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## RESEARCH ON APPLYING RASPBERRY PI 5 IN THE IoT AND STEM EDUCATION: AN INTRODUCTORY STUDY

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### Abstract

*This study focuses on exploiting the potential of Raspberry Pi 5 in enhancing STEM and IoT education capacity in high schools in Vietnam. The study focuses on building effective application models, suitable for the Vietnamese educational context, using Raspberry Pi 5 in teaching and learning activities. The study also qualitatively assesses the challenges and opportunities in implementing this technology in education in general and high school education in particular. This study was carried out carefully and systematically in technical aspects. Thereby, the study proposes solutions to develop STEM education integrating IoT based on Raspberry Pi 5 in training high-quality human resources, meeting the requirements of the fourth industrial revolution.*

**Keywords:** high school, IoT, innovation, Raspberry Pi 5, STEM.

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## **NGHIÊN CỨU ỨNG DỤNG RASPBERRY PI 5 TRONG GIÁO DỤC IoT VÀ STEM: MỘT NGHIÊN CỨU GIỚI THIỆU**

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### **Tóm tắt**

*Nghiên cứu này đề xuất khai thác khả năng của Raspberry Pi 5 trong việc nâng cao năng lực giáo dục STEM và IoT ở các trường phổ thông tại Việt Nam. Nghiên cứu tập trung xây dựng các mô hình ứng dụng hiệu quả, phù hợp với bối cảnh giáo dục Việt Nam, thông qua việc sử dụng Raspberry Pi 5 trong hoạt động dạy và học. Nghiên cứu cũng đánh giá định tính những thách thức và cơ hội khi triển khai công nghệ này trong giáo dục nói chung và giáo dục phổ thông nói riêng. Nghiên cứu này thực hiện một cách cẩn thận và hệ thống ở khía cạnh kỹ thuật. Từ đó, nghiên cứu đề xuất các giải pháp phát triển giáo dục STEM tích hợp IoT trên nền tảng Raspberry Pi 5 trong đào tạo nguồn nhân lực chất lượng cao, đáp ứng yêu cầu của cuộc cách mạng công nghiệp lần thứ tư.*

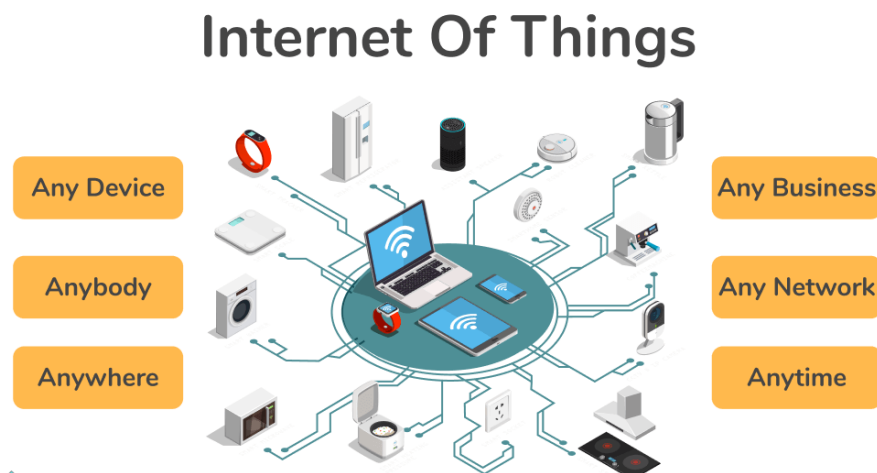
**Từ khóa:** *IoT, Raspberry Pi 5, STEM, sáng tạo, trường trung học.*

## 1. Introduction

In the era of the fourth industrial revolution, STEM education plays a key role in preparing human resources with skills and knowledge to meet the needs of society and technological development (Bybee, 2010). STEM education not only equips students with multidisciplinary knowledge but also promotes critical thinking, problem-solving skills and creativity through practical activities and experiences (Rotatori et al., 2021, Le et al., 2025). The purpose of STEM education is to equip learners with STEM competencies right from high school, preparing a basic foundation for learners when participating in STEM careers later. Recently, Vietnam has been interested in promoting STEM education at many levels of education (MoET, 2020; Resolution No. 71/NQ-CP; Le et al., 2024). In STEM education, it is necessary to coordinate the four elements (S: Sciences, T: Technology, E: Engineering, M: Math) smoothly. Many studies show that STEM education is important and necessary, but there are still technical barriers for students and teachers (Bybee, 2010; Le et al., 2024; Le et al., 2025). The application of advanced technology devices, especially embedded computers such as Raspberry Pi, has been proven to be effective in promoting active learning, enhancing practical experiences and arousing students' passion for science and technology. Raspberry Pi 5, with improvements in performance and connectivity, brings many new opportunities for STEM teaching in Vietnam.

