BEST OF BOTH WORLDS: ISSUES OF STRUCTURE AND AGENCY IN COMPUTATIONAL CREATION, IN AND OUT OF SCHOOL

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In the opening lines of *Experience and Education* (1938), John Dewey calls attention to the human tendency to dichotomize.

> Mankind likes to think in terms of extreme opposites. It is given to formulating its beliefs in terms of *Either-Or*, between which it recognizes no intermediate possibilities. (p. 1)

In this thesis, I have been preoccupied with the often-assumed dichotomy of *agency* (defined earlier as *a learner's ability to define and pursue learning goals*) versus *structure* (defined earlier as *rules, roles, and resources, both explicit and assumed*) in learning environments.

Chapter 1 outlined my theoretical framework for agency and structure, which argues for thinking about agency and structure as mutually constitutive, drawing on Giddens' structuration theory. Chapter 2 introduced some of the assumptions (and myths) about agency and structure that are often associated with the adoption of constructionism (and its high-agency aspirations) as an epistemological stance. Chapter 3 described my methodological approach to studying agency and structure, which emphasized interview and observation. Chapters 4, 5, and 6 examined the tensions between structure and agency in two settings for computational creation – kids working with Scratch at home through the online community, and teachers working with Scratch in K-12 classrooms. These chapters described the learning processes in each setting (Chapter 4 and Chapter 5) and the key structures that enable or constrain learner agency (Chapter 6).

Here, I connect the threads from the previous chapters, offering strategies for thinking beyond an *either-or* approach to agency/structure, in favor of exploring *intermediate possibilities*. I argue that designers of agency-supporting learning environments, rather than setting structure in opposition to agency, should judiciously employ structure in order to amplify agency.

This chapter is organized into two parts. The first part – *Either-Or* – illustrates, with a story, how too much and/or too little structure can

inhibit learner agency. The second part – *Intermediate Possibilities* – provides advice for designers of learning environments, suggesting opportune ways of introducing structure in the service of learner agency.

EITHER-OR

During my time as a graduate student at MIT and as a member of the Scratch Team, I have had many opportunities to help people learn about Scratch. In workshops and presentations, I usually begin by describing Scratch and why it is important. I demonstrate the features of the authoring environment and online community, and talk about participation from a quantitative perspective, to give a sense of scale. I share what I think is most interesting about the online community as a space for learning – the incredible diversity of projects that kids create and share, and the types of connections that kids establish with each other, from giving feedback in comments, to remixing each other's work, to making projects together.

After talking about the online community as a learning environment, I explain my interest in supporting these types of activities in schools. I argue that not all young people have opportunities for these types of learning experiences at home, and that including Scratch in K-12 classrooms is one strategy for broadening participation in computational culture.

Occasionally, however, this strategy is questioned – "Isn't it OK for them to be separate? How can the type of learning happening at home even happen in the classroom? Won't schools take away everything that you think is great about the online community?"

Certainly, there are occasions in which Scratch's translation from out-of-school to in-school is unsuccessful. For instance, several years ago, I was asked to introduce 30 high school girls to the work of our research group, and to provide a hands-on experience with Scratch. As the participants arrived for the workshop, I noticed one girl scowling, with arms crossed – a markedly different comportment than her more animated companions. My colleagues and I

welcomed the girls to our lab, and described our plan for the afternoon's workshop: a brief overview of the Media Lab, an introduction to Scratch, and then time for creating their own Scratch projects. The girl's scowl deepened.

We showed the girls some projects that others their age had created and shared in the online community, and then introduced the theme of the afternoon's activity – an interactive dance party. We quickly modeled how to start a dance party project by adding music, a background, and several dancers, and then paired the girls to develop their own dance party projects. The girls worked for an hour with their partners, consulting their neighbors, importing their favorite songs, and taking photos of themselves to put into their projects. We took time at the end for the girls to share their projects with each other, which provoked laughter, questions, and applause.

In all of the activity, I lost track of the scowling girl, until she approached me and said, "I hate Scratch." It was the first time I had experienced such a negative reaction to Scratch. I waited for her to say something else.

She continued, amending her statement, "I *used* to hate Scratch." She explained that she had been dreading the afternoon's session because of a bad experience with Scratch at school. Her teacher had assigned the students to draw geometric shapes with Scratch's pen tool and had required them to follow the teacher's actions step-by-step. They had spent a week with Scratch in this way, building up increasingly complex programs, but with no opportunities to customize or explore, and discouraged from interacting with each other. In that setting, the girl didn't understand Scratch. It didn't mean anything to her. Why would anyone want to do anything like this? Why was it interesting or important to her – or to anyone else? Her inability to distinguish pedagogy from technology had led her to expect the worst from the afternoon workshop, but she was surprised by how much she (and the other girls in her group) had enjoyed Scratch. She asked for a Scratch postcard, so that she would know how to download Scratch at home.

