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Spatial and Socio-Economic Determinants of Advanced Level Stream Selection in the Norwood Division, Nuwara Eliya, Sri Lanka

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Abstract

This study investigates the holistic interplay of multiple factors influencing advanced-level stream selection in the Norwood Divisional Secretariat of Nuwara Eliya, Sri Lanka. The research highlights a significant disparity, with a high number of students opting for Arts and Commerce subjects, while fewer students choose Mathematics, Science and Technology subjects. The primary objective of this study is to identify the sub-factors affecting stream selection, examine their interdependence and propose strategies to provide evidence-based recommendations to educational stakeholders. The study focused on 25 Tamil medium Advanced Level schools in the area, selected using a simple random sampling method. Primary data was collected from students and teachers through questionnaires, interviews and direct observation. Secondary data was gathered from the Hatton Educational Department. Additionally, ArcGIS software, SPSS and Microsoft Excel were used to map student residences, school locations and private educational institutions, while simple statistical analysis was performed. SWOT and TOWS Matrix analyses were also conducted. Key findings reveal that traveling distance and transportation are crucial factors influencing stream selection, with 29% of students living more than 20 km away from their schools and 95% walking to schools. These factors, combined with the cost of transportation, significantly impact students' stream choices. Additionally, 76% of students did not choose their A/L education stream voluntarily and 85% expressed a desire to pursue a different stream. The study concludes that there is a pressing need to improve the Mathematics and Science stream selection in the Norwood area to create more career opportunities for students, while also enhancing the Arts stream. This research confirms that multiple factors are interrelated in the selection of academic courses for higher education.

Keywords: Norwood Divisional Secretariat, G.C.E. Advanced Level stream selection, spatial determinants, socio-economic determinants, Interplay

Introduction

Education plays a pivotal role in shaping the social, economic and political development of societies globally. Research consistently demonstrates that education contributes to human capital formation, which, in turn, supports national economic growth (OECD, 2019). A well-educated population enables both individual advancement and collective national progress. In the current era of technological transformation, the increasing emphasis on Science, Technology, Engineering and Mathematics (STEM) fields along with digital technologies, artificial intelligence (AI) and the Internet of Things (IoT) has transformed the structure and delivery of education (Looi et al., 2022; Zhao & Perez-Felkner, 2022).

In Sri Lanka, secondary school pathways and higher education systems have begun to reflect these changes by emphasizing STEM subjects, highlighting their growing significance in the modern labour market (Ministry of Education, 2018). In remote areas, such as the Norwood Divisional Secretariat in Nuwara Eliya District, bridging the gap in practical STEM education is particularly crucial to equip students with skills needed to thrive in a rapidly changing economy. However, despite national efforts to modernize education, students in this region continue to face multiple socio-economic and spatial obstacles that influence their advanced-level (A/L) stream choices.

Socioeconomic status, parental education, family income and school resources have all been shown to significantly shape students' academic pathways. For instance, research in the Philippines indicated that personal interest, perceived job opportunities and the convenience of school location were more influential than academic performance or parental socio-economic status in shaping students' strand selection (Niu, 2017). Similarly, U.S. based research shows that students' perceived ability in mathematics and science positively predicts subsequent STEM choices, whereas interest in these subjects is generally a weaker predictor (Perez-Felkner et al., 2014; Riegle-Crumb & King, 2010). In Sri Lanka, the selection of the Biological Science stream in the Western Province has been declining, influenced by factors such as school infrastructure, student performance and socio-economic background. Other institutional factors availability of qualified teachers, laboratory facilities and medium of instruction further affect student choices (Weerarathna et al., 2022).

In sum, stream selection at the upper secondary level is influenced by a complex interplay of factors: academic performance, career aspirations, socio-economic background, parental and peer influence, teacher guidance, school resources, geographic access and transportation. Understanding these interrelationships in a

local context such as the Norwood Division is crucial for designing interventions to foster equitable access to STEM education. This study, therefore, explores the spatial and socio-economic determinants of A/L stream selection in Norwood, Nuwara Eliya, with the objectives of identifying influencing sub-factors, examining their interdependence and providing evidence-based recommendations to educational stakeholders.

Literature Review

A substantial body of research has examined predictors of students' postsecondary STEM major selection, often focusing on mathematics intensive fields such as Computing and Engineering. Early exposure to STEM-related courses can awaken student interest and facilitate progression into STEM majors (Bottia et al., 2015). Completion of advanced mathematics and science courses in high school has been found essential for pursuing STEM subjects in college (Dalton et al., 2007; Schneider et al., 2013). Psychological factors, including interest and self-efficacy, also influence course taking and subsequent STEM choices (Milesi et al., 2017; Perez-Felkner et al., 2017; Renninger & Hidi, 2011).