## 2. Overview of IoT and Raspberry Pi 5

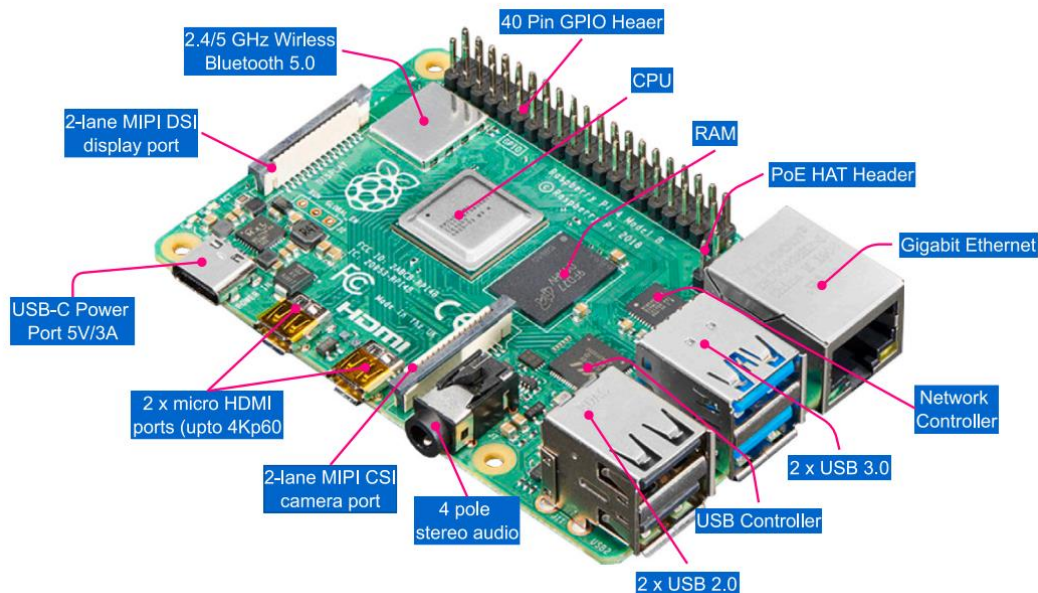
The Internet of Things (IoT) refers to a network of interconnected devices (Figure 1) that collect and exchange data via the internet, enabling automation and real-time monitoring (Culic et al., 2020). In education, IoT fosters interactive learning by connecting sensors, actuators, and single-board computers like the Raspberry Pi (McManus et al., 2021) to create hands-on projects (Mahmood et al., 2019).



**Figure 1. Images to illustrate IoT**  
(<https://bap-software.net/vi/knowledge/iot-advanced-technology/>)

The Raspberry Pi 5 is a compact, affordable single-board computer developed by the Raspberry Pi Foundation, released in October 2023 (Figure 2). It's an upgraded version of its predecessors, designed for education, hobbyist projects, and professional applications, including IoT. The Raspberry Pi 5 is widely used in classrooms due to its low cost, flexibility, and ability to run Linux-based systems like Raspbian. Its improved specifications—faster quad-core processor, up to 8GB RAM, dual-band Wi-Fi, and enhanced

GPIO pins—make it ideal for teaching IoT concepts, programming, and hardware interfacing (Zhong et al., 2016).



**Figure 2. Components of the Raspberry Pi** (Mathe et al., 2024).

Applying Raspberry Pi 5 to STEM teaching in high schools not only helps students get acquainted with advanced technology early, but also creates a vivid visual learning environment, stimulating interest and creativity in the learning process. However, to maximize the potential of Raspberry Pi 5, there needs to be specific research on teaching methods, appropriate curriculum and solutions to integrate this device into the current educational program in Vietnam. The two tables (Table 1 & Table 2) below are the features of Raspberry Pi 5, and compare it with other components.

