Models of Learning

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Contents

1. Introduction

In this paper, I contrast the learning models implied by Don Norman in Things that Make us Smart and by Seymour Papert in Mindstorms: Children, Computers, and Powerful Ideas and in The Children's Machine. Jean Piaget inspires many of Papert's ideas, so I also plan to make references to The Psychology of the Child. After reading these books, I found that Norman and Papert's models contradict each other at times. For example, Norman implies the effectiveness of repetition of words to learn them, but Papert stresses that this does not work. However, I also found that at other times, rather than contradicting each other, they emphasize different aspects of learning. For example, Norman tends to emphasize fun and curiosity as motivators for learning. Papert admits that these are important, but he focuses more on the learner's confidence and his sense of purpose in learning. To justify one model or the other (or both), I will use my research experience in computer graphics as a concrete example.

2. Accretion vs. Assimilation

A model of learning must have an explanation for how new data is learned. Piaget proposes that this is done through *assimilation*: "meaning that...data are treated or modified in such a way as to become incorporated into the structure of the subject". (Piaget 5) Norman's model, which he calls *accretion*, at first seems to agree with Piaget. Norman explains that when one has a "proper conceptual framework," new data can easily be learned by tying it into this framework. However, Norman soon breaks with Piaget when he claims that the absence of such a framework "requires repeating the material over and over again..., using mnemonic strategies, or writing down the

information" (Norman 28) Papert supports Piaget's model and contradicts Norman. He gives an example of how he fails to learn the names of flowers by memorizing their characteristics. Instead, he "began to build up a more personal kind of connection" through folklore. (Children's Machine 102-3) Papert insists that a connection is essential to the effective learning of new data. It is more worthwhile to look for any connection, no matter how unlikely a connection seems (i.e. folklore to flower's names), than to spend time using Norman's suggestions to memorize the data. Put another way, Papert believes that when there "isn't a good conceptual background," the learner should try to build it using what he already knows before he tries to absorb the new information.

My personal experience supports Piaget and Papert's model. All of the new information I have learned through my research has been learned through connections. In fact, I rarely even remember information that I have at one point memorized or written down without making any connections. I have found that these kinds of "learning" are good only for short-term memory. Anyway, I do not need to memorize facts because these facts are usually recorded in books or computer files that I can always access. On the other hand, the new data that I actually learn is connected to information I already know. I am usually exploring or searching for the new information, so it is always connected to the context of the problem I am trying to solve. My idea of learning new facts involves understanding them, as opposed to only knowing what they are. This is why I find it difficult to consider memorizing as a way of learning. An example of this is when I learn the syntax of a new programming language. My learning goes beyond knowing the names of the commands and the rules of the language. It includes

my connecting these commands and rules to concepts that I already know. If I encounter a command and I do not connect it to anything, then I do not learn or even remember it. I agree with Papert, a connection to something that is already understood is essential to learning something new.

3. Restructuring intuition

In the previous section, I discuss ways of learning new information when no conceptual structure exists with which to make a connection. Here, I discuss models for learning new information when it conflicts with an existing conceptual structure, or what Papert refers to as an "intuition." In my reading of Norman, I found nothing that directly addresses this issue. His model implies that accretion is the only prerequisite to restructuring. His idealized view of the classroom supports this: "classrooms ought to be the ideal settings in which to provide...the information needed for later reflection." (Norman 41) Consequently, I assume that in this scenario, the exposure to new data is all that would be needed to fix a "bad intuition." Papert, however, does not agree with this line of thinking. He argues that in this case, simple accretion of new facts alone does no good: the intuition itself must be fixed first. To illustrate his point, Papert gives an example of a student that could calculate the correct answer to a physics problem but did not have a physical understanding of what he was solving. When his teacher tried to help by reinforcing the calculations, he only "[rubbed] salt in the wound but [did] nothing to heal it." (Mindstorms 144) To solve this problem, Papert proposes that "when there is [such] a conflict..., look for intermediate [cases]." (Mindstorms 148) Rather than

jamming more new information into the student, his intuition must be restructured by relying on a model that is already understood correctly.

