stated in the 2007 Cambodian Law on Education and the Higher Education Vision 2030:

> 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)

Efforts to produce more competent, well-rounded graduates started in the mid-2000s with the introduction of the Foundation Year Program. Based on a liberal arts philosophy, this program 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 introduction of the Cambodian National Qualifications Framework in 2012 provided normative guidelines for the development of education, including the development of higher education graduates with knowledge, interpersonal skills, ICT literacy and numerical skills, as well as a sense of civic responsibility.

However, existing national STEM policy is utilitarian oriented and supports plans for the economic transformation of Cambodia, as laid out in IDP 2015–25. There is an indication that siloed STEM subjects or disciplines are the norm and the current Higher Education Reform project might change this view of STEM. The Education Strategic Plan 2014–18 added an "A" to STEM, to include arts subjects, thus becoming STEAM. None of the policy documents provide STEM or STEAM models or definitions of STEM education; yet, the overall purpose of STEM higher education is well articulated.

A review of the visions, missions and objectives of the 15 selected higher education institutions offering STEM programs in Cambodia indicates that they all aim to develop a STEM-focused triple helix relationship model for university teaching, research and community engagement as part of the current reform, thus supporting the view of Wolfmeyer, Lupinacci and Chesky (2017, 72) that STEM knowledge ultimately results in corporate profit. Cambodian policy documents clearly highlight the political purpose of STEM in its relation to the economic transformation of the country, yet no clear pedagogical or institutional models are apparent.

5.2. Pedagogy

Traditional teacher-centred teaching methods dominate classroom practice in Cambodian higher education institutions. Interviews with STEM teachers suggest little awareness of inquiry and problem-based pedagogical practice. The participants acknowledge the lack of debate or open discussion in university classrooms, where teaching and learning methods mostly remain teacher-led instructional practice, with students playing a passive role, listening to lectures. This pedagogical approach is based on Cambodia's inherently hierarchical student and teacher culture, with power dynamics residing with teachers as the main repositories of knowledge.

Few examples of the concepts of teamwork and collaboration arose in the interviews and discussions with university teachers. The following comment typifies the attitude:

> Students from University A are usually independent and familiar with individual work. I personally did not want students to work in teams because I knew there would be hard-working students doing all the work and lazy students doing hardly anything. (PU21, interview, 9 May 2017)

The teaching laboratories at the participant higher education institutions were generally poorly equipped. Although public engineering and health universities were relatively better resourced due to financial and technical support from foreign development partners. However, overall there are few innovative approaches such as problem-solving, science or engineering inquiry. As one lecturer explained:

> In the [chemistry] lab, students seem to follow the process of doing an experiment as if combining ingredients for cooking. All students are expected to follow the same patterns and both the students and teachers already know the results before they do it. Knowing the results beforehand does not mean doing an experiment. (PU10, interview, 22 August 2017)

University connections to real Cambodian contexts are also limited, exemplified by a student in an agricultural university in Phnom Penh and an academic staff member in a provincial university, who both acknowledged that practical course work such as growing crops or raising livestock has little relationship to existing farming practices.

Closely related to the closed teacher-centred pedagogical practices are the evaluative mechanisms used to measure intended learning outcomes. The study reveals that normative grading based on in-class tests and exams are common across all institutions. The concept of formative evaluative processes including feedback is still unknown to many teachers. But a few of the participant higher education institutions stipulate in their curriculum that students undertake an internship to gain hands-on experience in industry.

As many participants pointed out, Cambodian higher education institutions lag far behind their ASEAN counterparts in ICT, which is considered essential to supporting teaching and learning. While widespread internet access is transforming students' access to information and ICT skills, Cambodian's Technology Readiness index (World Economic Forum 2018) indicates a score of 3.4 (out of 7), compared to its ASEAN neighbours' average of 4.4.