**Table 1. The Key Specifications of the Raspberry Pi 5 (Raspberry Pi, 2025)**

<b>Processor</b>	Quad-core 64-bit Arm Cortex-A76 CPU at 2.4GHz
<b>RAM</b>	Available in 2GB, 4GB, or 8GB variants
<b>Graphics</b>	VideoCore VII GPU, supporting dual 4K HDMI outputs
<b>Connectivity</b>	Dual-band Wi-Fi 802.11ac, Bluetooth 5.0, Gigabit Ethernet.
<b>Ports</b>	2x USB 3.0, 2x USB 2.0, USB-C power, 2x micro-HDMI, 40-pin GPIO for hardware interfacing.
<b>Storage:</b>	MicroSD card slot; supports high-speed SDR104 mode.
<b>New Features</b>	PCIe 2.0 interface (for NVMe SSDs with an adapter), RP1 I/O controller for improved peripheral performance, and a real-time clock (RTC)

**Table 2. Comparison of Raspberry Pi 5 and other components**

Criteria	RPi 5*	RPi* Pico	Jetson Nano	Arduino Nano	ESP32
Year of release	2023	2021	2019	2008	2016
Type	EC*	BB*	EC*	MB*	MB*
Operating system	Linux	No	Ubuntu	No	No

CPU	4 cores, A76, 2.4GHz	Dual-core Cortex-M0+	Quad-core A57	8-bit AVR	Dual-core Xtensa LX6
RAM	2–8 GB	264 KB SRAM	4 GB	2 KB SRAM	520 KB SRAM
AI/DL Support	High	No	Very high	No	Limit
Programming languages supported	Python, C/C++, Scratch	MicroPython, C/C++	Python, C++	C/C++	MicroPython, C/C++
Scalability	PCIe, Camera, USB, GPIO	GPIO, I2C, UART	Camera, GPU	Basic GPIO	GPIO, Wi-Fi
Internet connection	Wi-Fi, LAN, Bluetooth	No	LAN, Wi-Fi	No	Wi-Fi, Bluetooth
Relevance to high school STEM curriculum	Very suitable, because of its versatility	Relatively Suitable	Suitable for advanced AI applications	Relatively Suitable	Relatively Suitable
Difficulty for students	Easy	Easy	A bit complicated	A bit complicated	Easy
Community & Support Documentation	Very large	Few	Limit	Very large	Large

\*Embedded Computer (EC); Microcontroller board (MB); Raspberry Pi (RPi)

### 3. IoT and Raspberry Pi 5 in education

Using Raspberry Pi 5 in STEM education activities has many advantages, so it should be exploited more. Some advantages are listed below.

**3.1 Project-Based Learning:** IoT with Raspberry Pi 5 enables students to build real-world applications, such as smart irrigation systems or environmental monitors, fostering skills in coding (e.g., Python), electronics, and data analysis. For example, students can connect sensors to monitor soil moisture and control water pumps, learning about IoT architecture (sensing, networking, and application layers).

**3.2 Affordability and Accessibility:** The Raspberry Pi 5’s low cost (starting at ~\$60) democratizes access to computing education, allowing schools to equip labs without breaking budgets. Its open-source ecosystem supports free tools and community-driven resources, reducing barriers for educators and students.

**3.3 Interdisciplinary Applications:** IoT projects integrate computer science, engineering, and environmental studies. Students can explore smart classroom solutions, like attendance systems using RFID (Radio Frequency Identification) or temperature monitors, enhancing collaboration and problem-solving.

**3.4 Skill Development:** Using Raspberry Pi 5, students learn IoT protocols (e.g., MQTT, HTTP), cloud integration (e.g., AWS IoT), and cybersecurity basics, preparing them for Industry 4.0 careers. The device’s GPIO pins allow interfacing with sensors and actuators, teaching hardware-software integration.

**3.5 Challenges:** Technical Complexity: Setting up IoT systems requires knowledge of networking, Linux, and hardware, which can overwhelm beginners without proper guidance.

