INFRARED THERMOGRAPHY IN SCIENCE EDUCATION: A PROJECT-BASED APPROACH TO ENHANCING LEARNING AND MOTIVATION

IOCES 2026 Conference

J. Jorge Teixeira[1], Armando A. Soares[2]

[1]Department of Experimental Sciences, School Dr. Júlio Martins, Chaves, Portugal, jorgeteixeira@aejm.pt

[2] ECT-UTAD University of Trás-os-Montes e Alto Douro, Vila Real, Portugal INEGI-LAETA, Instituto of Science and Innovation in Mechanical and Industrial Engineering, Porto, Portugal, asoares@utad.pt

INTRODUCTION & AIM

Infrared thermography detects infrared radiation (IR) with thermal cameras, allowing the visualization of temperature distribution and the analysis of physical and chemical phenomena inaccessible to direct observation [1]. This work highlights its didactic potential in science education, reducing the abstraction of phenomena, increasing student learning and motivation.

Fig. 1 - Thermal camera used in this study (UTi730V)

METHODOLOGY

In 2025, a project involving 22 tenth-grade students from the Science Club of a public school in inland Portugal explored infrared thermography. Using a project-based methodology with student-selected topics, the activities integrated Physics, Chemistry, and Mathematics, promoting an interdisciplinary and experimental approach. Students developed activities or investigated specific scientific principles, contributing to a collective project.

RESULTS

Figures 2 and 3 show thermal images of materials with different thermal conductivities. Figures 4–6 illustrate thermal convection inside a heater, energy dissipation when a rubber slides on a wooden table, and energy dissipation when a copper wire is bent several times.

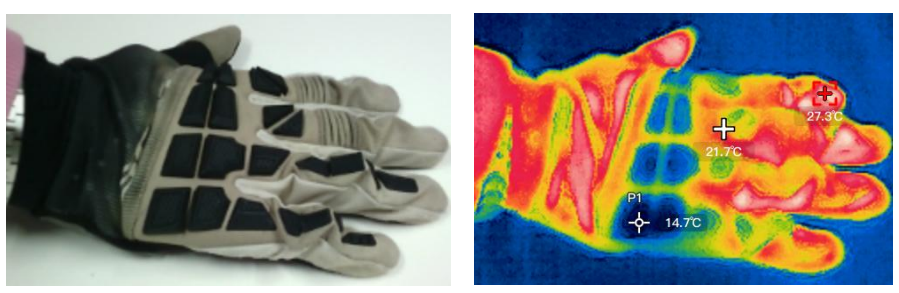

Fig. 2 - Thermal conductivity variation across different regions of a motorcycle glove.

