

The Possibility of Integrating Geography into STEM Education Framework: The Case of School Geography in Sri Lanka

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Abstract

The education authorities in Sri Lanka strongly advocate for the adoption of the STEM (Science, Technology, Engineering, Mathematics) education approach within the school system. However, education professionals in the country have noted that there is still no clear understanding of how to effectively institutionalise this process. This paper argues that Geography, as a social science discipline, can be integrated into the STEM framework relatively easily and without compromising its integrity. Based on evidence from school geography curricula for Grades 6 to 13, prepared by the National Institute of Education, Sri Lanka's education policy formulation body, the study highlights three major foundational pillars of the discipline: geographic inquiry, spatial thinking, and the use of geospatial technologies. These pillars serve as channels through which successful integration can occur. Furthermore, the integration of Geography into STEM is not a one-sided process; it offers mutual benefits, providing reciprocal advantages for both fields.

Keywords: STEM, Geography Education, Integration, Learning Outcomes, Inquiry Skills, Spatial Thinking, Geospatial Technologies

Introduction

Recognising the essential role of education in promoting economic and social progress, especially in the context of the knowledge economy, many nations are revisiting traditional educational approaches. Education must adapt to the rapidly changing economic, social, and political landscapes that define our increasingly globalised world. One effective solution that has emerged is STEM education, which combines the fields of Science, Technology, Engineering, and Mathematics. This integrated approach not only encourages interdisciplinary and multidisciplinary learning but also develops skills such as critical thinking, problem-solving, and innovation. Furthermore, it promotes important soft skills

like collaboration and adaptability, significantly enhancing student employability and preparing them for future challenges.

The origins of STEM can be traced back to the early 1990s when a group of educators, with support from the National Science Foundation in the United States, introduced the concept of SMET (Science, Mathematics, Engineering, and Technology). The goal was to integrate pure and applied sciences into a single framework. Later, the acronym was changed to STEM, but the focus on the same disciplines and objectives remained unchanged. Today, the STEM concept has gained significant momentum, and efforts are being made in both developed and developing countries to incorporate this approach into their educational policies.

Since its inception, STEM education has faced numerous challenges. A major issue has been the identification of interdisciplinary connections among the STEM fields and the transformation of these connections into a cohesive curriculum (Terzieva et al., 2024). Some critics argue that many programs continue to rely on an individual disciplinary approach. Others have noted that, out of the four STEM disciplines, more emphasis has been placed on science and mathematics (Timms et al., 2018). A significant criticism, particularly relevant to this discussion, is that the STEM framework has largely excluded the humanities and social sciences. In an article published in the *Washington Post*, Fareed Zakaria, author of "In Defence of a Liberal Education," argues that this dismissal of broad-based learning stems from a fundamental misunderstanding of the facts. He warns that it could place the United States on a dangerously narrow path for the future. Zakaria points out that the United States has led the world in economic dynamism, innovation, and entrepreneurship largely due to the kind of education they are now being told to abandon. According to him, a well-rounded general education fosters critical thinking and creativity, and exposure to a variety of fields can produce synergy and cross-fertilisation (Zakaria, 2015).

STEM education in Sri Lanka

Although the need for a STEM education approach has been recognised by education authorities in Sri Lanka since as early as 2001, serious attention to the concept did not materialise until much later (National Science Foundation of Sri Lanka [NSF], 2017). In 2016, NSF conducted a series of meetings and workshops focused on STEM education and in the following year, “The Interim Report of the Working Committee on STEM Education” was published (NSF, 2017). The report emphasised strategies for revolutionising the teaching of subjects such as mathematics and science by integrating technology and engineering into the regular curriculum to create a “meta-discipline” (NSF, 2017; p. 9). In that same year, recognising the importance of STEM, the Cabinet of Ministers of the Government of Sri Lanka approved a financial grant to develop a strategic plan aimed at reforming the education system by incorporating STEM into K-13 education (Priyadarshani et al., 2022). In 2022, during a meeting of core group members of STEM from the Ministry of Education to discuss the progress of the program's implementation, the acronym STEM was expanded to STEAM to include Arts, signifying a blend of aesthetics with science. The report from this meeting also noted the necessity of including the subjects like history and Geography in school education; however, no specific details were provided on how this would be accomplished. Despite the discussions and literature surrounding STEM, a report by the National Education Commission of Sri Lanka (NEC) published in 2023 indicated that there is still a clear lack of consensus on how to conceptualise and institutionalise the STEM education approach (NEC, 2023). Additionally, while there have been sporadic suggestions on how to integrate humanities and social sciences, no comprehensive plan has been introduced to effectively incorporate them. Many teachers express concern that the humanities and social sciences are being neglected and fear that they may eventually be eliminated from the school curriculum.