Research shows that self-assessed mathematics ability significantly affects STEM major selection, even when self-assessments are biased by sociocultural norms around who "belongs" in these fields (Beyer, 1990; Correll, 2001). Interest, though widely studied as a motivational variable, is also socially conditioned and does not fully account for disparities in STEM choice (Watt et al., 2012). Furthermore, U.S. studies have highlighted persistent gender and racial disparities in STEM education, despite increased access (Carter et al., 2019; Saw et al., 2018; Xie et al., 2015). Gender differences in post-college earnings are partially explained by postsecondary degree fields, including STEM majors (Bobbitt-Zeher, 2007; Xu, 2015; Zhang, 2008).

Nationally representative longitudinal studies, such as the high school longitudinal study of 2009 (HSLS:09), provide insights into the interplay of perceived ability and interest in predicting STEM major selection. Findings indicate that mathematics and science ability positively influence STEM selection, whereas interest is a weaker predictor. Gender disparities remain, with women less likely than men to select STEM majors, particularly in Computing/Engineering fields. Additionally, secondary STEM course completion explains much of the race gap in STEM postsecondary outcomes, including major choice (Tyson et al., 2007; Riegle-Crumb & King, 2010; Perez-Felkner et al., 2014). These studies, however, often overlook the role of science ability beliefs and subject interest in shaping STEM pathways.

Contextual factors including parental occupation, family income and school characteristics also influence STEM major selection (Shapiro & Sax, 2011; Wang, 2013; Oguzoglu & Ozbeklik, 2016; Niu, 2017). Private schools and urban schools often provide more advanced STEM courses, positioning students better for postsecondary STEM education (Lee et al., 1998; Ketenci et al., 2020; Bottia et al., 2018). Gender specific analyses reveal that perceived ability affects major intentions differently, with implications for the persistent underrepresentation of women in mathematics intensive majors (Nix & Perez-Felkner, 2019; Wiswall & Zafar, 2015).

In Sri Lanka, students in remote regions face additional barriers to selecting STEM streams, including distance from school, transportation limitations and limited availability of advanced-level courses. Research in other area of Sri Lanka (Weerarathna et al., 2022) has shown that a majority of students do not choose their A/L streams voluntarily and many express a desire to pursue alternate streams. These findings highlight the misalignment between student aspirations and actual enrollment patterns and suggest that spatial and socio-economic factors play a critical role in shaping educational pathways. Building on this prior research, the present study examines how these factors collectively influence A/L stream selection in the Norwood Divisional Secretariat of Nuwara Eliya, providing a holistic perspective on secondary level educational decision making. This study builds upon international and national research by examining how spatial, socio-economic and individual factors collectively influence A/L stream selection in a Sri Lankan context, providing a holistic perspective on educational decision making at the secondary level.

Methodology
Study Area and Features
The Norwood Divisional Secretariat Division is a hilly area situated at an altitude of over 1,500 m, home to the historically significant Mount Sivanolipadhamalai, which stands at 7,359 feet (2,243 m). The area experiences a humid climate, receiving 1,400 to 1,900 mm of rainfall annually, with the heaviest rains occurring between May and June. Temperatures range from 13°C to 15°C, with the warmest months in March and April. The geology of this area is part of the Precambrian highland series, with various rock types such as cherts, quartzites, marbles and gneisses. The vegetation is temperate and evergreen, with species like Uyarachai Unayanaya and Pusayanelai. The soil is fertile, with sandy loam and clay loam in the upper layers, suitable for tea and vegetable cultivation. The population of the region is 96,975, including a diverse mix of Buddhists, Hindus, Muslims, Christians and non-Christians, with some communities maintaining Indian cultural practices. Urbanization is growing as younger generations

migrate to cities. Economically, the region benefits from favorable conditions for tea production, alongside vegetable farming, flower production, dairy farming and a growing tourism sector that creates significant employment opportunities.

