Implementation of STEAM in schools in Timor-Leste: Challenges and Opportunities

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ABSTRACT

Education is evolving rapidly to keep pace with a world increasingly driven by technology. Traditional teaching methods often fail to adequately prepare students for today's challenges. This study looks at STEAM education, which brings together Science, Technology, Engineering, Arts, and Math, and how it can help students in Timor-Leste develop important skills like critical thinking, creativity, teamwork, and flexibility. Using a review of existing data, including national policies, reports from international organizations, and successful examples from countries like Finland and Singapore, the study examines key areas such as curriculum, teacher training, school resources, digital tools, and policy support. The results show that STEAM education can make learning more engaging and effective, but Timor-Leste faces problems like limited resources, not enough trained teachers, and no clear national plan for STEAM. To improve this, the study suggests a careful, step-by-step approach that fits Timor-Leste's needs and supports fair and lasting changes in education.

Keywords: STEAM Education, Timor-Leste, Curriculum Design, Teacher Preparation, Educational Policy

1. Introduction

Since gaining independence in 2002, Timor-Leste has made good progress in getting more children into school and lowering illiteracy rates. However, many problems still hold back the quality and fairness of education. These include poor school facilities, not enough well-trained teachers, and big differences between cities and rural areas. On top of this, issues like uncoordinated education planning, uneven teacher training, and a lack of basic materials like textbooks make the situation even tougher (World Bank, 2022; UNESCO, 2023).

STEAM education, which combines science, technology, engineering, arts, and math, is still new in Timor-Leste. While the National Curriculum Framework (Ministry of Education, 2014) guides education across the country, it doesn't specifically include or support STEAM ideas. Because of this, what students learn in the classroom doesn't always match the real skills they will need for jobs in today's fast-changing and global work environment (World Bank, 2022; UNESCO, 2023).

Even with these challenges, there are examples from around the world where STEAM education has been successful, even in tough situations. For example, Samsung's Solve for Tomorrow program shows how STEAM learning can grow by using creative, local ideas, even when resources are limited (Samsung, 2021). But in Timor-Leste, there is still no national policy or clear plan to expand STEAM education across the country.

STEAM builds on the traditional STEM subjects by adding the arts, making learning more well-rounded. This way of teaching focuses not just on science and technology, but also on creativity, working together, critical thinking, and solving problems (Yakman & Lee, 2020). Including the arts helps keep students motivated and encourages new ways of thinking, which are important skills for success in today's tech-driven world (Beers, 2019). According to the National Research Council (2021), STEAM not only improves school performance but also helps students develop important traits like adaptability and resilience that they'll need in the future.

STEAM education shines in subjects like science and math. It uses project-based and hands-on learning, which helps students think more creatively and build stronger critical thinking skills (Hall & Miro, 2016). Studies show that teachers appreciate STEAM because it makes students more motivated, encourages learning across different subjects, and brings fresh, new ways to teach (Margot & Kettler, 2019). However, fully putting STEAM into practice is still hard because of limited class time, not enough teacher training, and a lack of materials that combine all the subjects.

Looking at countries like Finland and Singapore gives us good examples. Finland's curriculum focuses on learning through questions and connecting different subjects, which has improved its science and technology education a lot (Kumpulainen & Sefton-Green, 2021). Singapore, on the other hand, supports STEM with strong policies and works hard to promote innovation and problem-solving skills (Chong & Lee, 2021).

Table 1: Comparison of STEAM implementation readiness across Finland, Singapore, and Timor-Leste.

Criteria	Finland	Singapore	Timor-Leste
National Policy	Integrated into a flexible curriculum	Strong policy support for STEM	No national STEAM policy
Teacher Training	Emphasis on collaboration and STEAM pedagogy	Mandatory STEM PD programs	Limited, mostly general training
Infrastructure	Fully equipped classrooms, high digital access	Advanced ICT infrastructure	Major shortages, especially in rural areas
Curriculum Approach	Project-based, inquiry learning	STEM integrated with innovation	Rote-based, few interdisciplinary links
Digital Access	Universal	Very high	Low, especially outside urban areas
Assessment Methods	Performance-based, portfolio	Integrated assessments	Mostly traditional exams

There aren't enough well-trained science teachers, and this makes the challenges even harder. Many teachers in less-resourced areas have little experience with modern, hands-on teaching methods. They don't often get chances for training, and only a few are prepared to teach STEAM lessons that involve projects and active learning (World Bank, 2022). Without more support to help teachers improve their skills, it will be hard for STEAM education to reach its full potential.

