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INCLUSIVE STEM EDUCATION: BRIDGING GAPS, EMPOWERING AUTISM COMMUNITY THROUGH AQUAPONICS FOR A SUSTAINABLE FUTURE

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Introduction

In Malaysia, the autism community faces substantial barriers in accessing Science, Technology, Engineering, and Mathematics (STEM) education—fields that are pivotal for driving innovation and economic growth. As of December 31st, 2021, there were 40,743 registered individuals with autism in the country, encompassing both adults and children. By 2022, the Department of Social Welfare Malaysia reported an increase to 42,349 registered individuals with autism.

Alarmingly, the unemployment rate among the autism population exceeds 70%, underscoring a critical gap in workforce participation and inclusion.

Traditional educational frameworks predominantly rely on standardized teaching methods that may not cater to the diverse needs of students with autism. This challenge is compounded by a lack of access to specialized assistive technologies, such as customized learning platforms and sensory-friendly tools, as well as a shortage of educators trained to effectively teach students with autism. Consequently, many individuals with autism are excluded from equitable participation in STEM education, limiting their ability to acquire the skills essential for contributing to national development.

Beyond education, societal misconceptions about the capabilities of individuals with autism, inadequate workplace accommodations, and employer hesitancy to hire them further exacerbate employability gaps. These barriers in STEM education not only undermine the potential of the autism community but also deprive the nation of their valuable perspectives, talents, and contributions.

This research, conducted at Pusat Jagaan dan Latihan Insan Istimewa IMC Subang Jaya, Selangor and Pusat Pemulihan Dalam Komuniti (PPDK) Teluk Bahang, Pulau Pinang aims to address these challenges by investigating inclusive STEM education frameworks and the integration of assistive technologies to bridge the employability gap. By equipping individuals with autism with technical, creative, and problem-solving skills, the study seeks to empower them to achieve economic independence, enhance workforce diversity, and contribute meaningfully to Malaysia's social and economic progress. Furthermore, it envisions fostering a more inclusive society that recognizes and values the unique potential of all its members, aligning with

Malaysia's broader goals of innovation and equitable development.

At IMC Subang Jaya and PPDK Teluk Bahang, aquaponics is being integrated into STEM education to support students with autism. These institutions have tailored their aquaponics programs to provide sensory-friendly, structured learning experiences that cater to the specific needs of their students.

Pusat Jagaan dan Latihan Insan Istimewa IMC, Subang Jaya: Students with autism participate in hands-on aquaponics projects, enhancing their understanding of STEM concepts while developing practical skills. The program focuses on visual learning and structured tasks, helping students build confidence and independence.

PPDK, Teluk Bahang: This community center uses aquaponics to teach sustainability and STEM skills, creating an inclusive environment where students with autism can thrive. The initiative also aims to equip students with job-ready skills, contributing to their future employability and economic independence.

Figure 1: Pusat Jagaan dan Latihan Insan Istimewa IMC Subang Jaya, Selangor (Source: Author's own collection)

Figure 2: Pusat Pemulihan Dalam Komuniti (PPDK) Teluk Bahang, Pulau Pinang (Source: Author's own collection)

Aquaponics and its integration with STEM disciplines

Aquaponics is a sustainable farming method that combines aquaculture (raising fish) and hydroponics (growing plants in water) in a symbiotic environment. The fish waste provides essential nutrients for the plants, while the plants naturally filter and purify the water for the fish. This closed-loop system mimics natural

ecosystems and offers a practical demonstration of various STEM principles.

Integration with STEM Disciplines:

- Science: Students explore biological processes, such as nitrogen cycles, plant biology, and aquatic ecosystems. They also learn about environmental science, water chemistry, and sustainability.
- Technology: Aquaponics systems can be enhanced with sensors and automation to monitor water quality, temperature, and nutrient levels. This introduces students to technological tools, data analysis, and programming.
- Engineering: Designing and building an aquaponics system involves understanding mechanical systems, fluid dynamics, and structural engineering. Students apply engineering principles to create efficient and effective setups.
- Mathematics: Mathematical skills are essential for calculating water flow rates, nutrient concentrations, and system capacity. Students learn to apply math in real-world contexts, enhancing problem-solving and analytical thinking.

Adapting Aquaponics for individuals with autism

Aquaponics can be tailored to meet the learning needs of individuals with autism by creating structured, predictable, and sensory-friendly learning environments. Here's how it can be adapted:

- Visual Learning: Aquaponics systems are highly visual, allowing students to observe the growth of plants and fish. This can be particularly beneficial for students with autism who may prefer visual learning methods.
- Sensory Engagement: Hands-on activities like planting, feeding fish, and monitoring water quality engage multiple senses, providing stimulating yet controlled sensory experiences.
- Structured Tasks: The repetitive and structured nature of aquaponics tasks can offer a sense of routine and predictability, which many individuals with autism find comforting.

Customization: The system can be scaled and adapted to individual learning paces and abilities, allowing students to progress at their own comfort level.

Potential for hands-on, experiential learning

Aquaponics provides a rich, hands-on learning experience that is both engaging and educational. Its potential includes:

- Active Participation: Students actively engage in the setup, maintenance, and observation of the aquaponics system, making learning interactive and dynamic.
- Real-World Application: Aquaponics connects theoretical knowledge to real-world applications, helping students understand the relevance and impact of STEM disciplines in everyday life.
- Inspiration and Creativity: The tangible outcomes of their efforts, such as healthy plants and thriving fish, can inspire students and boost their confidence and creativity.
- Diverse Learning Abilities: Aquaponics caters to a wide range of learning styles and abilities, making it an inclusive educational tool that can engage students with varying needs and interests.

Conclusion

By incorporating aquaponics into their activities or learning module, both institutions are creating inclusive, engaging educational environments that empower students with autism to excel in STEM fields, fostering their academic and personal development while promoting sustainable practices.