Figure 1. Map showing the study area and features
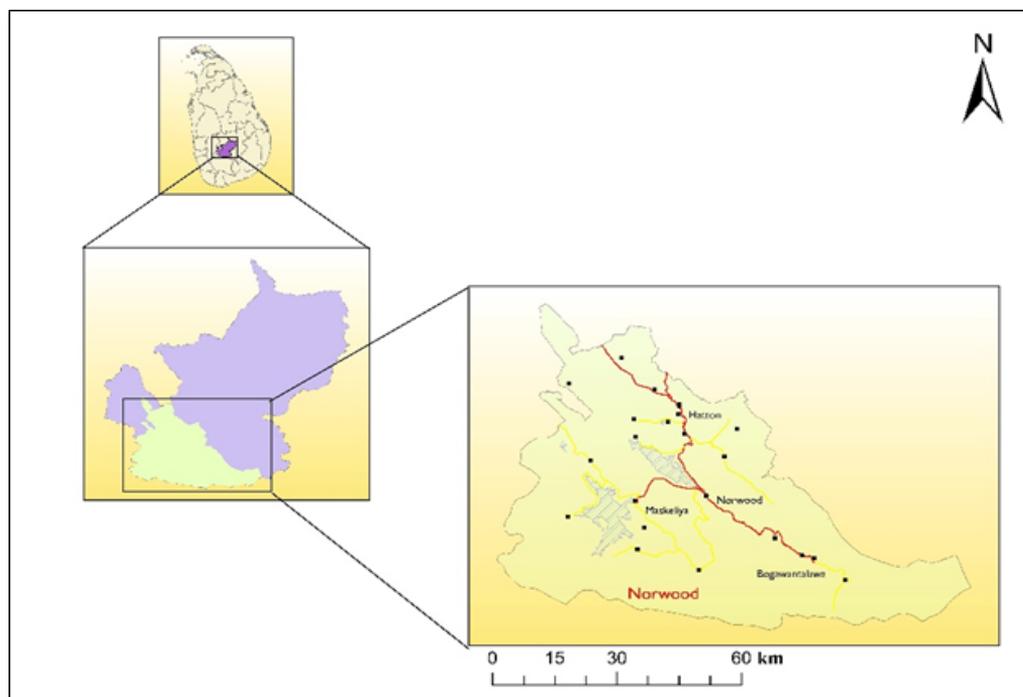
Source: Base map from Survey Department of Sri Lanka (1:10,000 scale); mapped in ArcMap (ArcGIS).

Materials and Methods

This study utilised both primary and secondary data collection methods to explore the factors influencing GCE Advanced Level (A/L) stream selection in the Norwood Divisional Secretariat of Nuwara Eliya, Sri Lanka. Simple random sampling was applied to select a representative sample of students from 25 Tamil medium GCE AL schools (Figure 2) and 12 institutions. Observations were made in 25 Tamil medium schools to assess the learning environment, school infrastructure, street conditions and students' living environments. Primary data were collected through a semi-structured questionnaire, administered to 15% of the student population and in-depth interviews were conducted with 50 participants, including school principals, teachers and students. Secondary data from the Hatton Zonal Education Office provided additional insights into stream selection trends, particularly the underrepresentation of Mathematics, Science,

Technology and Engineering subjects compared to Arts and Commerce. ArcGIS 10.4 was used to create a digital map that visualized geographical factors such as student residences, school locations, direct distance and travel distances. Descriptive statistical analysis and thematic analysis of qualitative data from interviews helped identify sub-factors influencing stream selection, including parental influence, socio-economic background and career aspirations. The integration of these data sets enabled a comprehensive understanding of the factors shaping students' subject choices, leading to evidence-based recommendations for improving the stream selection process.

Figure 2. Map depicts the locations of Tamil schools offering Advanced Level subjects in Norwood Division
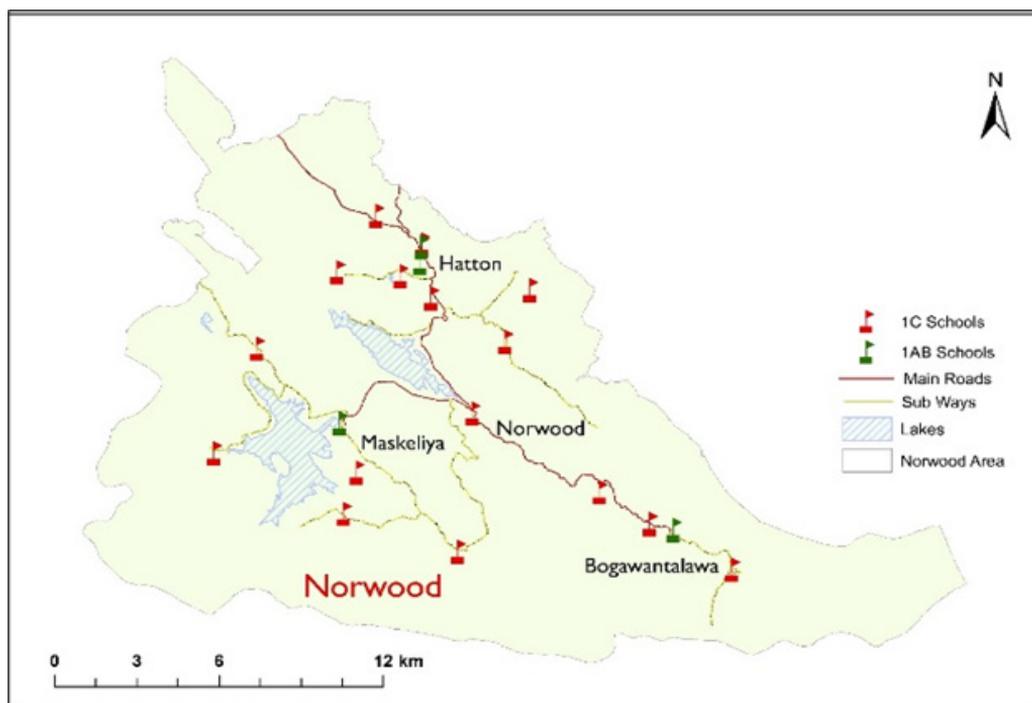
Source: Authors' field data (2024); base map from the Survey Department of Sri Lanka (1:10,000); ArcMap (ArcGIS)

