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Montessori Design Patterns

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Maria Montessori was a brilliant designer of didactic materials. For several decades, Montessori professionals have engaged in further design creation and evaluation as they extend Montessori's method for use with older children and devise new Practical Life materials adapted to different cultures and times.

However, there has been very little written about this design process. Further, existing articles on design do not reflect the depth of design knowledge within the Montessori community. Much of this knowledge is implicit knowledge that is absorbed over time through experience in Montessori classrooms or in Montessori training or workshops.

In 1977, architect Christopher Alexander wrote a book called A Pattern Language (Alexander, Ishikawa, & Silverstein, 1977). His purpose was "to organize implicit knowledge about how people solve recurring problems when they go about building things (Alexander)".

In this book, Alexander was addressing the architectural community. In time, however, Alexander's method of representing community knowledge became popular with other communities, including the software and interface design communities.

It is my belief the Montessori community would be well served by a pattern language of its own. In this paper, I would like to suggest some design patterns that might become part of a Montessori pattern language.

The Patterns

The design patterns below have been written with a title (such as *Isolating Attributes*) followed by a design problem and a common Montessori solution, together with an example that illustrates the pattern. I also added questions and brought up limitations of a particular solution as they occurred to me.

The patterns in this paper are focused on materials, specifically on math and sensorial materials. A full pattern language would include design patterns in all areas of the Montessori classroom at all levels of the Montessori environment. For example, it would include patterns in laying out the environment, patterns in building a particular classroom community with its particular set of norms, and patterns in creating school policy.

Design problem:	By definition, attributes are embedded in objects or events. Therefore, attributes can only be represented with objects or events. So, when we try to help a learner to recognize some attribute X by presenting a representation, it is likely that the learner will confound attribute X with other attributes of the representation or with the representation itself.
Design solution:	Isolate attribute X by presenting multiple representations that are identical except for attribute X.
Example:	Any of the Montessori sensorial materials.
Question:	When children are taught in this way, are they just as fast, faster, or slower to see attribute X in other contexts?

Design problem: We want to help the child recognize and construct understandings about attribute X. However, attribute X is ubiquitous, and cannot be separated out from any object of which it is an attribute.

Design solution: If different instances of attribute X can be contrasted, create pairs of objects that are identical except for attribute X. Make attribute X identical within the pairs but contrasting between the pairs. The child can construct an understanding of attribute X by putting together the pairs of objects that match.

Example: Color tablets.

Limitations: This solution will not work when there are other attributes that cannot be extracted or neutralized and which could be perceptually confounded with attribute X. For example, young children typically confound the attributes of altitude and vertical length (“higher” and “taller”). If you have this problem and both attribute X and confounding attributes can be graded, you might be able to use *sequencing* or *variable sequencing*.

Design problem: We want to help the child recognize and construct understandings about attribute X. However, pairing objects will not highlight attribute X because we cannot create an object with attribute X that does not also have attribute Y, so children will be apt to confound attributes X and Y.

Design solution: If attributes X and Y can both be graded, make four sets of objects that are graded as follows:

Set 1: Objects can be graded in increasing order by both attribute X and Y.

Set 2: Objects can be graded in increasing order by attribute X. Attribute Y remains constant.

Set 3: Objects can be graded in increasing order by attribute Y. Attribute X remains constant.

Set 4: Objects can be graded in increasing order by attribute X and, simultaneously, in decreasing order by attribute Y.

Example: Knobless cylinders. In this case, attribute X is diameter and attribute Y is height. Set 1 corresponds to the yellow cylinders, set 2 to the red cylinders, set 3 to the blue cylinders, and set 4 to the green cylinders.

Limitations: Because the attributes are differently sequenced, it is likely to be difficult to design a measuring tool that can be used in a straightforward way to measure the attributes on all of the objects.

Design problem: We want to help the child recognize and construct understandings about attribute X. However, pairing objects will not highlight attribute X because we cannot create an object with attribute X that does not also have *n*-1 other attributes, so children will be apt to confound attribute X with the other attributes.

Design solution: Create *n* sets of objects, one for each of the attributes that occur simultaneously. In the first set, vary all *n* attributes. In the second set, vary *n*-1 attributes, and so on. In the last set, vary attribute X only. The child compares objects within and between sets.