Objective and methodology of the study

This paper investigates the potential for integrating Geography, a social science discipline, into the STEM educational framework while preserving the integrity of the discipline. The paper is divided into two parts. Part 1 evaluates the feasibility and appropriateness of incorporating Geography into the STEM education approach, drawing on a growing body of literature that highlights the importance of such integration. Part 2 presents a case study of Sri Lanka, examining the possibility of this integration through an analysis of the current geography

curricula administered in the school system. The study utilises a qualitative content analysis approach to evaluate how geography education is integrated into the STEM framework within the national school system of Sri Lanka. The sample consists of the official, mandatory geography syllabus documents issued by the National Institute of Education (NIE) of the Ministry of Education, Sri Lanka. To ensure a comprehensive evaluation across all key developmental stages, the research targets the learning outcome statements specified for three distinct educational tiers: Junior Secondary Level (Grades 6, 7, 8, and 9), Senior Secondary Level (Grades 10 and 11), and Collegiate Level (Grades 12 and 13). This systematic approach resulted in a final dataset of nine curriculum documents, encompassing the complete range of learning outcome statements for analysis across these target grade levels. A structured, deductive coding framework was developed prior to data collection, specifically designed to capture three major pathways for integrating Geography into a STEM education approach: Inquiry-Based Learning/Scientific Inquiry Skills, Spatial Perspective and Geo-Spatial Technologies.

Part I

Geography and STEM

Geography is a discipline that examines the relationship between places and people. Geographers aim to explain the spatial variations and temporal changes in human activities across different locations, which result from the diverse interactions between humans and their environment. To achieve this, they utilise several key concepts, including location, place, space, scale, interrelationships, time, movement, and sustainability. In applying these concepts, geographers draw insights from various fields such as the humanities, natural sciences, and social sciences, which makes Geography an interdisciplinary field. While this interdisciplinary nature enhances Geography's holistic perspective, it has often struggled to communicate its potential to other disciplines. As such, many other fields tend to regard Geography primarily as a source of base maps for their studies, a perception that contributes to regard Geography as a discipline lying well outside the STEM framework. On the contrary, Hanson points out that Geography provides a deeper understanding of the relationships between people and the environment through a spatial and temporal lens, a perspective which she refers to as the *Geographic Advantage* (Hanson, 2004), which makes Geography a strong contender to be included in the STEM framework.

In recent years, many geographers have emphasised their discipline's capacity to

integrate itself with STEM mainstream without compromising its unique identity and mission (Goldstein and Alibrandi, 2013; Mamun et al., 2015; Oyana et al., 2015; Xiaowei Xuan et al., 2019; Jant et al., 2020; Selway, 2021; Caldis and Kleeman, 2019; Bourke and Caldis, 2021; Gilbertz et al., 2022; Tomai et al., 2024). Oyana et al. point out that “Geography, as a discipline, enjoys the advantage of providing interdisciplinary discourse because it offers both human and physical geographic perspectives. Moreover, it can be used as an alternative vehicle for catalysing STEM fields” (Oyana et al., 2015, p. 20). Meanwhile, Jant et al., (2020) argue that a broader approach to integrating spatial thinking into STEM is necessary, and in this endeavour, Geographic Information Systems (GIS) play a crucial role. At times, the issue has been discussed at the policy-making level. For instance, during an annual event called “Science Meets Parliament,” Susan Caldis, a former president of the Geography Teachers Association of New South Wales & ACT and the Australian Geography Teachers Association, succinctly presented the case to the Australian Parliamentarians, illustrating how Geography bridges the gap between the sciences and social sciences (2019). Caldis argues that place-based analysis, spatial reasoning skills, and an understanding of the human-environment relationship add depth and contribute to STEM (Caldis, 2020).