Results and Discussion
Advanced Level Stream Selection Patterns
The selection of G.C.E. Advanced Level (A/L) streams in the Norwood Divisional Secretariat exhibits a pronounced preference for Arts (45%) and Commerce (30%), while Mathematics, Science and Technology streams remain significantly underrepresented (Figure 2). This pattern reflects structural, environmental and socio-economic limitations rather than solely student interest or capability.

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Consistent with prior research, students in rural or resource constrained settings tend to opt for streams that are more accessible locally, require fewer specialised resources and impose lower financial and logistical burdens (Abeygunawardena, 2018; Alvarez, n.d.; Weerarathna et al., 2022). The dominance of Arts and Commerce reflects a broader rural-urban disparity in access to specialised education, with STEM streams concentrated in urban or better resourced areas. Milesi et al. (2017) and Induranga et al. (2022) highlight that such disparities can perpetuate systemic inequities, limiting the career and higher education trajectories of students from rural communities. Notably, 76% of students reported not selecting their stream voluntarily, indicating that external constraints overwhelmingly influence academic pathways.

Figure 3. Graph showing the number of students selecting Advanced Level streams in the Norwood Divisional Secretariat
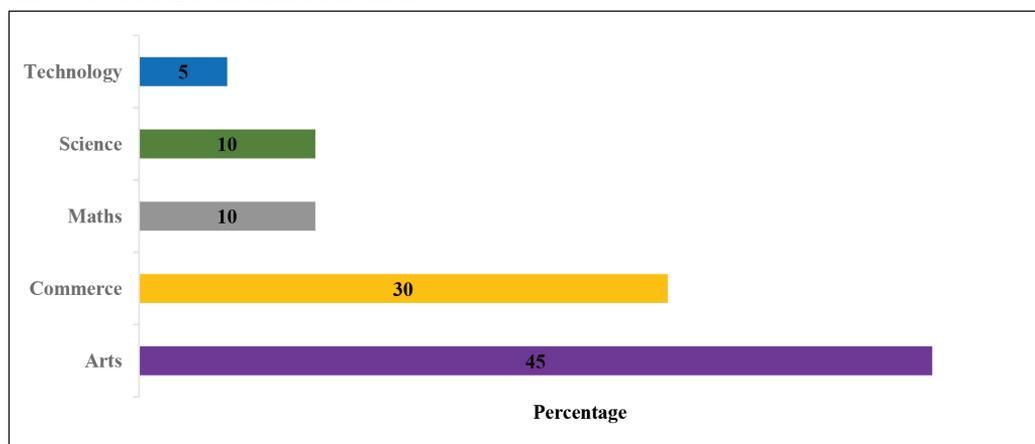

Source: Authors' field data (2024); graph generated using Microsoft Excel

Spatial Determinants

Geographical accessibility emerged as a critical determinant of stream selection. In the Norwood Division, 76% of schools are located in rural areas, with students traveling an average of 17 km, often on foot, across hilly terrains, valleys and single-track paths (Figures 4 and 5). The physical burden of these commutes not only affects attendance and punctuality but also limits access to schools offering STEM streams. Approximately 75% of students identified transportation limitations and 65% cited school location as decisive factors in their stream choice. These findings align with Hathella and Priyanath (2021), who reported that commuting distance and terrain challenges negatively affect subject selection and performance. Internationally, similar trends have been documented, rural students face disproportionate barriers in accessing STEM courses, which are often available only in well-resourced schools (Dalton et al., 2007; Estrada et al., 2016).

Furthermore, the interaction between spatial constraints and psychological stress is notable. Long commutes contribute to fatigue, reduced study time and lower engagement with demanding subjects, disproportionately affecting students who might otherwise have the aptitude for STEM fields. This underscores the need for integrated strategies addressing both infrastructural and well-being considerations in rural education planning.