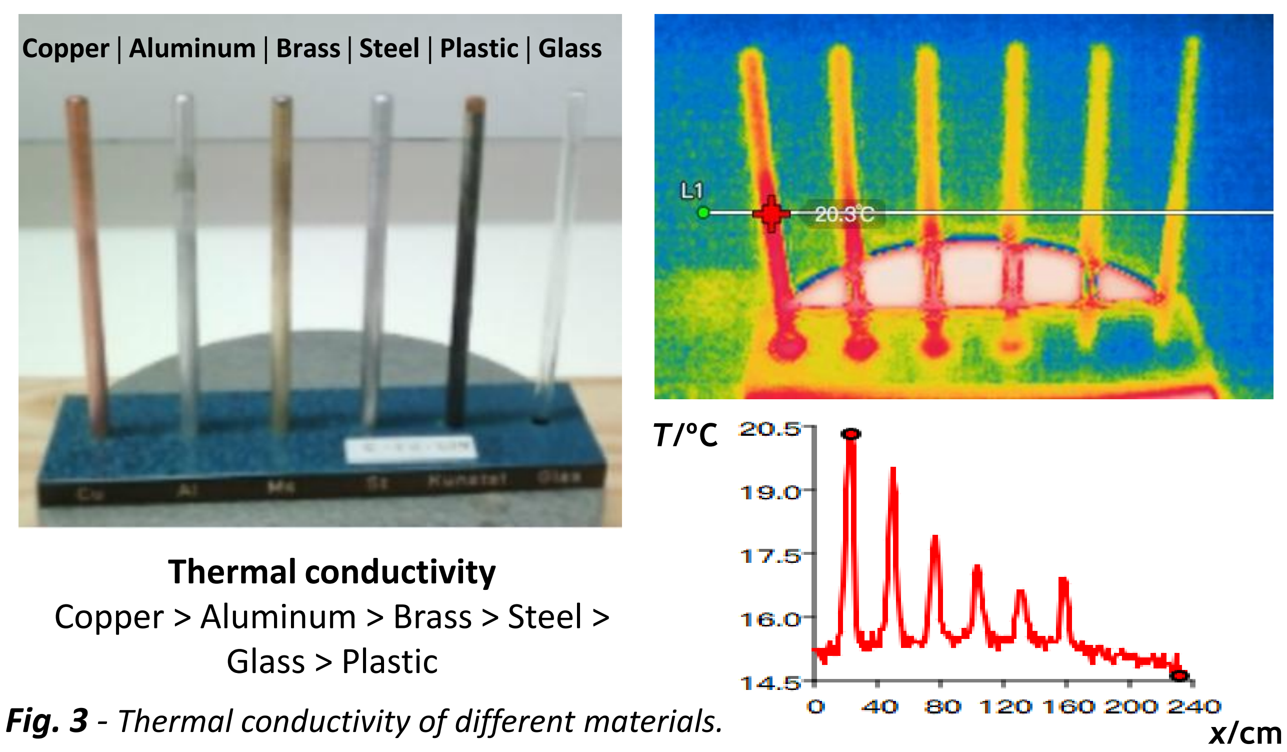

Fig. 3 - Thermal conductivity of different materials.

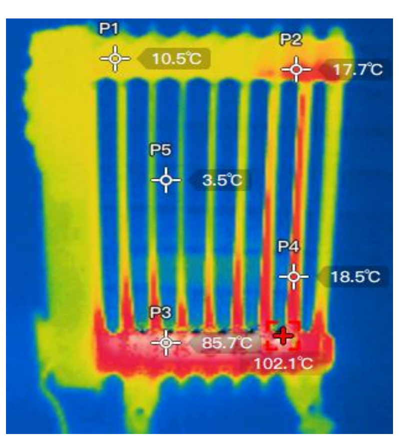

Fig. 4 - Thermal convection.

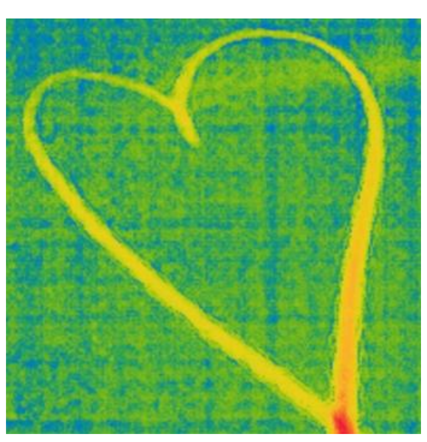

Fig. 5 - Mechanical energy dissipation.

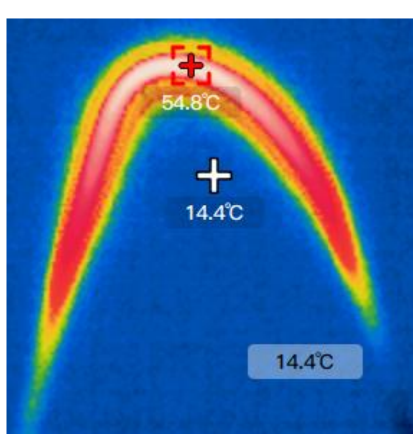

Fig. 6 - Deformation of a wire.