Including the arts in STEAM also helps promote teaching that respects and reflects different cultures. This is especially important in Timor-Leste, a country with many languages and traditions. Studies show that when learning connects to students' real lives and communities, they stay more interested and learn better (Yakman & Lee, 2020; Iversen et al., 2021).

STEAM education helps students develop important skills like critical thinking, creative problem-solving, teamwork, communication, and digital know-how, all of which are really useful for today's jobs and lifelong learning.

However, there is still a big gap in school facilities between cities and rural areas. For example, about 85% of schools in urban areas have electricity, but only around 35% of rural schools do. Similar differences appear with internet access, science labs, and availability of digital devices, making it harder for many students outside the cities to fully benefit from STEAM learning.

Table 2: Infrastructure Disparities Between Urban and Rural Schools in Timor-Leste

Even with these challenges, Timor-Leste has many chances to grow STEAM education. Programs like Samsung's Solve for Tomorrow show that innovation can happen even when resources are limited, especially when communities get involved and practical solutions are used (Samsung, 2021). Taking part in regional

Infrastructure Component	Urban (%)	Rural (%)	National Average (%)
Access to Electricity	85	35	~60
Internet Connectivity	70	18	~35
Functional Science Labs	40	5	~20
Number of ICT Devices	High	Low	Low

assessments like SEA-PLM helps Timor-Leste collect important information to focus on improving reading, math, and science skills (SEA-PLM Report, 2023). Also, the rise of free educational resources and digital tools is opening up more ways to bring STEAM learning to students in faraway areas (World Bank, 2021).

Making sure the curriculum includes local traditions, what communities care about, and indigenous knowledge can make STEAM education more relevant and meaningful. For example, projects like building with traditional methods or mapping local plants and animals give students hands-on experience, help them learn new skills, and boost pride in their culture.

With ongoing policy work, pilot programs, and strong support from international groups like UNESCO, DFAT, and the European Union, Timor-Leste can build a STEAM education plan that helps young people grow and also supports the country's development (Saavedra & Opfer, 2019; Beck, 2022; Kim & Park, 2021).

2. Research Methods

This study uses a conceptual review to look at the challenges and opportunities for STEAM education in Timor-Leste. It reviews existing information from different sources, such as government policies, reports from international organizations, academic articles, and examples from countries with strong STEAM programs like Finland and Singapore.

The documents were carefully chosen based on relevance and published mostly between 2018 and 2023. They came from trusted websites (such as UNESCO and the World Bank), academic databases (including Google Scholar and JSTOR), and official policy archives. The focus was on materials discussing STEAM education, teacher training, infrastructure, and policies, especially those related to countries similar to Timor-Leste.

The information was organized around key areas: curriculum design, teacher preparation, facilities, use of technology, and education policies. While this study relies exclusively on secondary sources without the collection of primary empirical data, it offers useful insights and ideas to guide future research and policy development. However, because it is based solely on existing documents and literature, the findings may not fully capture the current realities or perspectives of key stakeholders such as teachers, students, and policymakers in Timor-Leste. Therefore, future research involving primary data collection, such as interviews, surveys, or classroom observations, would be valuable to validate and deepen the understanding gained from this review.

3. Results and discussions

3.1 Results

This part shares the main findings about how STEAM education could be introduced in Timor-Leste. The results come from comparing other countries' experiences, national education reports, and observations from Timor-Leste.

Countries like Finland and Singapore give us good examples of how STEAM can work well in schools. Finland focuses on learning through asking questions and connecting different subjects, which helps students be creative and do better academically. Singapore supports STEAM with strong government policies, invests in training teachers, and builds good digital infrastructure. These examples show that having clear policies, well-trained teachers, and good access to technology are all important for making STEAM education successful.