Figure 4. Distribution of schools in the Norwood Division, showing urban and rural locations and student residences
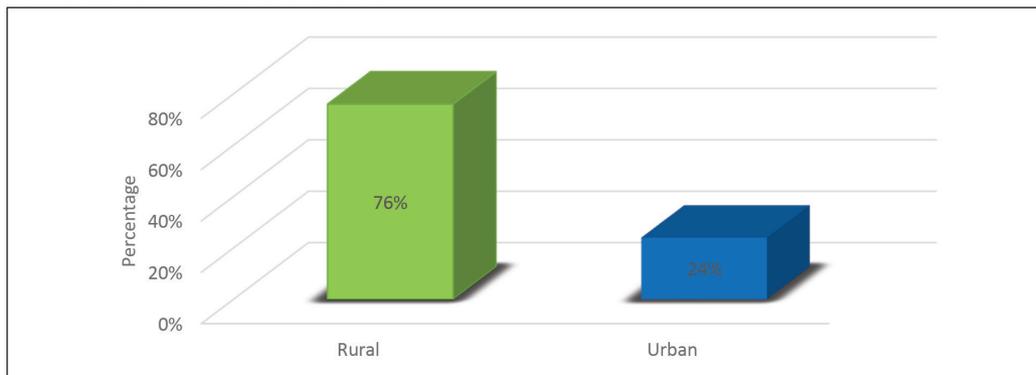
Source: Hatton Zonal Education Office (2024); graph generated in MS Excel.

Figure 5. Map depicting the locations of schools, private classes, student residences and major roads in the Norwood Division
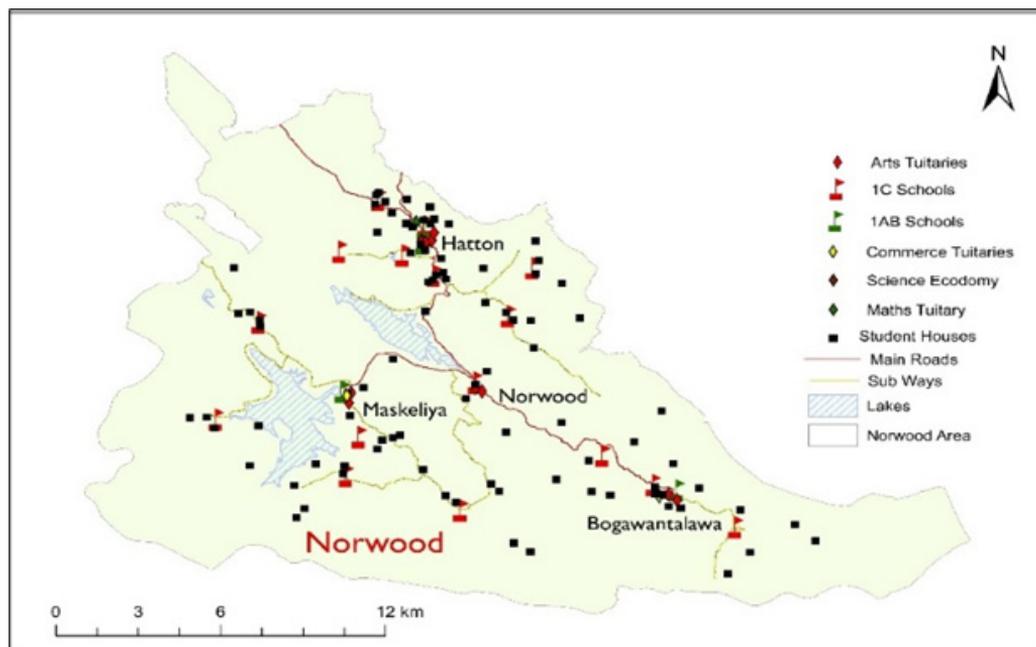

Source: Base map obtained from the Survey Department of Sri Lanka (Topographic Maps, 1:10,000 scale). Map generated using primary data collected through field surveys and processed in ArcMap (ArcGIS).

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Socio-Economic Determinants

Economic status significantly shapes stream selection in the Norwood Division. The majority of families are engaged in low-income livelihoods; tea estate work (40%), daily wage labor (13%) and agriculture (10%), with 61% earning below Rs. 30,000 per month (Figure 6 and 7).

Figure 6. Graph depicts the main sources of livelihood among the families of the students
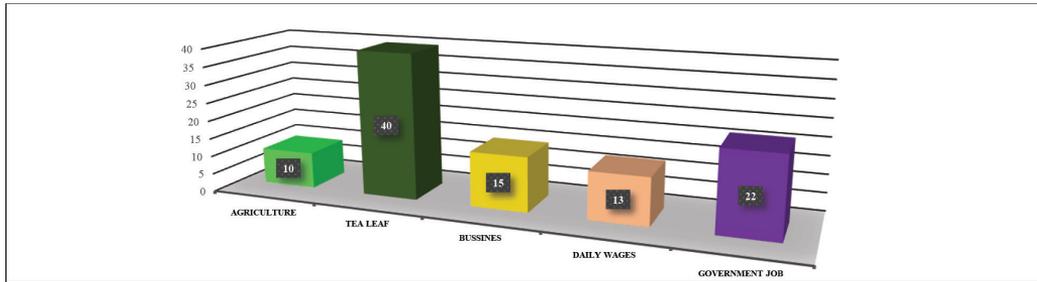
Source: Authors' field data (2024); graph generated using Microsoft Excel.