The integration of Geography into the STEM framework, as suggested by the literature, will be mutually beneficial. Maude highlights that the lack of formal recognition of Geography as a STEM subject contributes to the declining number of students pursuing this discipline and creates confusion about the career pathways associated with it (Maude, 2019). According to Selway, classifying Geography solely as a social science negatively impacts “the content within the curriculum, the backgrounds of teachers and their professional development opportunities, as well as the expectations and subject choices of students” (Selway, 2021, p. 18). To address this unsatisfactory situation, the National Committee for Geographical Sciences in Australia suggests that the discipline’s profile should be extended beyond the humanities, emphasising the fact that its significant scientific content qualifies it as a partial STEM subject (National Committee for Geographical Sciences, 2018).

Incorporating Geography into the STEM framework can enhance the effectiveness of the various STEM disciplines, too. Spatial thinking skills are vital for problem-solving, and they are especially crucial for students pursuing careers in fields like engineering and mathematics. As noted by Tomai et al. “large-scale or environmental spatial abilities are also important in many STEM

domains and involve spatial reasoning and solving spatial problems occurring in the environment” (Tomai et al., 2024, p. 735). In this context, geospatial technologies—particularly GIS—play a key role in developing and applying the spatial thinking skills to STEM.

Channels of integration

The concept of place, which is central to geographic inquiry, is not a standalone entity. Instead, it is influenced by other locations in space and, in turn, impacts its surrounding areas. The interactions and interdependencies of a place affect human activities in different ways from one location to another. This often leads to complex situations that require scientific solutions. Geographers seek explanations for the issues and problems encountered by a particular place by following a structured line of scientific inquiry. The process involves asking geographical questions, collecting and organising data and information, analysing data, interpreting the results, and arriving at logical conclusions. This enables students to take ownership of their learning by formulating questions, designing investigations, and drawing their own conclusions, an experience that aligns with STEM education expectations.

The second way that Geography integrates with STEM is through its spatial perspective, commonly referred to as *spatial thinking* or *spatial analysis*. This concept involves the ability to visualise, analyse, and understand the spatial relationships among objects, people, places, and phenomena. It requires consideration of the locations of places and people, the arrangement and distribution of these entities, and the connections that exist between them. This skill is a vital competency in the fields of Science, Technology, Engineering, and Mathematics, as spatial abilities are essential for developing expertise in these areas (Uttal & Cohen, 2012; Duffy et al., 2016).

The third channel through which Geography integrates into STEM—arguably the most frequently cited one—is geospatial technology. It comprises the tools, techniques, and technologies used to capture, store, manage, analyse, and visualise spatial data. Before the advent of digital means for displaying geospatial data, analogue maps were used historically. Though analogue maps have inherent limitations compared to digital technologies, they encourage spatial reasoning, critical thinking, and hands-on learning experiences that are essential for various STEM fields, including engineering and biology. A simple topographic map can help students understand the connection between land use and environmental degradation in a

specific area. While the contribution of digital geospatial technologies to STEM disciplines is widely acknowledged, the foundational knowledge and training gained from the learning of mapping techniques and methods should not be underestimated. The modern geospatial technologies primarily revolve around geographic information systems which utilise data derived through technologies like the Global Positioning System (GPS) and remote sensing (RS). Currently, these technologies are applied not only in Geography but also in various fields where spatial considerations are crucial, such as physical planning, disaster management, environmental management, public utility provision, highway construction, and settlement planning, among others. GIS enhances STEM literacy by integrating geospatial technology with science, technology, engineering, and mathematics in a cohesive and interdisciplinary way.

Part II

Integration of Geography into STEM in School Geography in Sri Lanka

Sri Lanka has a K-13 school education system. However, the subject of Geography is introduced to students with the commencement of the junior secondary stage of the system, where it is one of the mandatory subjects. In the senior secondary Phase I, students are required to take nine subjects, which include six core subjects and three optional ones. Geography is classified as an optional subject. After completing the senior secondary phase I, students take the General Certificate of Education Examination (GCE O/L) administered by the Department of Examinations of the government. Upon entering the senior secondary phase II, also known as the Collegiate Level, students begin the Advanced Level Cycle, which is divided into four academic streams: Science and Mathematics, Arts, Commerce, and Technology. Geography belongs to the Arts stream and is a popular choice among students in that stream.