Despite these challenges, some younger academics expressed openness to adopting innovative or technology-enhanced pedagogical approaches in their classrooms if they were given the opportunity. For instance, the head of the IT department at an agricultural university mentioned his intention to introduce ICT for agriculture:

> Many Cambodians have access to the internet and mobile phones, so the proper use of ICT, including e-learning, can improve the quality of learning. Farmers can benefit from this technological advancement. We can share new information with them regularly, along with new agricultural knowledge and innovations. (PU33, interview, 13 October 2017)

Rigid adherence to traditional teaching and assessment approaches, with limited integration of ICT, has been underpinned by insufficient human resources and inexperienced academic staff. To quote two lecturers, one in engineering and the other in chemistry:

> I have my own specialisations, but I have to teach many subjects which are not in my field. This is because of the lack of human resources which, in turn, is caused by high turnover … I also had no prior teaching experience. I started teaching once I finished my master's degree. (PU22, interview, 9 May 2017)

> They teach the way they were taught – it's a consequence of their learning experience. Now they are teaching students in that same bad way [of passive learning]. (PU10, interview, 22 August 2017)

Such perceptions are magnified outside of Phnom Penh:

> Battambang province is far from Phnom Penh, so many lecturers do not want to come and teach here. MOEYS has no policy to send more teachers here either. Currently we have only one lecturer in civil engineering. (PU6, interview, 17 May 2017)

At one university in this study, not a single academic held a phd and those with master's degrees were locally educated and trained and had limited exposure to research and international experience. Such lack of high-level disciplinary knowledge and experience certainly impacts on the quality of STEM teaching and learning in Cambodia.

Throughout the university system, there is no mechanism to develop academics' pedagogical practices. Senior administrators suggested that older teachers are not very receptive to student-centred teaching and learning approaches. Many university teachers were not even aware that they had the role or the authority to initiate reform in developing new concepts to modernise their curriculum. This has created a vicious circle – once their students become lecturers, they repeat their experiences and the status quo is reinforced and becomes political through the hierarchical organisations at all levels. To reinforce this view, notions of professional development for teaching and administrative staff remain elusive according to the participants, and pedagogical practice relating to student engagement through inquiry, Cambodian specific examples, or tasks requiring ICT tools and teamwork, remain new in the participant institutions.

5.3. Content

The content of STEM majors in Cambodia is very much discipline-based, with students mainly oriented towards the acquisition of knowledge through the practices outlined above. Majors such as mathematics, physics, biology and chemistry were considered by the participants as old fashioned. Across the universities, the instructors in the discipline areas use locally produced textbooks based on foreign materials and contents which are supplemented by imported foreign textbooks.

When asked about the quality of graduates, particularly through feedback from employers, many academics and deans pointed to a lack of soft skills among STEM graduates, specifically teamwork, innovation and entrepreneurship. As one lecturer at an elite engineering university explained, "There is no problem with their technical knowledge, but it is their arrogant attitude" (PU20, interview, 9 May 2017).

The elitist nature of Cambodian public higher education, based on the French (and Soviet) model that tends to promote individual achievement rather than student collaboration, helps to reinforce a narrow focus on course structure. Consequently, as several participants from the private sector concluded, the vast majority of Cambodian higher education institutions have failed to equip graduates with sufficient employability skills and knowledge. As a result, it usually takes significant time for graduates to make the transition to professional work.Several higher education institutions have acknowledged the paucity of soft skills among graduates and over the last decade have begun to embed soft skills into their curricula by providing various skill training courses and seminars. A few private universities have emulated the liberal arts tradition of the American credit system and have performed relatively better in students' soft skills development, while significant challenges remain in the public sector. However, caution must be exercised before any generalisation can be made that the private education sector is performing better than the public sector. The study covered only a few sizeable established private universities, despite private higher education institutions constituting 62 percent of the total.