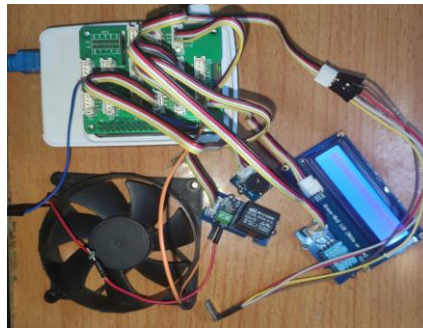
**3.6 Security Concerns:** IoT devices are vulnerable to attacks, necessitating education on secure coding and network protection.

#### 4. Results and discussion

The teacher teaches students the features of the device, basic programming skills and conducts simple project installation, step by step construction and design of the challenge project. This is a sample project: temperature and humidity monitoring.

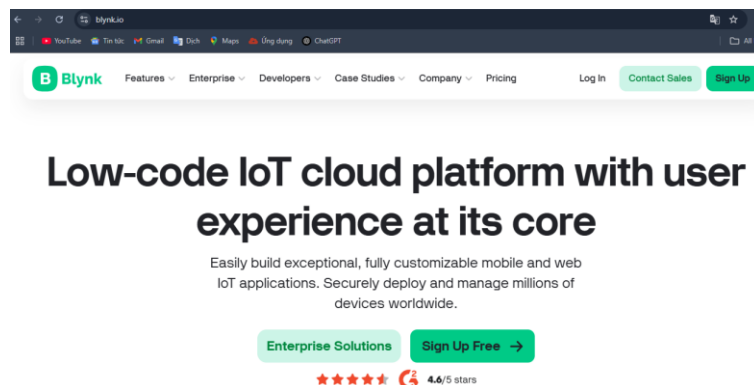
The project combines sensors together to create an IoT system that can be managed both directly and remotely. When reading data from the sensor, the system will display the data on the computer screen, LCD screen and on Blynk (Blynk, 2025). The siren will alarm if the temperature exceeds 40 °C or the humidity exceeds 70%. The electrical device will be connected to a 220 V – 10 A relay that allows the device to be turned on and off remotely via the Blynk web or the Blynk app on a smartphone. At the same time, weather data will be recorded and graphed. Because the project is aimed at non-specialized students, the device connected to the relay will be replaced with a 5 V fan instead of a 220 V electrical device to ensure safety.

**Step 1:** Install the circuit on the grove base kit HAT then connect it to the Pi 5 (McManus, 2021). The circuit diagram is as follows: DHT11 plugs into D22, buzzer plugs into D16, relay plugs into D5, LCD plugs into I2C, Bmp180 plugs into I2C, fan negative pin GND and 5 V pin plugs into the relay and from the relay plugs into 5 V on the grove. The relay works like a K switch but can automatically turn on and off, so the connection is similar to the K switch (Figure 3).