While the theoretical foundations of Geography align well with STEM concepts, the success of the integration hinges on practical factors such as the curriculum and teaching methods. The following sections will explore how well the Grade 6–13 geography curriculum in Sri Lanka fits into the integration strategies previously mentioned. This examination will analyse the intended learning outcomes outlined in the syllabus as well as the pedagogical instructions provided to teachers within the curriculum and by the Teacher's Guides.

Learning outcomes provide a clear understanding of what students should know, understand, and be able to do after completing a course or learning activity. They serve as a guide for teaching, assessment, and student learning and help students recognise their strengths and weaknesses, enabling them to create effective study strategies and monitor their progress. The geography syllabus for students in Grades 6 to 9 of the Junior Secondary Stage in Sri Lankan schools includes a wide range of learning outcomes. These outcomes are designed to enhance students' inquiry skills, spatial thinking, and their ability to utilise spatial technologies effectively. A scoping method was used to identify the above-mentioned specific learning outcomes cited in the geography curriculum from Grades 6 to 13, and they are presented in Tables 2 to 5 as a representative sample.

Inquiry-based learning is a process that encourages students to ask questions and seek answers through careful observation and reflection. This approach inspires students to learn independently rather than simply accepting information presented by their teacher. It encourages students to pose geographic questions, acquire and organise geographic information, analyse geographic information, and reach geographic explanations. As outlined in the Grade 6 syllabus (see Table 2), students are expected to complete four activities independently based on selected learning outcomes. These activities include collecting information about

Table 1. Structure of School Education in Sri Lanka

School Stage	Grades	Number of Years	Student Age (years)
Primary	1–5	5	5–9
Junior Secondary	6–9	4	10–13
Senior Secondary (Phase I)	10–11	2	14–16
Senior Secondary (Phase II) (Collegiate Level)	12–13	2	16–18/19

Source: National Education Commission of Sri Lanka (2022)

Table 2. Learning Outcomes included in the Geography Curriculum of the Junior Secondary Stage of School Education in Sri Lanka

Grade	Inquiry-based Learning	Spatial Thinking	Spatial Technologies
6	collects information regarding the community around the school describes techniques that can be adopted for the conservation of power describes the damage caused by the improper disposal of waste	prepares a table showing the distances and directions with respect to a few important, selected locations in relation to the school. explains the diversity of the agricultural economy of the people living in the neighbourhood of one's home understands that the surroundings of one's home are different from that of another	draws the plan of the land where the school is located. prepares a map showing the location of the school and a few important places in its neighbourhood
7	declares that Sri Lanka is a multicultural country states with facts that Sri Lanka is at a high level of social development among the South Asian countries describes how a hazard becomes a disaster with examples describes factors responsible for climate change	with the help of a World map shows that Sri Lanka is a country belonging to the continent of Asia shows the territorial sea of Sri Lanka in a map describes the regional diversity of the landscape of Sri Lanka marks and names on a map of Sri Lanka the areas where disasters occur	defines latitudes and longitudes identifies various locations in a map using direction as a guide
8	presents new knowledge about planets describes the rotation of the Earth and explains its impact on human activity	explains the relationship between the physical and human components of the geographical landscape of the South Asian region describes the geographical location of the South Asian region on a map	presents the location of various landscapes with the help of maps describes with examples the basic features of a 1:50,000 topographic map of Sri Lanka
9	explains the uniqueness of the Asian region explains by comparing maps the interrelationship between climate and vegetation in the Asian region describes basic characteristics of human landscape of Sri Lanka explains the importance of maintaining environmental balance	describes with the aid of maps the relief of the Asian region describes with examples the unequal distribution of Asia's population describes the interaction between the physical landscape and human activities explains what is meant by spatial disparities in development	Identifies the physical and cultural features in a 1:50,000 topographic map explains by comparing maps the interrelationship between climate and vegetation in the Asian region explains with the help of maps and diagrams the relief of Sri Lanka