As this story illustrates, imposing too much structure can constrain learner agency. Designing was constrained to following the teacher's process. Personalizing was discouraged and the subject matter was not personally appealing. Sharing was prohibited, with individual students working at individual computers on individual projects. Reflecting on the design activities was not promoted, leaving the girl to question why the activities were being done at all.

Given these kinds of experiences, it isn't hard to understand the motivation behind questions like, "Won't schools take away everything that you think is great about the online community?" These questions reflect underlying assumptions that learning at home is low structure and high agency, that learning at school is high structure and low agency, and that agency and structure – and out-of-school and in-school settings – are fundamentally incompatible.

But although excessive structure undermines the agency of young people, I argue that the response should not be to dismiss structure more generally. As described in previous chapters, a lack of structure does not equal agency.

At the other end of the spectrum, Chapter 4 illustrates the ways in which too little structure can constrain learner agency. Kids who go to the online community, create an account, but don't understand the range of creative possibilities afforded by Scratch. Kids who have big visions for a Scratch project, but can't figure out what they need to learn to actualize their visions. Kids who want to find another Scratcher to work with, but the size of the community makes it difficult for them to be seen or to find someone with shared interests.

Ostensibly, kids who learn primarily in the online community have a higher degree of learner agency – a freedom to choose what and how to learn – than kids who learn primarily in classrooms. But in addition to confusing a lack of structure with agency, this mistakenly assumes that all types of freedom are equally desirable. I began this chapter with the first lines of John Dewey's *Experience and Education* – and I return to Dewey for a critical reflection on learner freedom.

The ideal aim of education is creation of power of self-control. But the mere removal of external control is no guarantee for the production of self-control. It is easy to jump out of the frying-pan into the fire. It is easy, in other words, to escape one form of external control only to find oneself in another and more dangerous form of external control. Impulses and desires that are not ordered by intelligence are under the control of accidental circumstances. It may be a loss rather than a gain to escape from the control of another person only to find one's conduct dictated by immediate whim and caprice; that is, at the mercy of impulses into whose formation intelligent judgment has not entered. A person whose conduct is controlled in this way has at most only the illusion of freedom. Actually he is directed by forces over which he has no command. (p. 75)

There is enormous potential for schools to help support the development of this type of self-control, a form of structure that is the basis of learner agency, enabling young people to flourish as learners with the ability to define and pursue goals. Teachers need greater support to reconceptualize their roles in a way that enables these changes – including emotional support, classroom support, and institutional support.

And just as we should begin to think about agency and structure not as separate, but as mutually-reinforcing concepts, we have a similar opportunity to reconsider the dichotomy between out-of-school and in-school settings. We need to think about learning more continuously, the ways that out-of-school and in-school activities can support each other, and the ways in which kids can carry learning across settings, beyond facile ideas of "transfer". Learning is a life-long (across ages, not just K-12 and college) and life-wide (across settings, not just school) enterprise, with the life-wideness accelerated by network and other digital technologies (Banks et al., 2007; Dede, 2011; DML Research Hub, 2012; Pellegrino & Hilton, 2012; Roschelle, Bakia, Toyama, & Patton, 2011).

There are intermediate possibilities to be explored with *both* the agency/structure relationship and the out-of-school/in-school relationship – it is not *either-or* with agency and structure, and need not be *either-or* with out-of-school and in-school settings. We can have the best of both worlds. But how do we design for the best of both worlds, seeking the intermediate possibilities?

INTERMEDIATE POSSIBILITIES

Agency-centered learning that takes place within/across a variety of settings is not merely an aspiration. Chapters 4, 5, and 6 presented glimpses of the possibilities – and I end this chapter with five sets of concrete strategies and recommendations for designers of learning environments who aim to support the development of learner agency. The strategies – *introduce possibilities*, *encourage experimentation*, *support access to resources*, *cultivate connections with others*, and *create opportunities for reflection* – suggest ways to productively introduce structure into learning environments.

These strategies represent a synthesis of commonalities in the experiences of kids working with Scratch at home in the Scratch online community (from Chapter 4) and the experiences of teachers working with Scratch in K-12 classrooms (from Chapter 5), filtered through my own experiences as a designer of agency-centric learning environments focused on computational creation. For each strategy, I provide examples of how different types of learning-environment designers – *teachers* in K-12 classrooms, *parents* at home, and *developers* of learning technologies (using the Scratch Team as a concrete example) – have employed structure to support agency in computational creation. Although the examples stem from the context of computational creation with Scratch, these strategies are not, in general, limited to a particular domain or particular tool.