**Figure 3. The circuit diagram**

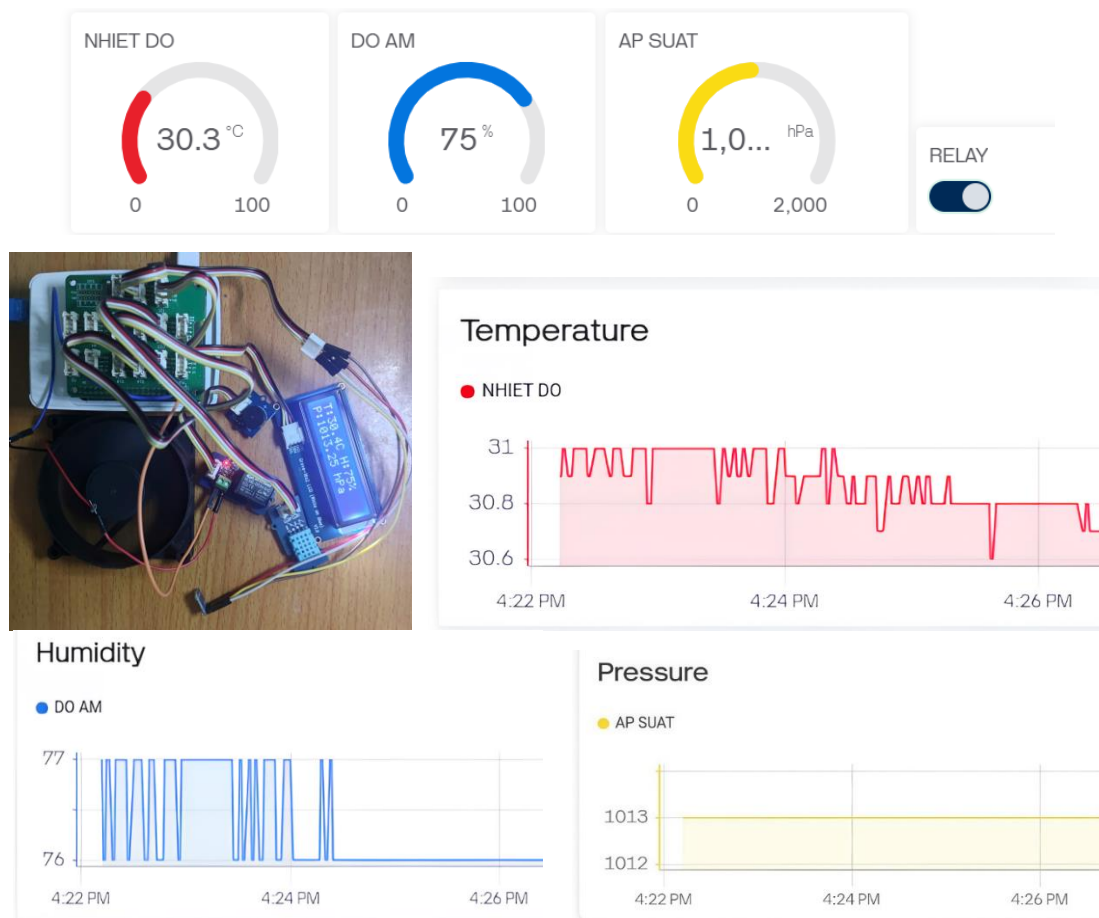
**Step 2:** Log in and set up Blynk (Blynk, 2025). The Blynk is a free IoT cloud platform.



**Figure 4. The Blynk interface: An IoT cloud platform**

**Step 3:** Write code to control the circuit and connect Blynk (Thonny, 2024). The program code is written in Python software (Hillar, 2016), which is widely used today.

After running the code, the graph on Blynk will be updated in real time. The project is completed with the results displayed as follows.



**Figure 5. Show the results of the sample project. Display the results of the sample project in different formats: i) Display numbers on Blynk cloud platform, ii) Display numbers on LCD device, iii) Display as time series.**

The measurements were performed at the Materials and Molecular Simulation Lab (MOMA Lab), Can Tho University. We also compared and found that the data matched the monitoring data of the Vietnam Center for Environmental Monitoring (CEM) at the time and location of the measurements. With a lot of data stored on the platform, users build data sets, use machine learning, artificial intelligence technology can build models, predict many new effects, enhance the integration of modern STEM education (Pappula et al., 2024; Thanh Tien et al., 2025). Measurement results are presented in different forms. This helps learners to be interested and enhances their creative ideas.

## 5. Conclusion

It is clear that developing Raspberry Pi 5 applications in STEM education in Vietnam is necessary and feasible. It shows: (i) Integrating theory and practice: This helps students and teachers approach technology in an intuitive and effective way. (ii) Highly practical modules: The modules are designed to range from installing the operating system, getting

familiar with GPIO, to advanced applications such as sensor control and IoT connectivity, helping learners apply knowledge in practice.

In addition to the achieved results, it is also noted that there are challenges that need to be overcome: (i) Deploying Raspberry Pi 5 in education requires investment in infrastructure and appropriate equipment. (ii) Teachers need to be trained so that they can use embedded computers such as Raspberry Pi 5, teach STEM and integrate IoT technology effectively in teaching. (iii) There needs to be more support from education policies to integrate Raspberry Pi 5 into the official curriculum in a reasonable and sustainable way. Through the survey, it is clear that Raspberry Pi 5 stands out with many advantages compared to other devices. Therefore, this device needs to be applied soon into STEM education programs in high schools.

In order for Raspberry Pi 5 to be more widely applied in education, it is necessary to continue to promote in-depth research on teaching methods, training programs and practical evaluation to perfect the integration of Raspberry Pi into education. Besides, Raspberry Pi should be combined with advanced technologies such as artificial intelligence (AI) and cloud computing. This combination in the future can open up many new directions, contributing to improving the quality of education and training human resources for the digital age.

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