Source: National Institute of Education, Sri Lanka (2015a; 2016a; 2017a; 2018a)

the community surrounding their school, describing techniques for conserving energy, explaining the damage caused by improper waste disposal, and discussing how waste can be utilised as a resource. Students are prompted to ask geographic questions such as what, where, how, and why in these learning outcomes. These tasks encourage 10-year-olds to think critically, explore, ask questions, and actively engage with the subject matter. In Grade 7, the scope of their inquiries expands, allowing them to explore topics related to all of Sri Lanka and its neighbouring countries, as well as general issues like disasters and climate change. In Grade 8, the students are directed to explore the beliefs and new knowledge about the solar system, and, in the following grade, their attention narrows to specific global topics, including the relationship between climate and vegetation, as well as the importance of maintaining environmental balance.

Different approaches have been employed to develop students' inquiry skills. For instance, the Grade 6 Teacher's Guide provides specific instructions for organising a small project that allows students to gather information about their immediate surroundings at school. Similarly, the Grade 8 Teacher's Guide offers guidance on involving students in a small project to explore beliefs surrounding the solar system and emerging knowledge about it. In addition, the Grade 9 Teacher's Guide features a case-based project titled "Let's Maintain the Environmental Balance".

The spatial thinking enhances students' understanding of how various phenomena on Earth are interconnected in space. The skills developed by this perspective include the ability to visualise, analyse, and comprehend the relationships between objects, places, and people. Key geographic concepts, such as location, movement, interrelationships, distance, direction, and patterns, are essential for developing these skills. As can be seen in Table 2 of the geography curriculum from Grades 6 to 9, the development of spatial skills in students has been structured progressively. It begins with their immediate surroundings and gradually expands to a broader perspective of the world. Here, the students are introduced to the concept of "place in space," which forms the foundation of spatial visualisation and reasoning.

Geospatial technologies include the tools, techniques, and systems used to capture, analyse, interpret, and visualise geographic data related to specific locations. It essentially refers to the science and technology involved in working with location-based information. Currently, the term is primarily associated with digital technologies such as GIS, GPS, and RS. These technologies

are increasingly utilised in various fields, including mapping and navigation, environmental monitoring, resource management, urban planning, business intelligence, among others. However, many have pointed out that the use of these technologies in school education is still at a low level for understandable reasons such as the high cost of the technology and the lack of expertise among teachers needed to create their own GIS projects (Jadallah et al., 2017). Sri Lanka is no exception compared to the global trend in integrating GIS into school geography curricula. Although recognised as essential, the use of GIS in Sri Lankan schools remains at an introductory level.

Encouragingly, the NIE has established GIS facilities at the Provincial Education Offices across the country, each supported by a master-trainer teacher. These facilities are designed to be accessible to schools, marking a significant step towards wider adoption of GIS technology. However, as shown in Table 2, it is evident that the fundamental tools for capturing, storing, presenting, and analysing spatial data are currently employed in geographical studies within Sri Lankan schools. Traditional cartographic techniques—through maps and other visual representations—continue to play a crucial role in the geography curriculum. These techniques not only help students read, analyse, and understand geographical phenomena in a spatial context but also provide a strong foundation for the future use of digital technologies.

In the senior secondary stage, students are expected to gain knowledge in various aspects of Geography, covering a broader geographical area. This includes understanding the components of the geosystem, the physical geography of the Earth, the characteristics of natural resources, population dynamics, agricultural land use, industry, human resources and development, natural disasters, climate change, and the use of thematic and topographic maps. Additionally, students should learn how to represent data through graphs and diagrams. From the limited number of Intended Learning Outcomes (ILOs) presented in Table 3, it is evident that the learning outcomes for the senior secondary stage have been primarily designed to develop students' inquiry skills, similar to the previous stage.