Strategy 1: Introduce The Possibilities

When encountering a new area of learning, the entry-points and trajectories of participation and learning are often not self-evident. Learners might wonder: *What can I do? Why might I want to do it?*

There are opportunities within learning environments for structure to bring clarity to these trajectories by introducing and describing the possibilities of what the learner can do, both broadly and in a focused manner at particular waypoints. In the broad case, this might involve explaining what a particular tool makes possible, discussing how an activity is connected to a learner's personal interests, or how an activity has larger social or technical relevance. In the more focused case, this might involve explaining what is possible for a learner at a particular moment, connecting to current abilities – like presenting an appropriately scoped and scaled learning challenge.

Examples

- Teachers: A middle-school teacher was facilitating a digital media production course that included a unit on interactive media creation with Scratch. Knowing how passionate her students are about music, she searched the Scratch online community for animated music video projects. She began the initial class by dimming the lights, pronouncing, "Look at what you'll be able to create in just a few weeks," and screening several of the music video projects for her students.

- Parents: A parent read a news article about Scratch and thought that his daughter might be interested in trying it. He searched for a tutorial and found an overview video that explained what Scratch is and illustrated what you can do with it. He shared the video with his daughter.

- Developers: The Scratch Team decided to include a series of Scratch projects as part of the distribution of the authoring environment. The sample projects span a range of genres – animation, games, art, simulation, and more – and include projects of varying complexity within each genre.

Strategy 2: Encourage Experimentation

Learning through designing involves negotiating constraints – it requires a learner to adopt a stance of flexibility and experimentation in relation to their learning goals. Learners might wonder: *What are the goals I want to pursue? What are different pathways to achieving my goals?*

Opportunities exist within learning environments to use structure in support of experimentation. Designers can support learners in experimenting with both the *what* of their learning (e.g., encouraging diversity in creation) and the *how* of their learning (e.g., highlighting different pathways or strategies for achieving goals). A learner's willingness to vary subject and method is, however, in tension with a simultaneous desire to persist with particular experiments. The balance between breadth (experimenting) and depth (persisting) should be supported, along both cognitive and affective dimensions.

Examples

- Teachers: An elementary teacher encouraged her third-grade students to define a project to work on. But one of her students, who was developing a playful story about an Arctic mishap, struggled with programming the visual behaviors of the story. The teacher helped the student identify several strategies for debugging the project. When the student shared her project with others, she described the array of troubleshooting strategies they employed, including her approach to experimenting with blocks in the *looks* category, and described how important it was to have "grit" while experimenting.

- Parents: An 8-year-old Scratcher was frustrated by his project, which wasn't working, and went to his mother, teary-eyed, for advice. His mother gave him a hug, and recommended working on a different project until he had an idea for how to fix the problem with his original project. Feeling better, he returned to his room and made a list of potential ideas for new projects.

- Developers: The Scratch Team designed the Scratch authoring environment to be "tinkerable" – enabling something large to be built up by playing with smaller pieces, rather than breaking apart a larger plan into smaller components (as is often the case with other tools for computational creation). In Scratch, this enables young designers to experiment with different blocks and observe their behavior and impact on a project in real-time.

Strategy 3: Support Access To Resources

In agency-centered learning environments, learners take ownership of and responsibility for learning goals, instead of primarily following the ambitions and direction of others. But in order to achieve their goals, learners require access to resources to support the pursuit of the individualized pathways. Learners might wonder: *What can help me achieve my goals?*

Ideally, designers will make resources available that are appropriately-timed and appropriately-accessible (both in format and complexity) for the learner. Resources may be centralized (e.g., a resource accessed by all members of the learning environment simultaneously) or decentralized (e.g., just-in-time resources accessed on demand by learners). Resources may take on a variety of formats (e.g., text, video, audio) and complexity (e.g., resources for beginners, resources for learners who are further along).

Examples

- Teachers: A high-school animation teacher made the *Scratch cards* (a resource developed by the Scratch Team) available to her students. The cards each describe something that one might want to do with Scratch, such as creating a character that dances back and forth or using variables to maintain a score in a project. The teacher used the Scratch cards as a model, encouraging her students to develop new resources based on the challenges they experienced when making Scratch projects.
- Parents: A mother saw her daughter wanting to make more sophisticated games with Scratch, but unable to make progress on her goal. She bought her daughter a book that included a series of tutorials for creating games.
- Developers: On the main page of the Scratch online community, the Scratch Team included links to resources designed to help people get started with Scratch. One link points to "Scratch Tours", which are collections of thematically-related, annotated projects, while another link points to a collection of introductory video tutorials. A link is provided to the ScratchEd online community, which contains

numerous resources for teachers (and is also available to young learners and parents).