Once again, my research experience supports Papert's model. Many times, I have encountered new information that contradicts my intuition. This new information alone is rarely enough to change my flawed intuition. As Papert suggests, I am forced to restructure my intuition by relying on other intermediate problems for which my intuition is correct. For instance, one of my research projects involves finding the shortest way of translating and rotating a 2D object through an obstacle course. Because the algorithm I use involves a single point moving in 2D space, the given object must first be transformed into a point. This means that the surrounding obstacles must also be transformed accordingly. When I first thought about this problem, my intuition was confused by images of morphing shapes. The solution is to convolute the shape of the object with the obstacles. However, being told that this was the solution did not help me at all; I could not understand how this convolution magically "morphed" the obstacles in the right way. This was until my research advisor took the time to help me fix my intuition. He advised me to solve the problem by placing the object at each point in space and blocking that point if the object touched an obstacle. I soon realized not only that this resulted in the transformed obstacles, but also that this was an equivalent operation to the convolution. Fixing my intuition is what led to my truly learning the solution.

4. Novice to expert transition

Another important aspect of a learning model is the way that one makes the transition from novice to expert. This especially applies to learning a new skill. In this case, Norman's model focuses on a performance-oriented view, whereas Papert's model focuses on the personal relationship between the learner and the skill. To Norman *tuning* is the key to becoming an expert, and it involves a great deal of practice. Norman explains that "tuning is a slow process" and that reaching expert behavior requires "a proper mix of accretion, tuning, and restructuring." (Norman 29, 36) Through tuning, what at first are uncomfortable, clumsy attempts at performing a skill become easy, fluent attempts that require little thought. Moreover, Norman stresses the fact that a skill must be maintained through tuning: "expert behavior must constantly be retuned" otherwise "performance deteriorates." (Norman 29) Papert does not contradict this model. Instead, he sheds light on a different aspect of the transition from novice to expert. He describes the novice as "one who obeys commands but...feels as if [he] is clumsily acting as someone else." (Children's Machine 47-8) For Papert, the "conversion experience" happens when one stops trying to be someone else and feels like he is being himself as he performs the skill. This describes a shift from an impersonal relationship with the activity to a personal one.

Both Norman and Papert's models have applied to the expert skills I have acquired in my research. The skill I have probably developed the most is my programming skill. A specific example is my learning the graphics commands for the Java environment. When I was first exposed to these commands, I used them in a clumsy manner. Similar to Norman's model, it took time and practice with various

schemes before I became skillful in applying the right commands for the right situations. I also related to Papert's model. When I studied sample code and tried writing my own versions of it, I felt "disconnected" with what I was learning. As a novice, I was still emulating rather than having ideas of my own. However, the more I practiced using the commands, the less I had to use reflective thinking to apply them. I soon was able to create more complicated effects with the commands because I did not have to spend time thinking about the easy cases. Notice that at this point, I was the one creating code, so I can relate to Papert's idea of having a more personal relationship with the skill as expertise grows. I can also relate to Norman's point of constant retuning even after one has reached the expert level. I have found that it takes some time to "relearn" programming skills that I have not used in a long time.

5. Who does the teaching?

The issue of who does the teaching is a conflict between Norman and Papert's learning model. Piaget suggests that children learn through their own exploration rather than from another person's teaching. In fact, in an experiment that involved teaching the arrangement of cubes to children in different ways, he found that "the [child's] perception of adult activity adds almost nothing to the...result." (Piaget 81) Papert embraces these ideas and hence stresses that learning should be under the learner's control as opposed to the teacher's. Papert argues that formal teaching can even hinder the learning process. He illustrates his point in his description of "school math:" "...it is so mindless and dissociated that it provides a shelter from having to think." (Children's Machine 51) Papert believes that a teacher's time is better spent teaching

the learner to teach himself: “the kind of knowledge...most need[ed] is the knowledge that will help...get more knowledge.” In contrast, Norman puts learning under the control of educators. He believes that “educators know what needs to be learned.” (Norman 39) For example, in the relationship between a coach and a player, he suggests that the “coach provides the reflection for the player.” (Norman 36) He argues that the reflection of an instructor is needed because self-reflection is difficult for a person that is learning something new.

One of the reasons I prefer my research to attending class is because I learn more through exploration than through lecture. My experience supports Papert’s model. Of course, there is always some need for outside guidance. Nonetheless, I have found that I learn more effectively when I have more control over what to learn next. For example, every project I work on requires me to learn some new mathematical concepts. My research advisor does not lecture the material to me. Instead, he gives me references and suggestions as to how I can learn the material for myself, and he leaves himself open to any questions I may have. This gives me the freedom to learn at a comfortable pace. Moreover, since I take the initiative to learn the new material, I put more effort into trying to understand it. In a lecture setting, however, I lose these advantages. What is worse is that this kind of instruction would teach me nothing about how to learn the new material. My ability to learn something new without guidance has been an essential part of the success of my research. Norman argues that this kind of learning is not always good because it is more difficult. Although I agree that finding the answers for oneself is indeed more difficult, I still believe that this is a more effective way to learn.

