Sherin, B., & Azevedo, F.S. (2000). Zones of Exploration: A Framework for Describing
and Designing Student-Directed Activities. In B. Fishman & S. O'Connor-Divelbiss (Eds.),
Fourth International Conference of the Learning Sciences (pp. 264-265). Mahwah, NJ: Erlbaum.

Zones of Exploration: A Framework for Describing and Designing Student-Directed Activities

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Abstract: Exploration zone refers to the "territory" that students explore in a particular student-directed activity. In this paper, we put forward a framework for describing the structure of an exploration zone, and we illustrate this framework by applying it to an example activity.

Keywords: learning environments, learning theory, science education

Introduction

With the goal of supporting the analysis and design of learning environments, we are developing a framework and terminology around the notion of *exploration zone*. By exploration zone we mean to refer to the territory that students might explore in student-directed activities. In our view, such a territory does not exist as a well-defined space of possibilities; rather, it is constructed in action. Although this construction process is dynamic, we believe it may exhibit regularities across contexts. It is these regularities that our framework intends to capture.

As an example of exploration zone, consider a classroom activity in which the teacher holds up a heavier and lighter object and asks what would happen if the two objects were dropped. In advance, we might anticipate several possible answers: (1) The heavier object will hit the ground first; (2) the heavier object will fall more slowly because heavier things are harder to move than lighter things; or (3) the objects will hit the ground at the same time. In addition, the teacher might have in mind some possible directions in which the discussion might proceed based on these answers. In such a situation, we would say that the teacher has a map of a relatively simple exploration zone.

In this short paper, our objective is to provide a very broad picture of our research program on exploration zones. We begin, in the next section, by presenting an example of the dynamics typical of a student-directed, open-ended activity. Then, in the last section, we illustrate our framework with this example in mind.

Inventing Representations of Physical Motion: A Case Study

The set of activities that serves as a basis for our analyses is one in which students are asked to design and refine paper-and-pencil representations of objects in motion. These activities, named the Motion Picture (MP) tasks, usually start with the teacher briefly describing a motion, such as the "the desert motion:" A motorist is speeding across the desert and he's very thirsty. When he sees a cactus, he stops short to get a drink from it. Then he gets back in his car and drives slowly away.

In prior work, we have argued that students' inventions in MP tasks fall roughly into three broad categories: *drawings*, *temporal sequences*, and *graph-like* depictions. Here we focus on the first two classes of representations.

By "drawings," we mean to indicate representations that are largely in accordance with a set of conventional techniques for depicting the three dimensional world on a sheet of paper. Because drawing techniques are numerous and because drawing conventions are highly adaptable, students are capable of creating a large number of representations that are drawing-like.

Another common class of representations that appear in MP sessions is what we call "temporal sequences." A temporal sequence is a sequence of representational elements, arrayed in linear fashion, each of which tells a piece of the story one is representing. Thus, Figure 1 shows a car moving fast, slowing down, stopping (a circle), backing up, stopping for a longer period of time (three circles), and finally going rapidly forward.

Despite students' strong ability to engage in MP tasks, the activity does not always unfold smoothly. For example, for a long period, students at "City High School" were unable to craft alternatives to "Dots" representations (Figure 2). Although the teacher regarded "Dots" representations as acceptable, she had hoped to foster a richer discussion by having students compare a number of different representations. To address this problem the teacher proceeded in the following way: She asked the students if they could amend the representation in Figure 2 so that it could better show the *duration* of the stop at the cactus. This seemed to break the logjam; the students struggled with this question for just a few minutes, and then quickly proceeded to generate a wide variety of representations, some of which we considered to be temporal sequences.

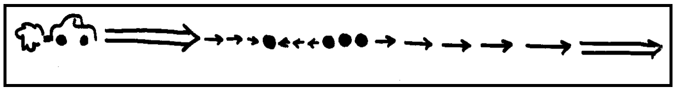

Figure 1. Representation of a motion that includes backing up. Trenton (2). Scanned from original.

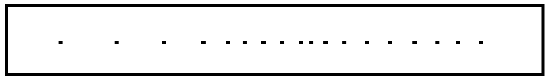

Figure 2. “Dots” representation of the desert motion.

Characterizing Exploration Zones

In advancing the exploration zone framework, our *first goal* is to develop a language that allows us to describe some familiar phenomena in student-directed activities. (e.g. students sometimes limit themselves to small areas of the exploration). To account for this range of phenomena observed in such activities, we propose two basic structural components of exploration zones: *pockets* and *pathways*. A pocket is a portion of an exploration zone that consists of points that are easily reachable from each other. In general, a pocket can be explored rapidly, but the jump to another pocket requires a breakthrough. In the case of MP activities, for example, the pockets are largely identified with the categories of representational forms we identified: drawings, temporal sequences, and graph-like representations. So, for example, once the first temporal sequence is invented—an event that sometimes takes minutes, but sometimes hours—a wide variety of temporal sequences is usually immediately proposed.

Pockets can be characterized by their types. *Pits*, for example, are pockets with “deep topography” which, for various reasons, results in students being stuck in a relatively narrow exploratory region. The episode in which City High students had difficulty moving beyond the “Dots” representation illustrates a pit. Conversely, we predict the existence of *craters*—pockets in which a very large number of solutions are perceived to be equally good, and thus design progress is equally hard to obtain. Finally, within an exploration zone one finds *landmarks*, representative points within a pocket that are returned to frequently.

Because it is often difficult to help students move from one pocket to another, one of the most critical features of an exploration zone to understand are its *pathways*—the collection of trajectories that take students from pocket to pocket. For example, referring back to the Dots episode above, we can infer that there is a pathway leading from a certain class of drawings into the temporal sequences pocket.

Given our understanding of the structure of an exploration zone, our *second goal* is to identify how different factors (students’ knowledge, social constraints, cultural resources, teacher’s guidance, etc.) shape such a structure. Consider, for example, a data-exploration task in which students are given a large set of material resources (say, data provided on a computer software) and a task to perform given those resources. In these cases, the structure of the exploration zone is, in large measure, shaped by the resources that are provided. In contrast, the structure of MP exploration zones is primarily shaped by the resources students bring to the table.

As designers of learning environments for science education, our *third goal* is to devise ways to help students move through an exploration zone in a specific direction or, at least, to have them visit certain locations.

As a *final step* in characterizing exploration zones, we would like to find out what properties of explorations zones lead to engaging explorations. For instance, we believe that the engaging character of the MP activities is in part due to the structure of the exploration zone typically constituted in these activities. Briefly, there are three pockets—not too many and not too few—and each of these pockets has a markedly different character. Furthermore, within each pocket there is room for variation, leaving space for individual expression. This, we believe, makes for an engaging exploration.