Figure 7. Graph depicts data on the income levels representing the economic status of the students' families
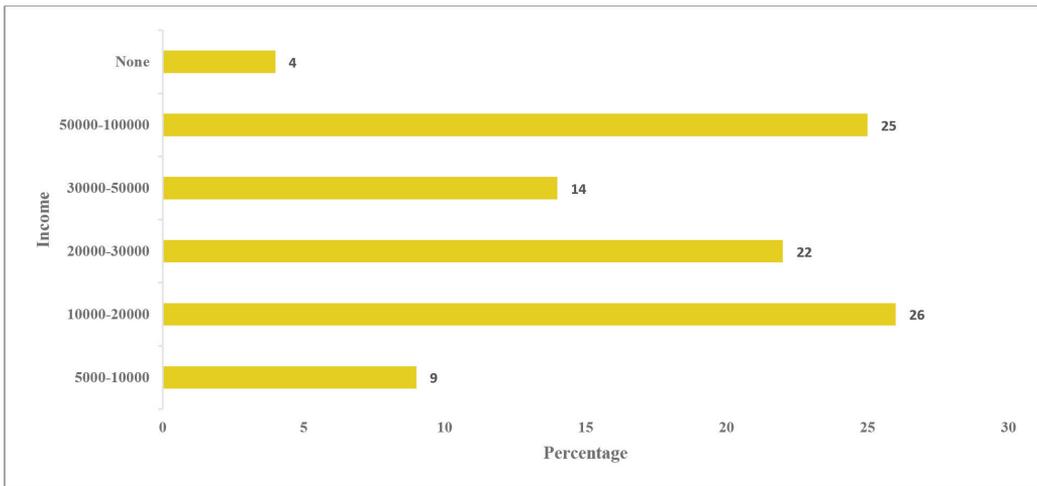
Source: Authors' field data (2024); graph generated using Microsoft Excel

These constraints limit the ability to invest in private tuition or additional academic support, particularly for STEM subjects, which often require specialised instruction due to teacher shortages (Abeygunawardena, 2018; Niu, 2017; Lakshmi et al., 2023). The study highlights the compounding effect of economic and spatial determinants. Students from low-income households are less able to travel long distances to access specialised streams, exacerbating rural-urban disparities. This is consistent with the human capital theory (Mincer, 1958) and

research by Bobbitt-Zeher (2007), indicating that economic limitations constrain educational and, ultimately, occupational opportunities. The findings suggest that socio-economic barriers are a key driver of the underrepresentation of STEM streams, independent of students' abilities or interests.
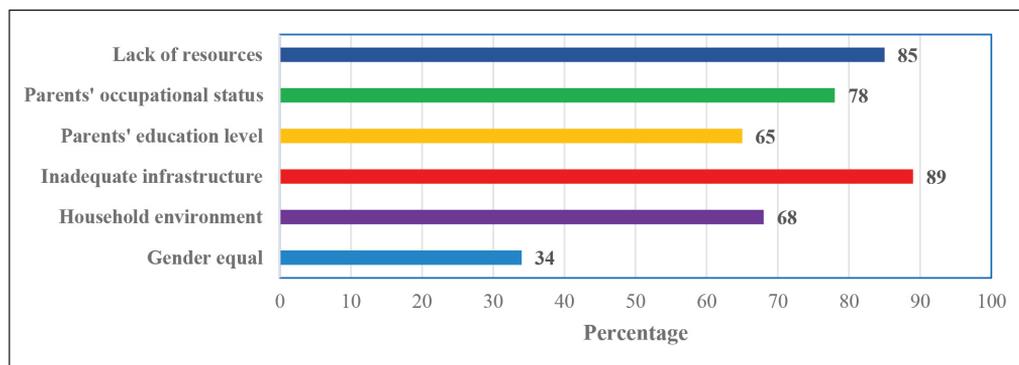
Institutional, Human and Physical Determinants

Institutional capacity and human resources are critical determinants. Tamil medium schools predominantly offer Arts and Commerce, with limited access to Mathematics, Science and Technology. A shortage of qualified STEM teachers and inadequate classroom infrastructure further limits enrollment in these streams. Around 89% of students reported challenges attending classes punctually due to transport and infrastructural constraints (Somarathne & Jayasuriya, 2021; Weerarathna et al., 2022). Psychological stress also plays a pivotal role. Approximately 66% of students reported stress, fatigue and reduced motivation resulting from long commutes and insufficient rest. Research by Renninger and Hidi (2011) and Nix & Perez-Felkner (2019) demonstrates that motivation, interest and self-efficacy are central to persistence in STEM pathways. In Norwood, these psychological pressures interact with structural barriers to discourage students from pursuing distant or academically demanding STEM streams.

