NEUROSCIENCE RESEARCH NOTES

OPEN ACCESS | NEWS & VIEWS ISSN: 2576-828X

Neuroscience for all: empowering memory and learning among orang asli students through STEM@USM program

Farizan Ahmad [1,2], Mohd Harizal Senik [1], Ahmad Tarmizi Che Has [1], Sarina Sulong [2], Azlina Ahmad [2,3,4], Surini Yusoff [2,5], Siti Norasikin Mohd Nafi [2,6], Ahmad Hayani Awang [7] and Zul Faizuddin Osman [7]*

[1] Department of Neurosciences, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[2] Department of Medical Genetics, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[3] School of Dental Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[4] Tissue Bank, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[5] Department of Paediatrics, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[6] Department of Pathology, School of Medical Sciences, Universiti Sains Malaysia, 16150 Kubang Kerian, Kelantan, Malaysia.
[7] SK Sungai Rual, 17600 Jeli, Kelantan, Malaysia.

* Correspondence: zulfaizuddin@gmail.com; Tel.: +60147946790

Received: 23 October 2025; **Accepted:** 10 June 2026; **Published:** 17 September 2026
Edited by: King Hwa Ling (Universiti Putra Malaysia)
Reviewed by: Pike See Cheah (Universiti Putra Malaysia); Garry Kuan (Universiti Sains Malaysia)
https://doi.org/10.31117/neuroscirn.v9i3.515

ABSTRACT: The STEM@USM program is a neuroscience-driven university-community engagement initiative conducted by the Department of Neurosciences, USM at SK Sungai Rual, Jeli, Kelantan. The school serves Orang Asli communities, Malaysia's indigenous population, and is the only school of its kind in the district. Grounded in neuroscience in education, the program was designed to enhance memory formation, learning processes, motivation, and student engagement through experiential learning and multisensory approaches. Implemented from June 2024 to July 2025, the initiative comprised three phases: experiential exposure to neuroscience and medical sciences, creative integration of STEM concepts through digital art and NFT-based learning, and impact evaluation. Based on the assessment, the program improved students' scientific understanding, learning motivation, and classroom engagement, consistent with stronger memory retention through hands-on and visual learning strategies. By combining neuroscience concepts with digital innovation, the initiative reinforced the role of active learning environments in supporting cognitive engagement and sustained interest in STEM subjects, particularly among underserved learners. Overall, STEM@USM illustrates how neuroscience-informed pedagogy can bridge the STEM gap for indigenous education while providing a versatile platform for community empowerment. Beyond its local impact, the initiative offers a scalable, adaptable framework that integrates cognitive science, digital technology, and community engagement. Future directions include extending the program to other underserved schools, strengthening longitudinal evaluation of educational and cognitive outcomes, and positioning neuroscience-based experiential learning as a strategic approach for advancing equitable STEM development.

Keywords: Neuroscience, STEM education, NFT-based learning, Experiential learning

1.0 INTRODUCTION

Despite the Malaysian government's long-standing 60:40 policy target to produce more Science, Technology, Engineering, and Mathematics (STEM)-oriented graduates, recent reports indicate a persistent decline in students pursuing STEM pathways (Ghazali et al., 2023; Idris et al., 2023). This challenge is particularly pronounced among marginalised communities, including the Orang Asli, who continue to face multiple educational barriers such as limited exposure to STEM careers, low learning motivation, geographical isolation, and inadequate access to learning facilities (A.H. Abd Jalil et al., 2024). These systemic challenges underscore the need for innovative, inclusive, and context-sensitive educational interventions.

In response, the STEM@USM Innovation via Non-Fungible Token (NFT) program (hereafter STEM@USM) was established under the Universiti Sains Malaysia (USM) Community Engagement (CE) Grant. This initiative represents a university–community collaboration between the Department of Neurosciences, School of Medical Sciences, USM and the School of NFT, SK Sungai Rual. The program aligns with the Malaysia Sustainable Development Goals (SDGs), particularly SDG 4 (Quality Education) and SDG 10 (Reduced Inequalities), by addressing educational inequities through STEM capacity building among indigenous learners.