Example: Pink tower, brown stair and red rods. Attribute X is length. The other attributes that always occur with length are height and depth. In the brown stair, we refer to simultaneous changes in height and depth as changes in thickness.

Related Pattern: Variable sequencing.

Design problem: We want to highlight a relationship between more than one set of ordered objects.

Design solution: Pair objects between the two sets.

Example: Pairing of cubes in the pink tower with the prisms in the brown stairs. Creating a “table” of color tablets with a different hue in each “column” a different shade in each “row”.

Design problem: We want to prepare a child for analysis of a form. This form has many components and aspects with which we are familiar, and we can easily highlight them or point them out to the child. However, the child has trouble differentiating these components and aspects and loses sight of their significance in relation to the whole.

Design solution: Present the form as a visual whole and give the child extensive experience with various representations of the form, providing opportunities for observation of the form under various transformations that are under the child's control. Leave room for spontaneous analysis to occur. At a later stage, if the child has not already done so spontaneously, it may be appropriate to highlight aspects or components of the form for analysis.

Example: Geometric insets are used to introduce shapes before analysis of sides and angles.[1] Children have opportunities to manipulate these shapes and thus observe them under various transformations of orientation.

Known to Unknown

Design problem: We want to introduce the child to something new. However, all learners construct new knowledge based on existing knowledge and experience. Also, an appropriate level of familiarity provides the level of comfort needed to accept the challenge of constructing new knowledge.

Design solution: Present experiences in a sequence that begins with more familiar experiences and proceeds to less familiar ones.

Example: Children have years of experience with the binomial and trinomial cubes before they are introduced to the cubing material.

[1] See discussions in the Montessori Method (Montessori, 1964) on pages 113, 234-235, and 243.

Design problem:	We want to introduce the child to a new task. However, even with repetition, the child is unable to complete the task.
Design solution:	Present related but more accessible experiences to serve as stepping stones to the more difficult task[5].
Example:	Tracing the geometric insets is indirect preparation for writing.

There are a number of patterns that may be associated with control of error, which will be outlined in this section.

There is a whole class of materials that can be introduced with this approach. Here are some feedback ideas that can be taken from this them:

Limit the moves to be made. For example, matching can rely purely on visual cues or failure to match appropriately can cause failure to continue or complete the activity.

Help the student see where she's going or what she's doing. Isolating attributes is one way to do this.

By limiting moves or showing more of the current state at different points in the activity, we can provide immediate or delayed response to provoke expectation failure. For example, the geometric cabinet gives immediate feedback, knobbed cylinders give delayed feedback, color tablets give only "internalized" control of error. Exercise of haptic sense gives feedback when child removes blindfold.)

As the child gains more experience, the need for a particular control of error fades. Here are the kinds of fading that do or could take place in Montessori environments:

From reliance on cues to reliance on memory.

From having representation provided (this is…) to selecting representation (which one is…) to generating representation (what is this?)

From control of possible moves (i.e., can't proceed or complete activity without required moves) to guidance through sensory feedback

From direct sensory feedback to indirect feedback. For example, from manipulation of the golden beads and numerical cards to working only with cards or pencil and paper.

From teacher demonstrating task to teacher supplying means (resources, plans) and ends for completion of task to teacher supplying ends (goals) only to child pursuing self-selected goals with independently obtained resources.

What Now?

There are countless more Montessori design patterns that are yet to be mined. A set of design characteristics for Practical Life materials was presented in The Constructive Triangle by Sonja Donahue (Donahue, 1974). Almost without exception, these characteristics apply to Montessori materials in general and could be written up in the if-them format of design patterns.

Montessori classrooms are full of patterns—in materials, layout of physical space, work processes, and roles of students and teachers. Design patterns give us an explicit characterization of these patterns that are general, but concrete enough to be useful to designers of materials. A pattern language would also be another means to communicate about the Montessori method with people outside of the Montessori community, including researchers, manufacturers, publishers, and educational software developers.

Finally, since the ultimate goal of a pattern language is the creation of quality materials, we must have explicit, shareable methods for verifying the quality of new materials. This might come about through dialogue between the Montessori community and the design-based research community (The Design-Based Research Collective, 2002).

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