Social and Family Determinants

Social and family contexts strongly influence students' stream selection. A significant proportion of students identified key household and social factors that shaped their academic pathways. Approximately 78% reported that parental occupation affected their choices, while 85% emphasized the role of family income and employment status as major determinants. Additionally, 89% of students cited inadequate infrastructure as a barrier that limited their ability to pursue the stream of their preference.

Notably, 76% of students did not voluntarily select their stream, reflecting a mismatch between their personal interests and the opportunities available within their educational environment. Parental education, social capital and exposure to career pathways also play critical roles in shaping STEM engagement. Previous research shows that students with limited parental exposure to STEM careers or higher education are less likely to pursue such fields (Lee et al., 1998; Pepple, 2014; Oguzoglu & Ozbeklik, 2016; Perez-Felkner et al., 2014). Overall, these findings demonstrate that socio-cultural and family dynamics intersect with spatial, infrastructural and economic constraints to shape students' educational outcomes.

Figure 8. Graph illustrates the interrelationships and relative importance of key social factors

*Source: Authors' field data (2024); graph generated using Microsoft Excel*

Interrelation and Critical Analysis

The study demonstrates a complex interplay between geographical, economic, social, institutional and psychological determinants. Distance and transport limitations restrict access to STEM streams, while economic constraints limit private tuition options. School infrastructure and teacher availability further concentrate students in Arts and Commerce. Psychological stress compounds these barriers, discouraging participation in distant or demanding streams. This multilayered interdependence mirrors global evidence showing that underrepresented students face overlapping barriers to STEM participation, including access, financial limitations and motivation (Griffith, 2010; Estrada et al., 2016; Tyson et al., 2007). In Sri Lanka, rurality, plantation-based livelihoods and linguistic medium of instruction further exacerbate these inequities (Induranga et al., 2022; Weerarathna et al., 2022).

### Strategic Analysis for Improving Stream Selection in Education

To develop evidence-based recommendations for educational stakeholders and to enhance the Advanced Level (A/L) course selection process in the Norwood Division, a SWOT (Strengths, Weaknesses, Opportunities, Threats) (Figure 9) and TOWS (Threats, Opportunities, Weaknesses, Strengths) (Figure 10) analysis was conducted. These strategic tools help evaluate internal and external factors that influence students' subject choices, particularly in rural and plantation areas.

Figure 9. Sketch diagram illustrating the impelling and impeding forces (SWOT Analysis) of the educational environment
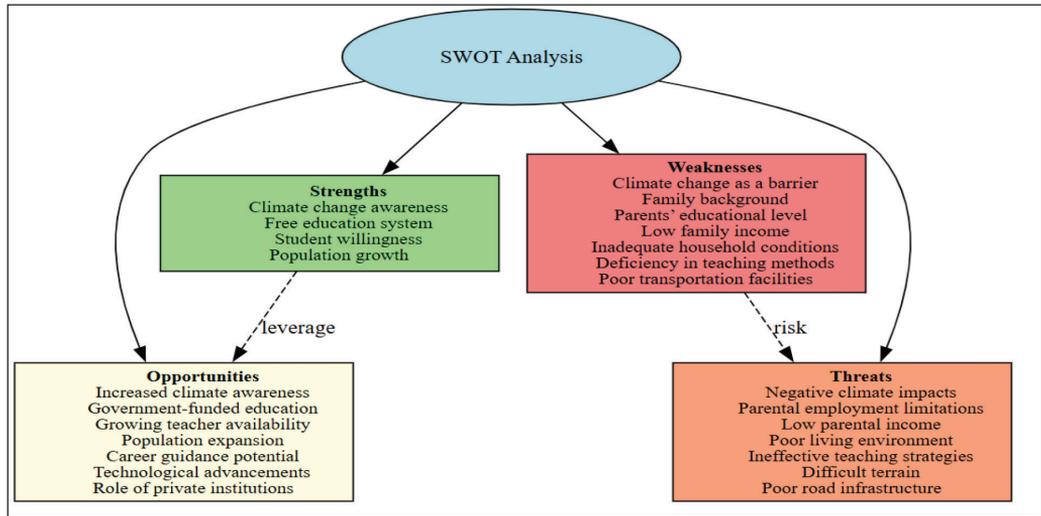
Source: Author's own work, 2024