At the senior secondary stage, various approaches to developing students' inquiry skills have been proposed in the Teacher's Guides. For example, Grade 10 students are encouraged to prepare a wall poster that highlights the problems and trends in the cultivation of paddy, tea, rubber, and coconut in Sri Lanka. Additionally, they are tasked with compiling a report on the distribution, challenges, and trends in dairy farming in Sri

Table 3. Learning Outcomes included in the Geography Curriculum of the Senior Secondary Stage

Grade	Inquiry-based Learning	Spatial Thinking	Spatial Technologies
10 and 11	describes the structure of the Lithosphere with the aid of a diagram reveals the unfavourable and harmful human activities that threaten the existence of the Atmosphere describes the new trends in the dairy farming and fishing industry explains the significance of agriculture in the economy of Sri Lanka explains the factors contributing to the formation of soils and soil horizons emphasises the value of forests and wildlife as a resource discusses the land use pattern of Sri Lanka emphasises the significance of conserving energy resources describes the meaning of human resources development explains the role of information technology and communication in development	marks the distribution of paddy and wheat in an outline map of the world and presents it to the class marks and names on a map of the world the distribution of commercial dairy farming areas explains the distribution of tea and rubber with the help of world map marks and names the distribution of the main agricultural crops on an outline map of Sri Lanka describes the distribution of major mineral resources of the world describes the distribution of natural resources in Sri Lanka using a map presents the distribution of the world population on a map marks the areas on a map where natural disasters occur	explains the difference between thematic maps and topographic maps names the fundamental characteristics of the 1:50,000 topographic maps of Sri Lanka explains and defines the peripheral information defines the peripheral information depicted in the 1:50,000 topographic maps explains the interrelationship between the physical and cultural features depicted in the 1:50,000 topographic maps constructs a cross profile to describe the relief features in a topographic map interprets the information contained in a graph

Source: National Institute of Education, Sri Lanka (2015b; 2016b)

Lanka, which can be completed individually or in groups. Similarly, for Grade 11 students, an activity has been proposed to create a poster illustrating the characteristics of the world population. This particular task will encourage students to consider what information is most important and how to best present it—whether in textual form, through maps, or using graphs. They will also be required to think critically about the most suitable types of maps and graphs to select for their presentations.

As shown in Table 3, the learning outcomes designed to develop students' skills in spatial thinking focus on explaining the distribution patterns of natural resources and the associated human activities, using maps. Students are expected to describe and analyse these distribution patterns while highlighting the factors that contribute to them. In these cases, they should pay attention to the spatial relationships relevant to the topic, considering additional factors such as climate, terrain, water resources, soil types, population distribution and density, transportation facilities, and the locations of markets.

At the senior secondary stage, students are expected to explain the differences between topographic and thematic maps, identify the fundamental characteristics of topographic maps, interpret the relationships between physical and cultural features depicted in topographic maps, and construct cross-sections that illustrate variations in relief of a selected area from a topographic map. Additionally, students should be able to interpret the information contained in graphs representing geographic data. Mastering these essential geospatial tools helps students understand and explain the spatial distribution of both physical and human activities, as well as select the appropriate tools for representing geographic information.

At the collegiate level, which represents Grades 12 and 13, the geography curriculum expands into two syllabi as Geography I and II. Geography I is on Cartography, and Geography II covers Physical Geography and Human Geography. A selection of intended learning outcomes that appear on both syllabi are reproduced in Table 4.

At the collegiate level, students are expected to engage in a wider range of geographical issues

Table 4. Learning Outcomes included in the Geography Curriculum of the Collegiate Level of School Education in Sri Lanka

Grade	Inquiry-based Learning	Spatial Thinking	Spatial Technologies
12 and 13	investigates the nature of the geosystem and its components investigates the geomorphic process describes with illustrations the landforms resulting from denudation agents explains the tropical climate type in Köppen's classification examines issues relating to world population investigates reasons for urbanisation explains with examples urbanisation-related environmental problems in the developing world examines the problems and challenges relating to technology used in world agriculture explains recent trends in industrial location explains with reference to selected examples factors that have influenced the location of industries in Sri Lanka explains the impact of tourism on the society, culture and environment of Sri Lanka explains globalisation describes the positive and negative effects of globalisation on developing countries	explains spatial relationships and temporal changes explains that geographical processes and relationships range from local to global levels explains the reasons for variations in the distribution of temperature in Sri Lanka explains variations in human landscape explains temporal changes in the human landscape explains how human activities result in spatial variations in the human landscape analyses with the help of a map the population distribution of Sri Lanka explains human settlement patterns	describes that geographical information could be presented by different techniques explains that practical geography helps to arrive at informed decisions draws physical and cultural features depicted in a topographic map introduces modern cartographic techniques (GIS, GPS, RS) describes the uses and importance of modern cartographic techniques (GIS, GPS, RS)

