Project Title: Investigating The Impact of Robotics Education as a Mandatory School Subject on STEM Academic Performance for Students in Middle Schools: A Mixed-Methods Approach

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Abstract

This mixed-methods study investigates whether robotics education, when implemented as a mandatory school subject, contributes to higher STEM academic performance and stronger academic resilience among middle school students in Bangladesh. Quantitative data were collected from 50 Grade 9 students in two Cambridge-curriculum schools – one with mandatory robotics education and one without – while qualitative insights were gathered through interviews with 30 participants. Academic resilience and performance change were analysed using descriptive statistics, independent samples t-tests, Pearson correlations, and reliability testing in SPSS, and complementary resilience behaviours were examined through thematic coding in NVivo. As students transition from grade 8 to grade 9, they obviously face tougher study challenges; therefore, the majority of the students have shown a decline in marks. However, results show that students exposed to robotics experienced a significantly smaller decline in academic performance from Grade 8 to Grade 9 ($p = 0.004$) and consistently demonstrated higher tendencies toward iterative and adaptive problem-solving strategies. Although individual resilience indicators did not directly predict academic marks, robotics education was associated with behaviourally observable resilience patterns and adaptive learning strategies. These findings suggest that integrating robotics as a mandatory subject may provide educational value beyond performance metrics, supporting long-term academic resilience and STEM-related problem-solving skills, which are essential to advance a developing country and society overall.

Index Terms: Robotics Education, Academic Resilience, Problem-Solving Skills, Mixed-Methods Research, STEM, SPSS, NVivo

Introduction

In the 21st century, where the world is rapidly progressing in terms of science and technological advancements, robotics has become one of the most significant fields of study, enabling learners to explore its wide-ranging applications across various fields [1]. Exploring the skills of designing and building a mechanical robot not only adds exciting new knowledge about science, technology, engineering and mathematics but also fosters critical thinking abilities and motivates learners to solve complex problems practically. In today's world, it has become even more urgent to solve difficult real-world problems, such as manufacturing, healthcare, automation, construction, AI, etc., which are even more significant for LEDC countries like Bangladesh.

Educational robots have made strides in K–12 education due to recent advancements in robotics. The impact of robotics on student engagement and developing computational thinking has been shown by a bibliometric study by Lu et al. [2] In practice, robots are now used as tutors, assistants, and interactive learning tools, transforming traditional classrooms into vibrant, interdisciplinary learning spaces. For example, students are seeing a stronger grasp of complicated math and science – abstract concepts – thanks to working with robots. Other studies which reported gains in programming skills and motivation