# Energy-Efficiency Assessment of Windows using Temperature Sensors

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# GIFTS: Energy-Efficiency Assessment of Windows using Temperature Sensors

This Great Idea for Teaching, and Talking with, Students (GIFTS) presents a first-year engineering student project dedicated to the energy assessment of windows in campus residence halls, through the analysis of quantitative and qualitative data. This multi-week problem-based learning (PBL) project introduces first-year students to electrical, computer, mechanical, civil, and environmental engineering topics while addressing ABET Outcomes stressing design, teamwork, communication, and experimentation. PBL is a high impact teaching method where students are given open-ended, complex problems that promote their understanding of concepts and principles while improving critical thinking [1].

Teams consisting of four or five students with diverse individual strengths (identified through the Clifton Strengths Inventory) [2] are treated as small consulting firms tasked with evaluating the condition of residence hall windows, as requested by their client, the energy auditor of the College. As part of their work, students build sensors to measure and record temperature over time, using thermocouples and Arduinos. Simultaneously, they investigate performance indicators of energy efficiency and develop scoring guides to inspect and evaluate the condition of windows based on qualitative data. After designing experiments and testing the sensors, students collect temperature data in the residence halls for one week. Subsequently, students analyze the quantitative data using statistical methods and computational tools, including Excel and MATLAB. Finally, students communicate their findings, providing recommendations on window replacement or repair, and considering the economic impact of such suggestions. Final reports follow technical aspects discussed in class, include a concise presentation of the methodology and a thorough discussion of the results and are formally addressed to the campus Facilities staff.

Through this activity, students familiarize with skills and concepts that will be further developed in upper level engineering courses, aiming to increase their curiosity to learn more about particular engineering subjects, and expand their interest in developing and using technology to address problems that have a direct impact on the community, and resonate with their personal interests. At the end of the semester, students reflect on the project, contemplating perspectives from diverse engineering fields and roles. Feedback from student evaluations indicates that they enjoyed developing their teamwork skills while working in groups, and integrating research, engineering methods, and technology to create value by solving an authentic problem and learning from failures. Future plans for this project involve adding soldering and 3D-printing components to strengthen fabrication skills.

This GIFTS presentation also includes project instructions and schedule, a supply list, assignments, and tips, so other first-year engineering instructors can easily use and adapt the project for their courses.

**References**

[1] C.E. Hmelo-Silver, Educational Psychology Review, 2004 16: 235. https://doi.org/10.1023/B:EDPR.0000034022.16470.f3

[2] T. Rath, StrengthsFinder 2.0, New York: Gallup Press, 2007.