The relevance of education content to the labour market has also been stymied by the limited engagement of higher education institutions with outside communities. Limited support from the government and the private sector is reflected in the country's low spending on research and development investment. While Cambodia's first National Science and Technology Master Plan 2014–20, launched in late 2013, aims to make Cambodia an innovative science and technology society, it has faced challenges due to talent shortages and a science and technology environment that is not conducive to innovation for future advanced production and manufacturing. Recognising the limited collaboration with the outside community, several

universities have sought to update program content, including through annual partner consortia and student internship opportunities. To quote one participant:

> We have an annual consortium meeting every March at our university and we can get feedback from the private sector and others on the quality of our program. We have invited local and international partners from Europe and Asia to discuss our curriculum and other issues … We also asked students about their internship experience in the private sector in order to update our programs. (PU22, interview, 9 May 2017)

Limited engagement with the outside community has resulted in a narrowing of graduate career pathways in such disciplines as mathematics, physics, biology and chemistry. Most of the Cambodian students enrolled in STEM programs believed they would end up being high school teachers. Yet, the poor working conditions and low pay of teachers in Cambodia mean that STEM majors are less attractive to many high school graduates, including talented ones.

Students and academic staff at one provincial public university close to a special economic zone seemed to have a better understanding of the career paths for basic sciences. This was reflected in a focus group discussion with IT, mathematics and agronomy students:

> I love maths. I understand that students who want to get a university place have to pass a maths test first. I also think about the job market. With maths, I can work in accounting or marketing in a bank, though the most common job for maths graduates is as a lecturer. (PU41, interview,7 May 2017)

STEM content in Cambodia is very locally oriented, posing some challenges for Cambodia to produce graduates who can work in the region. For instance, there was little awareness among students and academic staff of the eight priority programs for engineers, architects, nurses, medical practitioners, dentists, accountants and tourism professionals in ASEAN, which were proposed to promote the freer flow of skilled labour in the region. Khmer also remains the main medium of instruction at most higher education institutions and most graduates therefore are not sufficiently proficient in English to seek professional opportunities in the wider ASEAN Economic Community and further afield.

The lack of English proficiency has clearly restricted students' learning, as has the lack of Khmer language texts and materials needed at present. An architecture faculty member noted that few students could understand materials in English or other international languages, and the textbooks (mainly donated by ngos and other partners) do not always meet program needs, adding that he would buy different textbooks if he had the funds (PU35, interview, 19 June 12017). This was a common issue raised across the higher education participants.

Most Cambodian academics teach part-time at several universities, with relatively few having enough time to conduct regular research. This situation is compounded by the fact that few Cambodian university teachers contribute to international journals, leaving them lagging behind ASEAN counterparts in research performance. Furthermore, student knowledge is confined to what they are taught in the classroom and such traditional teaching-learning approaches are anachronistic and irrelevant to current world realities and the skills graduates need in the workplaces of today and the future.

6. Conclusion and recommendations

While attracting more public interest and gaining popularity, STEM remains a new concept in Cambodia, largely driven by the country's industrialisation vision as well as the utilitarian STEM policy discourse at the regional and global level. Cambodia's reform of higher education institutions is part of the STEM journey; however, linking purpose with pedagogy and content is still confused. Such perceptions are reinforced by the lack of a clear Cambodian pedagogical or institutional and organisational STEM model.

The Cambodian sociocultural values of education that are clearly embraced in national and institutional visions tend to be dismissed, or even completely ignored, in practice. Holistically, this not only reflects a disconnection between STEM purpose, pedagogy and content, but also suggests that Cambodian higher education institutions have traditionally performed simply a teaching function, predominantly shaped by teacher-centred pedagogical approaches. This is just one of the factors in the low quality and irrelevance of Cambodia's present STEM education and should present a major concern for all stakeholders.

Cambodian public higher education institutions remain specialist by nature. The inclusion of liberal arts or interdisciplinary approaches in STEM education has faced many challenges, as has been the case in other countries outside of North America (Marber and Araya 2017). This has been attributed to limited resources and a lack of policy guidance for higher education development. STEM specialists have traditionally undervalued humanities, hence the push to expand the concept into STEAM. Few study participants demonstrated an understanding of the core aims of a liberal arts education despite the introduction of the Foundation Year Program more than a decade ago, or a thorough grasp of the intended educational outcomes in graduate quality outlined in the Cambodian National Qualifications Framework. This suggests that relatively few Cambodian academics have understood STEM as an integrative or interdisciplinary approach, though most of the respondents were aware of and repeatedly used the term.