1.1 Program rationale and educational framework

STEM@USM was designed based on principles of neuroscience in education, emphasising how memory formation, learning processes, motivation, and engagement can be enhanced through experiential, hands-on, and multisensory learning (Gazioğlu & Karakuş, 2023; Kong et al., 2021). These approaches are especially relevant for Orang Asli students, as culturally meaningful and experience-based learning has been shown to improve engagement and retention within indigenous communities (Mohamad Shah et al., 2020).

Within this framework, the program sought to raise awareness among teachers and students about applying STEM concepts in neuroscience and medical sciences, broadening their understanding of STEM's relevance to real-world contexts. At the same time, teachers were exposed to advanced facilities and emerging technologies at USM to inspire innovative teaching strategies they could adapt to their classroom settings.

For students, the initiative provided structured experiential learning opportunities that connected abstract STEM concepts to tangible, real-world applications through direct engagement with scientific models, laboratory environments, and interactive activities. Complementing this experiential approach, STEM@USM integrated STEM education with digital art and Non-Fungible Token (NFT) technology, using creative expression to stimulate interest, sustain motivation, and enhance engagement in STEM subjects. Collectively, these elements formed an educational framework that bridges neuroscience, technology, and community-based learning to support inclusive and meaningful STEM education.

Central to the initiative was the use of scientific human models, including the brain, heart, and nervous system, as interactive teaching tools. These models served as a platform for merging art, science, and technology, allowing students to translate complex scientific concepts into visual and digital forms. Through this integration, STEM@USM sought not only to strengthen scientific understanding but also to introduce students to emerging digital tools and digital-oriented learning environments.

1.2 Community and institutional background

SK Sungai Rual is a rural primary school located in Jeli, Kelantan, serving predominantly students from the Jahai sub-tribe of the Orang Asli. As the district's only indigenous school, it plays a critical role in providing the surrounding community access to formal education. Despite geographical and infrastructural limitations, the school has demonstrated a strong commitment to educational innovation, most notably through the introduction of digital-based learning initiatives.

One such initiative is the School of NFT, founded in 2020 by Dr Zul Faizuddin Osman during the COVID-19 lockdown period. By integrating digital art using iPads and the Procreate application, the School of NFT promotes creativity, self-expression, motivation, and digital literacy among Orang Asli students (Osman et al., 2025). This initiative reflects the school's proactive efforts to bridge traditional community life with modern, technology-driven education.

Recognising the transformative potential of the School of NFT, the Department of Neurosciences, USM initiated a collaboration to extend this digital creativity into STEM learning grounded in neuroscience principles. The partnership aimed to nurture scientific curiosity while strengthening memory, learning, and engagement through experiential exposure to neuroscience and medical sciences.

2.0 Implementation of the program

The STEM@USM program was implemented over a 13-month period, from June 2024 to July 2025, and was structured into three interconnected phases to progressively engage students through experiential and creative learning. The first phase focused on experiential exposure to neuroscience and medical sciences through structured educational visits to USM, allowing students to gain first-hand insight into real-world scientific environments and applications. Building on this foundation, the second phase emphasised creatively integrating STEM concepts through digital art and NFT-based learning. During this phase, students and teachers actively created digital artworks and NFTs using STEM models, reinforcing conceptual understanding through artistic and technological expression. The final phase involved a systematic impact evaluation to assess the program's educational, cognitive, and engagement outcomes.

The program was delivered through a collaborative effort between USM and SK Sungai Rual, involving a multidisciplinary team of seven USM lecturers alongside the school's STEM teachers. Dr Farizan Ahmad served as the Program Leader, supported by Dr Mohd Harizal Senik, Dr Ahmad Tarmizi Che Has, Associate Professor Dr Sarina Sulong, Associate Professor Ts. Dr Azlina Ahmad, Dr Siti Norasikin Mohd Nafi, and Dr Surini Yusoff. At the school level, Dr Zul Faizuddin Osman coordinated program activities as the Person-in-Charge, with Mr Ahmad Hayani Awang, Headmaster of SK Sungai Rual, providing advisory oversight. Strong institutional support from both SK Sungai Rual and USM, particularly through the Division of Industry and Community Network (BJIM), was instrumental in the program's successful implementation.