On the other hand, Timor-Leste faces some big challenges. There aren't enough qualified teachers, especially in science and technology. According to the 2023 SEA-PLM report, students in Timor-Leste are behind their neighbors in basic skills like reading, math, and problem-solving. Without well-trained teachers, changes to the curriculum won't lead to real improvements in learning.

Besides the shortage of skilled teachers, the limited infrastructure also slows progress. Many rural schools don't have reliable electricity, internet access, or digital learning tools. Beck (2022) points out that broken-up education policies and the ongoing lack of funding make it hard to bring technology into classrooms. This digital gap is a big challenge for giving all students fair access to STEAM education.

Still, there are good opportunities locally. Creating a STEAM curriculum focused on things like sustainable farming, traditional engineering, and local wildlife can give students meaningful, hands-on experiences. Moving away from just memorizing facts to project-based work and performance tasks can boost student interest and help them develop important skills for today's world. Choi and Pak (2020) found that project-based learning sparks creativity, critical thinking, and teamwork among students.

It's also clear that building up teacher skills is key. Training should focus on teaching across different subjects and improving digital skills, especially for teachers in remote areas. Kim and Park (2021) explain that teachers gain more confidence with STEAM methods when they learn interdisciplinary approaches early in their training.

Finally, Timor-Leste can benefit from working with international partners. Organizations like UNESCO and programs such as Samsung's "Solve for Tomorrow" can offer resources, pilot projects, and technical help. Saavedra and Opfer (2019) note that education innovation often moves faster when countries collaborate and share ideas globally.

3.2 Discussion

The results of this study show that while Timor-Leste faces several challenges in starting STEAM education—

like limited infrastructure and not enough trained teachers, there are also good opportunities to move forward with the right plans.

Countries like Finland and Singapore teach us that investing in teacher training, having clear policies, and building digital infrastructure are key to making STEAM programs work well. Although Timor-Leste is quite different, these ideas can be adapted to fit its own situation. For example, Finland's focus on teamwork and Singapore's strong policy support offer useful examples for Timor-Leste to follow as it reforms education.

One of the biggest problems is the shortage of teachers skilled in STEAM subjects. Along with this, unequal access to technology, especially in rural and poorer areas, must be tackled in any national plan. If these issues aren't fixed, STEAM education risks making existing gaps in learning even wider instead of closing them.

It's also very important to adapt STEAM to fit local culture and needs. Including subjects like protecting the environment, valuing traditional knowledge, and involving community projects in the curriculum can make learning more meaningful. Project-based learning helps students connect with real-life problems and use what they learn across different subjects.

Teacher training plays a central role in making STEAM successful. Training programs should be ongoing, easy to access, and designed to meet local needs. Offering support through online teacher groups and partnerships with universities can give teachers the confidence and tools they need to adopt STEAM teaching.

Working together with international and regional partners creates another strong opportunity. Collaborating with NGOs, global agencies, and universities can bring valuable support for pilot projects, teacher training, and curriculum improvements. These partnerships also help share new ideas and adapt successful approaches from other countries.

Despite the challenges, this study finds that bringing STEAM education to Timor-Leste is both necessary and possible. Starting step-by-step with local adaptation, and wisely investing in teacher development and digital infrastructure can help build a more inclusive, creative, and future-ready education system.

4. Conclusion

This review looked at the challenges and opportunities of bringing STEAM education, Science, Technology, Engineering, Arts, and Mathematics to Timor-Leste. By learning from examples around the world, local policies, and research, it's clear that STEAM can help change education for the better. It encourages students to think critically, be creative, and solve problems, skills that Timor-Leste needs to keep up with a fast-changing world and support sustainable growth.

However, there are still big challenges. There aren't enough trained teachers, many schools don't have the right facilities, students often lack access to digital tools, and the country doesn't yet have a clear national plan for STEAM education. These issues are even harder in rural areas, where resources are scarce and education gaps are bigger.

Still, Timor-Leste is at an important moment. There's growing interest in new teaching methods, more digital learning opportunities, and support from international partners. By carefully improving the curriculum, training teachers, upgrading facilities, and coordinating policies step by step, the country can build an inclusive education system that truly prepares students for the future.