Infrared radiation passes through materials that visible radiation cannot, and vice versa (Figures 7 and 8). It can also be reflected and absorbed (Figure 8). Figure 9 shows the Joule effect in three types of lamps. Figure 10 presents the infrared radiation emitted by an X-shaped target exposed to the light of a lamp. Figure 11 shows that clay containers keep the water temperature lower than the ambient temperature. The Erlenmeyer flasks in Figure 12 illustrate an endothermic dissolution (left) and an exothermic dissolution (right). By scanning the QR code (Figure 13), short videos of some activities can be viewed.

Fig. 7 - Transmission of IR radiation.

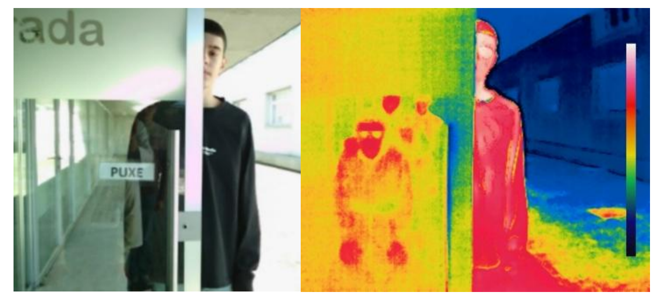

Fig. 8 - Absorption and reflection of IR radiation.

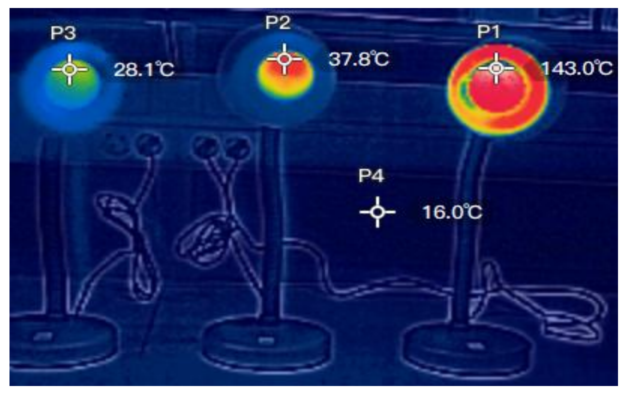

Fig. 9 - Joule heating in different types of lamps (LED, fluorescent and incandescent)

Fig. 10 - Infrared radiation emitted by an X-shaped target

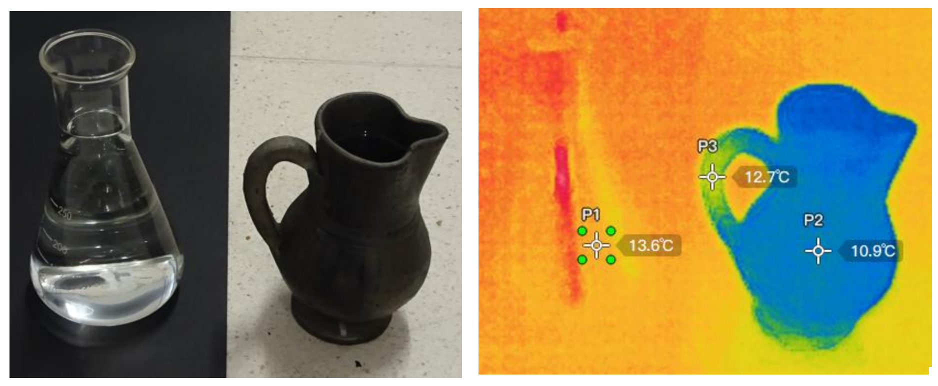

Fig. 11 - Capillarity and evaporation allow water in a clay container to remain below ambient temperature.

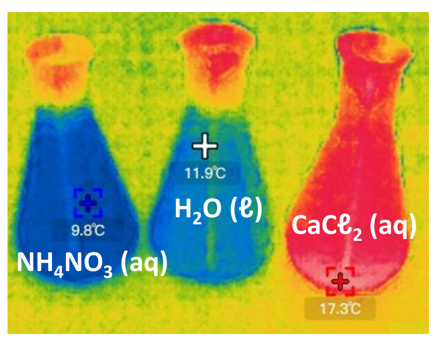

Fig. 12 – Endothermic and exothermic dissolution

Fig. 13 - QR code to watch videos of some activities.