2.1 Phase I - Experiential exposure to neuroscience and medical sciences

The first phase of the program involved an educational visit by SK Sungai Rual, successfully conducted on 26 September 2024. The visit brought together 30 upper primary students (Standard 4, 5 and 6) and six accompanying teachers, who visited the School of Medical Sciences and Hospital Pakar USM.

The program aimed to provide early exposure to medical sciences while cultivating students' interest in STEM. Throughout the visit, students appeared highly enthusiastic and excited, as it was their first opportunity to explore the world of medical science firsthand. They observed advanced medical technologies used in patient care and clinical research.

Key facilities included the Integrative Gallery for Medical Sciences (SPICES), the Robotic Rehabilitation Unit, and the Human Genome Centre. The visit provided both students and teachers with the opportunity to experience a more creative and dynamic approach to learning. At SPICES, more than 200 pathological organ specimens representing various human body systems were displayed. Students also explored Virtual Reality (VR) and Augmented Reality (AR) applications, which let them view 3D mappings of human organs and offered an exciting, immersive learning experience.

Figure 1. Aerial view of SK Sungai Rual, Jeli. The school is situated about 98 km from Kota Bharu.

At the Robo-Rehab Unit, students were introduced to robotic technologies designed to assist patients recovering from injuries or physical impairments, enabling them to regain mobility and independence in daily life. Among the equipment showcased was the Hybrid Assistive Limb (HAL) Robot Suit, for which students received a briefing on the neuro-based robotic technology developed by the Cybernics Research Centre, University of Tsukuba, Japan (Kuroda et al., 2023). The students also had the opportunity to observe how the HAL robotic system operates to support limb rehabilitation. It was a valuable, eye-opening experience for both teachers and students to see advanced robotic rehabilitation technology in action at Hospital USM.

Finally, the students visited the Human Genome Centre, where they were introduced to the fundamental units of life, deoxyribonucleic acid (DNA), and chromosomes in the human body. At the Cytogenetics Laboratory, the students were thrilled to see human chromosome samples for the very first time. Students and teachers also participated in a group activity with the staff, arranging chromosome pairs in the correct sequence, which provided a fun, hands-on learning experience in human genetics. Figure 2 shows key activities during the educational visit and the program.

Beyond benefiting the students, the visit also offered valuable learning opportunities for the teachers. They broadened their understanding of neuroscience, medical sciences, and STEM by experiencing the latest developments in medical technology that could inspire them to enhance their teaching methods. The visit helped teachers link classroom theories to real-world applications, allowing them to develop more engaging and practical approaches to STEM education. It also gave teachers a platform to gather innovative ideas that could inspire students' curiosity and interest in science.

Overall, the visit not only enriched students' learning experiences but also instilled curiosity and a deeper appreciation for science, technology, and medicine. The educational visit also contributed meaningfully to SDG 4 (Quality Education) by promoting inclusive and high-quality learning experiences that foster lifelong learning opportunities. Furthermore, it supported SDG 10 (Reduce Inequalities) by giving Orang Asli students equal opportunities to experience advanced medical and scientific facilities that are rarely accessible to students from rural and indigenous communities. Collectively, these efforts supported the development of STEM literacy and innovation among both students and teachers of SK Sungai Rual.

2.2 Phase II – Creative integration of stem concepts through digital art and NFT-based learning

The second phase of the program focused on applying the students' creativity via digital arts innovation, NFT. This initiative integrated digital creativity with emerging technologies to enhance student engagement and experiential learning. iPads and the Procreate application were utilised as primary tools, enabling students to create original digital artworks, which were subsequently uploaded to local and international NFT marketplaces for viewing and potential trading.

NFTs are unique digital assets recorded on a blockchain, ensuring authenticity and ownership of digital creations such as artworks, videos, or educational materials. Unlike cryptocurrencies, each NFT is distinct and cannot be exchanged on a one-to-one. Through this initiative, students learn to transform their digital artworks into NFTs, gaining early exposure to concepts of digital ownership, innovation, and the creative economy. In the context of the STEM@USM program, NFT technology served as an innovative educational tool to connect neuroscience, art, and technology, while motivating students to explore science through creativity and digital expression.