Since STEAM education is just getting started, the first step should be to create a clear national policy. This policy will explain what STEAM means for Timor-Leste and how to bring it into schools. It will guide all future efforts to make STEAM teaching successful across the country.

Next, the STEAM curriculum should be adapted to fit Timor-Leste's culture and environment. Including local traditions and real-life problems will make learning more interesting and meaningful for students.

Teacher training is key too. Both new and experienced teachers need to learn how to teach STEAM well. They should also get ongoing support through online tools, mentoring, and chances to collaborate with others.

Improving school facilities, especially in rural areas, is very important. Schools need steady electricity, good internet, and digital devices so all students have an equal chance to learn STEAM.
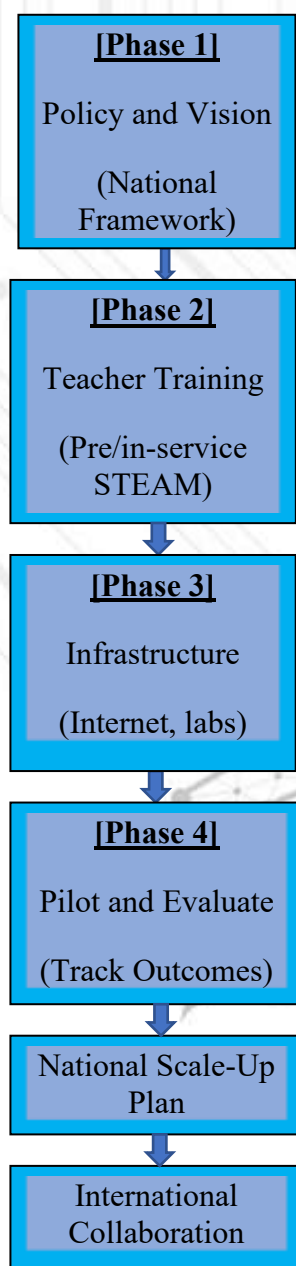
Building partnerships with international organizations, universities, and businesses can bring valuable resources and expertise needed to support STEAM projects and help them last.

Finally, starting with small pilot programs in a few schools will allow testing and refining the approach before rolling it out nationwide. Collecting feedback from these pilots will help make STEAM education work best for Timor-Leste.

Roadmap for STEAM Implementation in Timor-Leste

To introduce STEAM education across Timor-Leste, a step-by-step plan will help make the process smooth and effective. The following diagram presents an overview of the main phases involved in implementing STEAM education, providing a clear visual guide.

Figure 1: Roadmap for STEAM Implementation in Timor-Leste

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        │     [Phase 1]       │
        │  Policy and Vision  │
        │     (National       │
        │     Framework)      │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐
        │     [Phase 2]       │
        │  Teacher Training   │
        │   (Pre/in-service   │
        │       STEAM)        │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐
        │     [Phase 3]       │
        │   Infrastructure    │
        │   (Internet, labs)  │
        └─────────────────────┘
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                  ▼
        ┌─────────────────────┐
        │     [Phase 4]       │
        │  Pilot and Evaluate │
        │  (Track Outcomes)   │
        └─────────────────────┘
                  │
                  ▼
        ┌─────────────────────┐
        │ National Scale-Up   │
        │        Plan         │
        └─────────────────────┘
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        ┌─────────────────────┐
        │   International      │
        │   Collaboration     │
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The first step is to create a clear national policy that explains what STEAM education is all about and how it should be included in every school. This policy will guide everyone involved and make sure the government supports the effort.

Next, teachers need to be ready to teach STEAM subjects. Training programs should help both new and current teachers learn how to teach using teamwork, hands-on projects, and technology.

After that, it's important to improve school facilities. Schools need reliable electricity, internet access, and the right tools like science labs and digital devices, especially in rural areas.

Before introducing STEAM education everywhere, it's a good idea to start with pilot projects in a few schools. These pilots will test the curriculum, teaching methods, and resources. The feedback from these schools will show what works well and what can be improved.

Once the pilot phase goes well, the program can slowly expand to more schools. This should be done carefully, with good planning around money, teacher training, and regular check-ins to see how things are going.

Finally, working with international partners, universities, and other organizations can bring extra support, knowledge, and resources needed to help STEAM education grow strong in Timor-Leste.

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