Figure 14 presents three technical-professional applications: thermal leaks in the school's windows, moisture detection on ceilings, and an overheated line in an electrical panel.

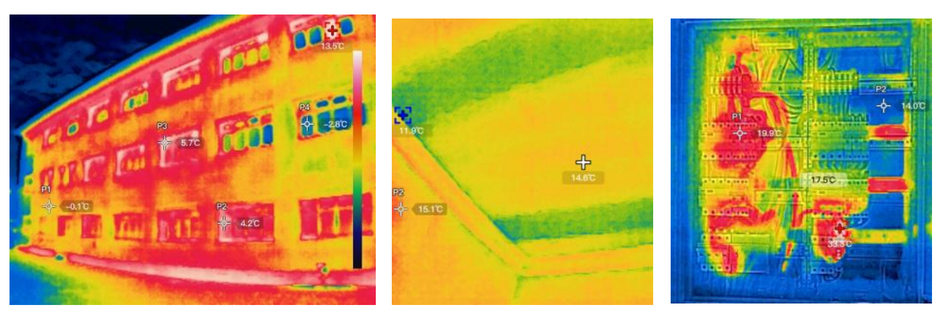

Fig. 14 – technical and professional applications

Figure 15 illustrates the setups used to determine the specific heat capacity of aluminum, while Figure 16 presents the setup used to determine the specific enthalpy of fusion of water. The obtained values were $860\ \mathrm{J\,kg^{-1}\,°C^{-1}}$ and $3.35 \times 10^5\ \mathrm{J\,kg^{-1}}$, with errors below 5%.

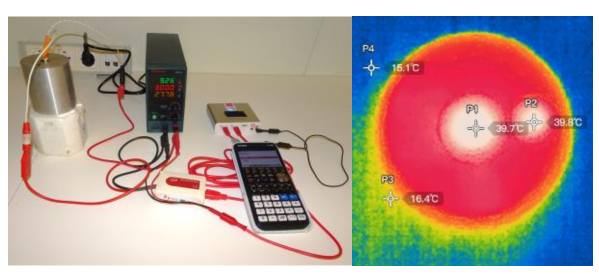

Fig. 15 - Setups used to determine the specific heat capacity of aluminum.

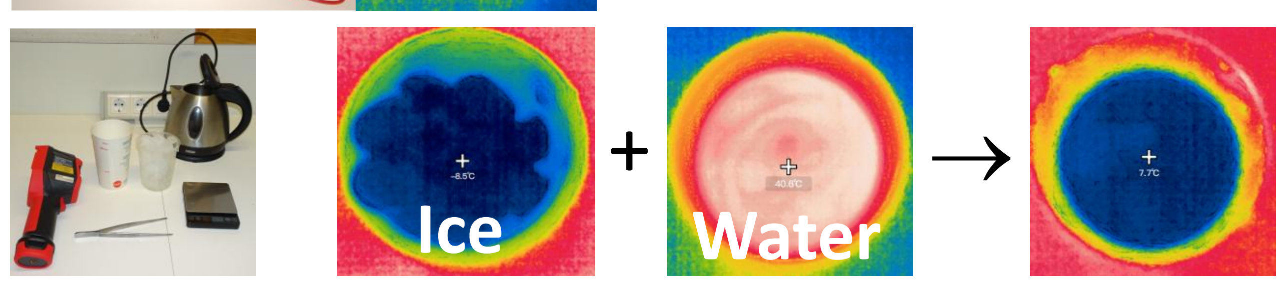

Fig. 16 - Setups used to determine the specific enthalpy of fusion of water.

CONCLUSIONS

It is concluded that infrared thermography, by making visible phenomena associated with matter and energy, establishes itself as a pedagogical resource of high educational value. Its ease of use and progressively more accessible cost reinforce the relevance of its integration into pre-university science education.

References: [1] Azpeitia, F. I. (2016). La termografía infrarroja: un sorprendente recurso para la enseñanza de la física y la química. *Revista Eureka Sobre Enseñanza Y Divulgación De Las Ciencias*, 13(3), 617–627.