Source: National Institute of Education, Sri Lanka (2017b; 2018b)

while improving their inquiry skills. As indicated in Table 4, in the field of physical geography, students are tasked with investigating the nature of the geosystem and its components, explaining the geomorphic process, and describing the landforms created by agents of denudation with illustrations. In human geography, when examining global population issues, students explore their demographic, social, economic, and environmental dimensions. A similar analytical approach is necessary for discussing urbanisation issues in the developing world. When assessing recent trends in industrial location, students need to consider the major factors influencing location

across various regions. Also, in examining the impact of tourism on the society, culture and environment of Sri Lanka or evaluating the positive and negative impacts of globalisation, students need to draw information from a variety of sources, which will sharpen their analytical skills.

To enhance students' inquiry skills, various approaches have been suggested in the Teacher's Guides. One example is a group activity in which students prepare a report on the characteristics of the climatic zone in which their school is located. Another project involves compiling a file that includes information about the differences

between rural, urban, and rural-urban settlements, complete with illustrations. Furthermore, students are tasked with creating a wall poster that illustrates how anthropogenic factors contribute to the greenhouse effect in the atmosphere. In another wall poster, they describe measures that could be adopted to conserve water resources in Sri Lanka.

At the collegiate level, students will have the opportunity to explore the fundamentals of modern geospatial technologies, specifically GIS, GPS, and RS. They will also learn to highlight the importance of these modern techniques in comparison to conventional mapping systems. Students will discover that digitising traditional cartographic methods offers numerous advantages, and those who master this technology will be in high demand. Teachers have been instructed to train students to determine the latitudinal and longitudinal coordinates of the school premises using a GPS receiver. If a GPS device is not available, students may use a mobile phone with GPS capabilities.

Discussion and Conclusions

This paper argues that the discipline of Geography can be effectively integrated into the STEM education framework without requiring fundamental changes. An analysis of the geography curricula in Sri Lanka demonstrates that the discipline aligns well with key attributes of STEM fields, such as scientific inquiry, spatial thinking, and the use of spatial technologies. These strengths form a solid foundation for Geography as a discipline.

The emphasis in the geography curriculum focuses more on enhancing students' inquiry skills and promoting spatial thinking rather than on utilising modern geospatial technologies. However, this trend is not unique to Sri Lanka; it is a common characteristic observed in geography curricula worldwide, as noted by many geographers. As Lee et al., 2022 point out, "internationally, there is a clear turn towards inquiry as a core approach to learning secondary school geography." After analysing the secondary school geography curricula in Australia, China, England, Hong Kong, Singapore, and the USA, they concluded, "through content analysis of national curriculum documents, we found that most jurisdictions have prominently placed inquiry in their curriculum" (Lee et al., 2022, p. 1).

It is essential to recognise that the three attributes—geographic inquiry, spatial thinking, and spatial technologies—are intrinsically interconnected. This interconnectedness ultimately fosters the ability to think geographically from a spatial perspective, which

is highly valued within the STEM education framework.

From Grades 6 to 13, the geography curriculum emphasises developing students' skills in representing geospatial data using maps, graphs, and statistical methods. While the techniques taught in the earlier grades are primarily non-digital, students in Grades 12 and 13 are introduced to modern cartographic methods, including GIS, GPS, and RS. The Department of Educational Publications capitalises on this opportunity by publishing textbooks on cartographic techniques that provide detailed information on digital geospatial technologies. Furthermore, assessments include questions related to these technologies.

There is always potential for improvement in the curriculum to enhance its role as a STEM discipline. One possible enhancement is to make the teaching and learning process in Geography more concept-based. Key concepts such as space, place, interrelationships, movement, scale, distance, and time, which align well with STEM attributes, should play a more significant role in this process. By integrating these concepts, students will develop the intellectual abilities to analyse, explain, predict, evaluate, and think about the world in ways that extend beyond their personal experiences (Maude, 2020; Dangalle, 2021). However, there is a potential overlap between Geography and other STEM subjects when applying an integrated framework. This overlap, in fact, can facilitate the development of cross-curricular lesson plans that can be more engaging and appealing to students, ultimately enhancing the teaching and learning process.

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