Figure 10. Sketch diagram illustrating the TOWS Matrix of the educational environment, showing strategies derived from internal (Strengths, Weaknesses) and external (Opportunities, Threats) factors
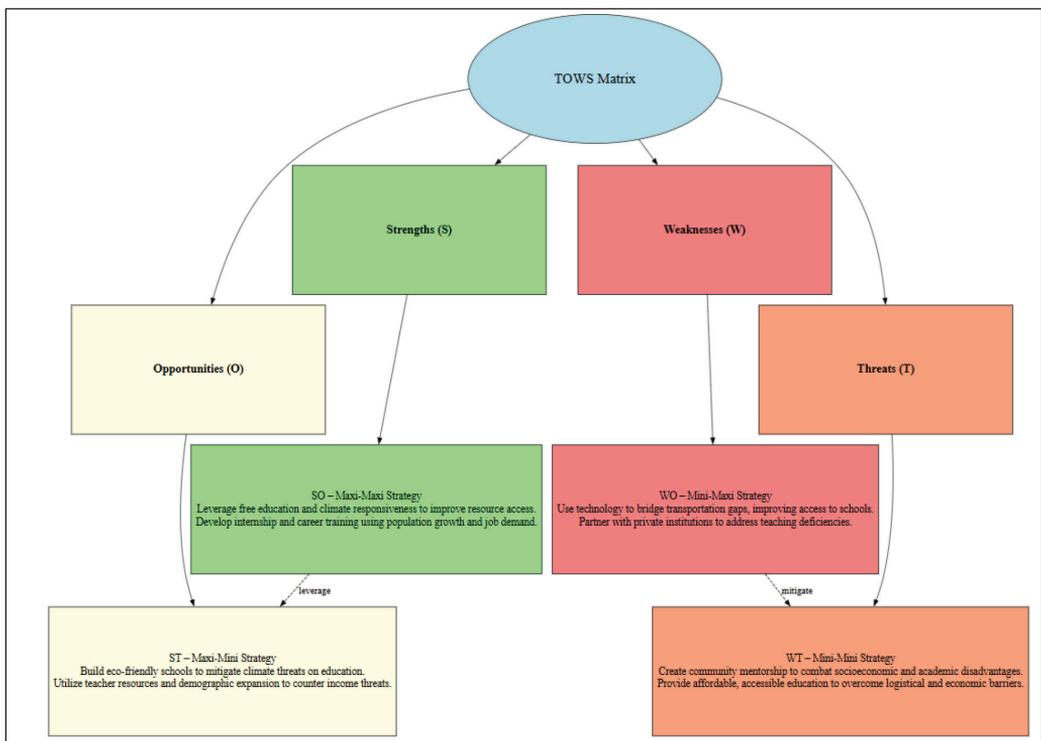
Source: Author's own work, 2024

The TOWS matrix (Figure 10) clearly illustrates how internal strengths and weaknesses interact with external opportunities and threats in shaping educational outcomes: SO Strategies (Maxi-Maxi): Aim to fully exploit strengths like free education and rising population to improve access and streamline stream selection. Introducing career linked experiences through internships would guide students in making informed decisions. WO Strategies (Mini-Maxi): Highlight how weaknesses like poor transportation and teaching methods can be addressed using opportunities such as the rise in private institutions and technological tools. Digital platforms and hybrid learning models can significantly reduce educational inequality. ST (Maxi-Mini Strategy): This approach aims to use existing strengths such as teacher engagement and climate adaptability to reduce risks from external threats like climate challenges and family economic instability. Creating sustainable educational environments and low-cost after-school programmes can insulate students from such risks. WT (Mini-Mini Strategy): The most defensive strategy involves minimizing both weaknesses and threats. Targeted interventions, such as mentoring for underprivileged students and community-based support programmes, can offset the effects of poverty, poor teaching and transport barriers on course selection.

Conclusion
This study demonstrates that Advanced Level (A/L) stream selection in the Norwood Division of Nuwara Eliya is shaped by a complex interplay of spatial, socio-economic, infrastructural and psychological factors. Geographic constraints, including long travel distances (mean = 17.18 km) and inadequate transport facilities, limit students' access to schools offering Mathematics, Science, and Technology streams. Rural schools predominantly provide Arts and Commerce subjects, reinforcing a structural barrier that restricts equitable access to STEM education. Socio-economic determinants, particularly low household income and limited parental education, further exacerbate this inequity. Students from economically disadvantaged families are less able to afford private tuition, laboratories, or supplementary academic resources, constraining their ability to pursue STEM streams and make informed educational choices. Psychological stress from long commutes, coupled with the scarcity of qualified STEM teachers and poor infrastructure, reduces motivation and contributes to the underrepresentation of students in Science, Mathematics and Technology streams. The findings highlight a multi-layered interdependence of spatial, economic and institutional determinants that collectively shape A/L stream selection. Without strategic intervention, these factors will continue to limit STEM participation, reduce career opportunities and perpetuate educational disparities in rural and plantation areas. Addressing these systemic challenges is crucial to fostering

equitable educational outcomes and supporting long term socio-economic development in the region.

3. Graphical Recommendations

Figure 11. Research-based graphical representation of recommendations derived from the TOWS Matrix of the educational environment, illustrating strategies based on internal (Strengths, Weaknesses) and external (Opportunities, Threats) factors.

Source: Author's own work, 2024.

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