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Exploring Local Microclimates with Open-source Environmental Sensors

By ***Kenneth Y T Lim, Ahmed Hilmy, Yuen Ming De & Joshua Lee***

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The relatively multidisciplinary nature of Environmental Science and its values orientation make it an ideal candidate for STEM-based curriculum design. Traditionally, however, data presented to students is often abstract, decontextualised and presented in forms which presume relatively high numeracy and graphicacy among students. During the National Weather Study Project 2007–9, for example, participating schools were given a set of weather instruments, with a view to "crowdsource" weather data for Singapore. However, the resulting datasets were too coarse to be meaningful to students; for instance, from the point-of-view of a student in one part of the island-nation, it would not have been very meaningful or authentic to know that it was raining somewhere else the preceding day.

Since conventional weather data is complicated by the microclimate of the built environment, especially due to urban heat island effects, conventional methods may not be particularly suited to the very dense urban geography of Singapore. Moreover, as students typically have no access to a mesh of data points and means to observe concomitant weather phenomena, the cause-and-effect reasoning is usually abstract and far removed from their daily lives. With their own sensor mesh and a means to visualise data, we believe students will be better able to "talk" through these data to surface their intuitions, confront them and develop the means to move from nascent forms towards more expert forms of knowledge.

Given this context, we are interested in investigating how children in Singapore perceive and understand the factors affecting, and systemic relationships between, their local environments. Specifically, an exploratory study is being conducted in collaboration with a school established with the mandate to approach STEM education with at-risk students in novel and authentic ways.

Through using a network of low cost, open-source and unobtrusive environmental sensors placed throughout the school campus, teachers in the school have designed a curriculum involving geography and science that would permit and encourage the interrogation of real-world microclimatic data within an environment already familiar to the students. This would enable their intuitions about local environmental factors and systemic relationships—which would otherwise have remained tacit—to surface and be dialogued upon in collaboration with their peers and teachers.

There are several advantages to this approach over any other potentially competitive design at similar levels of cost.

First, the approach builds data literacy and graphicacy among learners as they seek to analyse, interpret and represent the datasets to support their inferential activities.

Second, the approach is timely because initial enactments are carried out while learners' memories of the 2013 haze are still relatively fresh—they would be better able to appreciate the purpose of their field-based inquiry.

Third, the approach is only recently technologically feasible, in that it leverages not only open-source software, but also the open-source hardware movement. It is only because of the widespread availability of open-source hardware such as Raspberry Pi and Arduino that devices can be custom-built to suit particular learning needs at affordable costs, and very often, by the learners themselves.

Fourth, the approach provides an objective source of data against which teachers and students might compare their own subjective interpretations of local environmental variables within the microclimate of the school campus. This would potentially lead to learners being more effective in self-monitoring and questioning their own assumptions.

Fifth, the approach is authentic to the learner because it involves the interrogation of datasets generated from within a campus they are already familiar with, as opposed to any similar efforts in the past in which the data would have been obtained from neighbourhoods unfamiliar to the learners. Because of this familiarity, learners will be able to frame their analysis, interpretation and re-presentation of the data in terms of shared understandings and discourse structures.

Finally, because the devices are affordable and easy to customise (open-source hardware), they can be placed in a much finer mesh around a limited space than was formerly possible—the datasets will therefore be potentially much less granular (both in terms of time and space) than before, allowing for increased opportunities for learners to practice their deductive and inferential skills.

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