To support this phase, ten (10) STEM models were provided to SK Sungai Rual to support the teaching and learning of science subjects. The models included human anatomy, the skeletal system, the heart, the brain, male and female reproductive organs, the solar system, the eclipse system, a globe, and a light microscope. All models were placed in the SK Sungai Rual STEM Room, located within the school's Science Laboratory, to ensure easy access for students and teachers. These resources were intended to enhance hands-on learning, promote curiosity, and strengthen students' understanding of scientific and anatomical concepts through visual and experiential engagement.

Subsequently, a series of guided digital arts creation sessions were conducted with students and teachers, using the STEM models as creative references. Artworks inspired by the brain, heart, nervous system, and other scientific structures were transformed into NFTs and shared on NFT marketplaces for public access. The students' NFT digital artworks were uploaded to the NFT platform Mallow.art, an international NFT marketplace built on the Solana blockchain. The platform focuses on

Figure 2. Key activities conducted during the program: (*Far left*) Demonstration of Hybrid Assistive Limb (HAL) technology for rehabilitation. (*Middle left*) Experiential learning integrating science and art through Virtual Reality (VR), Augmented Reality (AR) and 3D human organ mapping at the SPICES facility. (*Middle right*) Creation of NFT-based digital art guided by the program's STEM framework. (*Far right*) Explanation of brain morphology and functions by Dr Farizan Ahmad to students from SK Sungai Rual.

digital art and offers a user-friendly minting process, efficient transactions, and a supportive community that promotes creative growth within the blockchain art ecosystem. The NFT digital artworks created by SK Sungai Rual students can be viewed at: https://mallow.art/collection/FLXC2BL5Uv3C1s4wwHy2A9PQxkkazCaHh13DStCQB74q

2.3 Phase III – Impact evaluation

The final phase of the program assessed its educational and cognitive impact. Feedback was gathered through pre- and post-program quizzes, teacher evaluations, and student reflections. Overall findings demonstrated marked improvement in students' scientific understanding, motivation, and engagement. Teachers also reported higher levels of classroom participation and sustained interest in STEM subjects, particularly during lessons that incorporated STEM models.

As part of this phase, an action research study (*Kajian Tindakan*) examined the effectiveness of integrating digital tools into science education for Orang Asli students. Guided by the Kemmis and McTaggart (1998) Action Research Cycle, the study involved 12 Jahai students (10 girls, 2 boys) who created science posters using both traditional materials and the Procreate app on iPads. Results showed that students completed posters faster with Procreate (average 15.7 minutes) compared to traditional methods (19.8 minutes) and produced more visually engaging work. All participants reported higher levels of engagement, enjoyment, and confidence using the digital method. The findings highlight how digital and visual learning approaches can enhance motivation, creativity, and comprehension in science among marginalised learners (Kong et al., 2021).

The study concluded that incorporating iPad-based learning can improve STEM interest, align with Malaysia's digital education goals, and support SDG 4 (Quality Education). The findings were published in *Jurnal Sains Insani* as "The Use of iPad and Procreate Application in Science Poster Creation Among Standard 6 Orang Asli Pupils of SK Sungai Rual, Jeli, Kelantan" (Osman et al., 2025).

Overall, the STEM@USM program has exemplified how neuroscience-based experiential learning can effectively bridge scientific knowledge, creativity, and memory enhancement, thereby fostering meaningful and sustained STEM engagement among Orang Asli students, particularly those of SK Sungai Rual.

3.0 FUTURE DIRECTIONS

The success of the STEM@USM initiative at SK Sungai Rual demonstrates that integrating neuroscience, digital creativity, and experiential learning can significantly enhance students' motivation, memory, and understanding of science. Building on these encouraging outcomes, several practical steps can sustain and expand the program's impact at SK Sungai Rual and other Orang Asli schools.

First, continuous teacher capacity building is essential. Training workshops led by USM academicians could equip teachers with practical knowledge of neuroscience-based learning techniques, hands-on STEM experiments, and digital art applications. Such

training would empower teachers to independently conduct similar programs and embed creative STEM learning in their regular classroom activities. Moreover, establishing long-term partnerships between universities and Orang Asli schools will be key of sustainability. Periodic visits, mentorship, and joint programs such as community science fairs or digital art exhibitions can ensure that the spirit of discovery and learning continues to grow.

