Practical Structure for Hands-On Inquiry in Upper Elementary

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Introduction

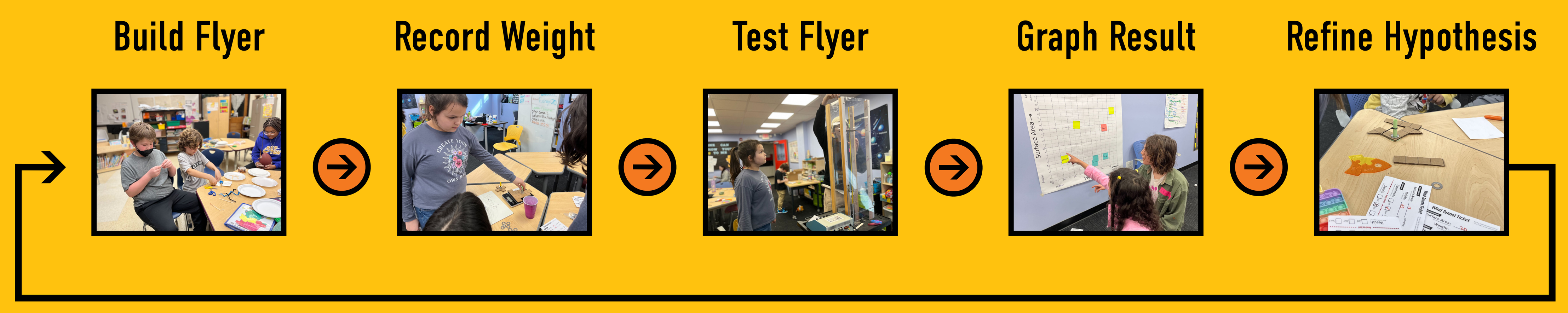
We present a description of a successful one hour, hands-on activity for upper elementary students based around a wind tunnel. We ran this activity multiple times in a variety of formats, where we focused on graphing, design iteration, and the process of making a hypothesis. Based on this experience, we formulate a general structure for inquiry-based activities in math and science. This structure incorporates our most important lessons, and involves a fast, multi-stage learning cycle centered around an exciting and interactive test/experiment setup (e.g. a wind tunnel); we discuss this structure and other key pedagogical elements that we think led to success.

Example: The Wind Tunnel Activity

Our activity employs three structures to engage and motivate students. The first is a set of stations (see below) which students complete in sequence. This structure creates motion throughout the classroom and choice for students. Some students focused on building their flyer, while others focused on testing or graphing. Since each station depends on the previous one, students have to complete every step of the process. In our example workshop, every student engaged with our graphing, surface area, and hypothesis development learning goals.

Iteration is important to the engineering process, so students had to cycle through the stations multiple times. This reduces the stakes of each attempt; students know they aren't expected to succeed the first time and feel more free to fail. Reframing failure as as neccessary precursor to success [1] instead of a bad outcome builds confidence and prepares students to engage with challengeing work in the future.

Our activity uses multiple objectives because students are not yet familiar with constructuve failure. We set three target outcomes and provided puzzle pieces for each unique outcome students achieve. No test is explicitly labeled a failure. Still, students experience trials where their design does not produce the expected outcome. This allows them to fail and still feel motivated to improve for the next trial.



Methods For Success

We will analyze the transferable (i.e. non-wind tunnel dependent) reasons for this activity's success. We will consider the practical and theoretical reasons for success:

- This activity structure motivates students by providing a variety of options for original inquiry: students can build part of the experiment in a way of their choice, develop a hypothesis of their choice within some bounds, and ultimately test and analyze their results using their own methods.
- The inquiry is still "guided," in the sense of Bonnstetter's inquiry continuum [2]. Students at this age still need some structure, and this workshop helps provide this structure by supplying a topic, materials, and most of the questions for students to ask.
- This activity has multiple steps, and students can choose to focus on a specific step. This allows for multiple means of engagement, which is an important component of universal design for learning (UDL) [3].
- Students can show their learning and find success in multiple ways—in our particular implementation of this activity, some students were excited to get a result that was "off the graph", while others sought to make aircraft that worked for the three canned hypotheses (they would hover, float, and sink). This integrated UDL's multiple means of expression [4].

A General Model

Although many schools don't have a wind tunnel, we believe that our activity provides a structure to manage the difficult task of guiding inquiry in a way that preserves the student agency, accessibility, and motivation advantages of self-driven work.

References

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