Strategy 4: Cultivate Connections With Others

Learning is not an individual process – learners can benefit from being connected with others. These connections can take different forms, with others potentially serving key roles as advisors (e.g., providing advice for challenges), as collaborators (e.g., jointly pursuing a learning goal), as audience (e.g., showing appreciation for creative work), and/or as advisees (e.g., someone with whom to share one's understanding). Learners might wonder: *Who can help me achieve my goals? Who might work with me to define and purse goals? Who might appreciate my achievements? Who might I help achieve their goals?*

Cultivating connections between learners and others involves at least two components: (1) helping learners identify potential connections (i.e., matchmaking), and (2) supporting positive interactions within those connections (i.e., respectful, productive, and mutually beneficial). Designers can introduce structures that support connection-making processes (e.g., introducing learners to those who have compatible and complementary interests, or grouping learners with those who have divergent interests as a way to broaden learners' perspectives). Further, designers can introduce structures that contribute to the success of these connections (e.g., by providing partnered learners with ideas for how to give each other constructive criticism).

Examples

- Teachers: At the end of every class, an upper-elementary school teacher encouraged his students to post challenges that they experienced with their Scratch projects on a whiteboard. At the beginning of each subsequent class, he asked students to select someone else's challenge and then meet for 10 minutes to discuss possible solutions. At the end of the Scratch unit, the teacher invited a lower-elementary class and several of his colleagues to attend final class

project demonstrations. His students introduced the younger kids, their teachers, and the school principal to Scratch.

- Parents: A father introduced his son to Scratch and they worked on making projects together. But the son quickly outpaced the father's abilities – and the father wished he could connect his son to another young Scratcher. He learned about a Scratch event being organized by a local university and brought his son. At the event, his son met another young Scratcher and they enthusiastically worked on a project together at the event. They continued working on the project through the online community and occasional face-to-face meetings.

- Developers: When the Scratch online community initially launched, the Scratch Team included an online forum where members could ask and answer questions, but the team was uncertain about the extent to which young Scratchers would use this feature. Much to the team's surprise, some kids in the community use the forums extensively – giving and receiving help, establishing partnerships, and advertising creations.

Strategy 5: Create Opportunities For Reflection

Learners need opportunities to reflect on their experiences – and the "learners might wonder" questions from the previous four strategies are examples of reflective prompts. Reflection happens both in real-time and in retrospect (e.g., Schön's reflection-in-action vs. reflection-on-action, as described earlier), and involves both cognitive and affective dimensions of learning experiences.

The designer of a learning environment can make use of structure to create opportunities for learners to articulate and negotiate these types of reflective prompts. Structures can be employed to support learners in identifying and taking steps to resolve the gap between what is currently known and what is not yet known. Structures can also be employed to support learners in negotiating feelings about their experiences, and the (expected) vulnerability of being a learner with responsibility for one's own learning. Learning can be simultaneously hard and fun (as described by Papert and echoed by kids in Chapter 4) – and structures that support reflection can

support awareness of when learning might be moving from eustress to distress.

Examples

- Teachers: A high-school computer science teacher asked his students to maintain design journals accompanying their Scratch projects. As students came into class each day, there were questions on the front board to which the students would respond in their journals. The questions spanned a range of topics, and encouraged the students to reflect on their experiences. What is your plan for today? What did you do yesterday that you were most proud of? What are three things you are able to do now that you weren't able to do when we first started?

- Parents: A 12-year-old girl felt creatively blocked. She had created several Scratch projects, but didn't know what she should create next. She went to her mother for assistance. Although her mother didn't know much about Scratch, she was able to help her daughter by asking questions about the types of projects that she had already created and then asking her what advice she would give to someone who was similarly stuck.

- Developers: The Scratch Team experimented with different ways to explicitly encourage and elicit reflection and reflective response. One Master's thesis explored augmenting the Scratch authoring environment with reflective prompts (Rosenbaum, 2009). The next generation of Scratch includes an area on a designer's profile page for the designer to describe what they are currently working on, as well as a summary of what they have been doing.

The process of designing learning environments, particularly those that emphasize learner agency, is complex and multi-faceted, with numerous factors shifting and in tension with one another. The five strategies presented in this chapter are intended to serve as points of focus in this shifting landscape, but also as points of continuous negotiation and iteration. The pursuit of intermediate possibilities between agency and structure is, to borrow an aphorism from Rogers (1961), "a direction, not a destination."