Through these practical, community-centred strategies, the STEM@USM model can evolve into a sustainable platform that not only strengthens memory and learning but also nurtures future generations of Orang Asli students into confident, creative, and science-literate contributors to society.

Acknowledgements: The author gratefully acknowledges the Division of Industry and Community Network (BJIM), Universiti Sains Malaysia (USM), for financial support through the 2024 University–Community Engagement Grant (R502-KR-ARP007-0000000521-K134). We also extend sincere appreciation to the School of NFT, SK Sungai Rual, the Department of Neurosciences, the Human Genome Centre, the Integrative Gallery for Medical Sciences (SPICES), and the Robotic Rehabilitation Unit for their invaluable collaboration and dedication in empowering the next generation of scientific learners. We also thank all the members of the organising committee for all events conducted.

Author Contributions: FA, MHS, and ATCH drafted the manuscript; SS, AA, SY, and SNMN contributed materials; AHA and ZFO reviewed and edited the paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

Abd Jalil A. H., Abdullah A. H. and Wani Wan Fakhrudidin W. F. (2024). STEM education and mathematics performance among orang asli primary school students in Johor, Malaysia: challenges and recommendations. *2024 IEEE Frontiers in Education Conference (FIE), 1–9.* https://doi.org/10.1109/FIE61694.2024.10893311

Gazioğlu M. and Karakuş N. (2023) The impact of multisensory learning model-based tale-telling on listening skills and student opinions about it. *Frontiers in Education*, *8*, 1137042. https://doi.org/10.3389/feduc.2023.1137042

Ghazali, A., Mohamad Ashari, Z., Hardman, J., Omar, R., & Handayani, S. W. (2023). Best practices in STEM education for preschool children: a case study in Malaysia. *Sains Humanika*, *16*(1), 87–99. https://doi.org/10.11113/sh.v16n1.2102

Idris, R., Govindasamy, P., & Nachiappan, S. (2023). Challenge and obstacles of STEM education in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, *13*(4), 773 – 780. http://dx.doi.org/10.6007/IJARBSS/v13-i4/16676

Kemmis, S. & McTaggart, R. (1988). The action research planner, (3rd edition) Victoria (Australia), Deakin University Press.

Kong Y. The role of experiential learning on students' motivation and classroom engagement. *Frontiers in Psychology*. *12*, 771272. https://doi.org//10.3389/fpsyg.2021.771272

Kuroda MM, Iwasaki N, Mutsuzaki H, Yoshikawa K, Takahashi K, Nakayama T, Nakayama J, Takeuchi R, Mataki Y, Ohguro H, Tomita K. (2023). Benefits of a wearable cyborg HAL (Hybrid Assistive Limb) in patients with childhood-onset motor disabilities: a 1-year follow-up study. *Pediatric Reports*, *15*(1), 215-226. https://doi.org/10.3390/pediatric15010017

Mohamad Shah, D. S., Mohd Adnan, A. H., Mohd Salim, M. S. A., Yusof, A. M., & Mohd Tahir, M. H. (2020). The non-formal education of orang asli adolescents in Malaysia: from community to university. *International Journal of Humanities Technology and Civilization*, *5*(1), 1-8. https://doi.org/10.15282/ijhtc.v5i1.4812

Osman, Z. F., Awang, A. H., Has, A. T. C., Senik@Nawi, M. H., Sulong, S., Ahmad, A., Nafi, S. N. M., Yusoff, S., & Ahmad, F. (2025). Penggunaan peranti ipad dan aplikasi procreate dalam penghasilan poster sains di kalangan murid orang asli tahun 6 SK Sungai Rual, Jeli Kelantan: the use of ipad and procreate application in science poster creation among standard 6 of orang asli pupils of SK Sungai Rual, Jeli Kelantan. *Sains Insani*, *10*(1), 176–186. https://doi.org/10.33102/sainsinsani.vol10no1.790