There is also an ever-present mismatch between policy and practice, indicating a lack of proper understanding in pre-policy stages and a lack of consistency or cross-referencing between policy documents concerning STEM or STEAM. Since the early 1990s, different international organisations and foreign bilateral aid agencies have played a role through their financial assistance, both direct and indirect, in re-establishing Cambodian higher education at institutional and national levels. The lack of understanding about the possibilities of integrative approaches to STEM at the higher education level emphasises the tension between global policies and concepts, and local practices in Cambodia.

Within the field of comparative education, this study has contributed to the ongoing debate on policy transfer, challenging the global isomorphic notion of world culture theorists who contend that education has become globally analogous along the lines of Western schooling ideals (Straubhaar 2014, 217). One of the recommendations from this issue of the failure to develop an integrated Cambodian STEM education framework is that future studies should delve into how policy making and implementation has been undertaken in the country.

Cambodia must improve STEM education and move towards building its own model with Cambodian cultural ways of knowing, rather than uncritically emulating the work from other countries. To realise this goal, STEM policy should be revised from its present economic growth focus to better align with Cambodia's overall higher education vision to encompass broader

dimensions of human development. The critical question will be: What does Cambodia's STEM literacy encompass?

Successful implementation of Cambodia's STEM model will need a critical awareness and understanding of the broader socioeconomic and political system and cultural ways of knowing, which are different from those of Western countries concerning perceptions of excellent teaching and progressive pedagogy, including open debate and discussion. The study has revealed how students and teachers, particularly in the public university sector, have almost exclusively been locally educated and trained and mostly exposed to teacher-centred teaching approaches, where teachers are still considered ontologically privileged. This has been shaped by inherent power dynamics in society – a phenomenon common throughout Asia (Heffernan et al. 2010; Ledgerwood n.d.; Öjendal and Antlöv 1998). STEM pedagogy – rooted in Anglo-American educational and cultural values – must be modified to fit the Cambodian sociocultural context of knowing and being and the current STEM curricula updated to include localised and translated materials to ensure their relevance to local needs. The process has to be inclusive and involve engaging in frank discussions various national and institutional stakeholders.

The study has identified several challenges in the quest for a Cambodian pedagogical approach to STEM. As noted, several private universities following the Anglo-American model of liberal arts philosophy have successfully instilled in students not only technical knowledge but also soft skills, including English language proficiency. One of the lessons learned here is that many academics were foreign educated with knowledge and acceptance of the importance of liberal education. By comparison, many academic staff in public institutions were less receptive to new ideas, which starkly highlights the limitations of a "vicious circle" that may ensue. Therefore, Cambodia must create professional growth opportunities that expose STEM academics to innovative ideas either through postgraduate training or exposure visits in more developed countries. There is a positive sign that the younger generation educated abroad are willing to champion this innovation for the benefit of Cambodia's development.

A Cambodian STEM model cannot be built and sustained based simply on academic staff performing only their basic teaching duties. To keep pace with the rapid advances in global science and technology, STEM lecturers need to engage in research to stay informed about progress in their field and to support Cambodia's competitiveness, innovation and productivity. Bush's (1945) report to the president of the United States remains relevant and serves as a reminder for Cambodia to push hard on this matter:

> A nation which depends upon others for its new basic scientific knowledge will be slow in its industrial progress and weak in its competitive position in world trade, regardless of its mechanical skill. (Bush 1945, 14)

Successful implementation of a Cambodian STEM model needs a supporting higher education system and the governmental and institutional policies and budgets need to support the institutions and departments. The current Higher Education Reform Project in STEM education may bring about meaningful interactions that build content, pedagogy and purpose for Cambodia's future, yet it is important that efforts and energies are maintained to ensure the necessary shifts in the higher education sector are made.

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