6. The role of technology

Norman and Papert have slightly different visions of the ideal role that technology can play in education. These visions reflect their models of learning. For instance, Norman tends to divide learning into an initial experiential phase followed by a reflective phase. This fits in with the "motivator" role of technology that he envisions. Norman implies that the heart of learning lies in the reflective phase, which most people do not reach because they do not have the motivation to do so. Hence, he proposes the use of "technology to provide a rich database of information and demonstrations" to appeal to the experiential side of the learner. Once a person has been successfully lured into learning, he is set up to enter the reflective phase on his own. Papert's role for technology differs from this because his model of learning is a mixture of experiential and reflective experiences. In fact, he rarely emphasizes the division between the two. For Papert, technology "can do much more for learning...than what educators like to call motivation... [it can] give children a way of thinking of themselves as 'doing science.'" (Mindstorms 97) Instead of proposing databases and demonstrations, he proposes interactive "microworlds" that both appeal to the experiential side of a student and challenge his reflective side as he explores it. This way, one learns directly through the technology, as opposed to being only lured by it.

My research experience with technology supports Papert's model. Computer graphics do much more than lure me into reflective thinking. I learn with such a mixture of experiential and reflective thinking that I can hardly tell when one or the other is happening. Most of my work involves visualizing the problem, so most of my reflective learning is closely tied to what I see. An example of such an experience was my

programming a simple 3D environment in Java. Most of my reflective thinking happened through the math involved in the 3D geometry. However, this process was mixed with experiential thinking as I drew the geometry and judged my results based on how they looked on a computer screen. I do not remember ever spending a long time in either the experiential or reflective mode. In fact, I repeatedly switched modes as I explored and learned. My experience was similar to those of the children using the Turtle microworld. Despite this, I do not think that Norman's model is necessarily incorrect. I have had other learning experiences that break up nicely into experiential and reflective parts, such as watching a TV documentary and then reflecting in silence after I am done. Still, I believe that learning is more effective when one is able to reflect while he "experientially" interacts with what he is learning.

7. Kinds of motivation

Norman and Papert both stress the importance of motivation in learning. Clearly, a person learns best when he wants to learn. However, Norman and Papert focus on different kinds of motivation. As I describe in the previous section, Norman believes that people can be lured into learning. He suggests that educators should use similar methods to those of the entertainment industry to do this. The idea is to appeal to people's perceptual senses to gain their attention and make them curious. "Once people are curious about the questions…, they are…willing to do the work involved in pursuing the answers." (Norman 30) In this model, the important factors of motivation are fun and curiosity. On the other hand, Papert focuses more on the learner's perceived usefulness of what is being learned and on his confidence in learning it. He

illustrates the former concept through an example of a girl that had trouble learning grammar rules: “she had simply seen no purpose in the enterprise [because] she had not been able to make any sense…of what [grammar rules] might be *for*.” (Mindstorms 49) Papert also illustrates the importance of confidence through an example of another girl who felt she could not work with fractions. This soon changed when she tried learning to manipulate them in an artistic environment in which she was comfortable. (Children’s Machine 145)

All of the kinds of motivation I describe above are important to my learning experience in my research. The motivation I feel to do my work is what makes it feel less like work: motivation has been the key to my work ethic. Part of what motivates me to research computer graphics is the lure of the technology. In short, it looks like fun. As Norman describes, this lure spawns a curiosity about the field that motivates me to learn about it. Nonetheless, these kinds of motivation are sometimes not enough for me to try to tackle a problem. When I was first exposed to the problem of computing the shortest path between two points on a 3D surface, I was curious, but I was also scared. At first, I did not feel confident in my mathematical ability to solve it. It was not until my research advisor helped me build confidence in my ability that I felt motivated to try. I also agree with Papert’s emphasis on the learner’s perceived usefulness of the material being learned. One of the reasons why I found school frustrating was because I felt I was wasting my time learning useless facts. Conversely, one of the reasons I am motivated to do research is because I clearly understand the purpose of everything I learn.

8. Discussion and Conclusion

Although both Norman and Papert provide interesting insights about learning, Papert's learning model is more complete than Norman's. This is partly the consequence of Papert focusing on learning throughout his books. In contrast, Norman devotes more of his book to the proper "representation" of what is being learned than to the learning itself. He implies that material that is represented well is easy to learn. Moreover, he stresses that good representations appeal to people's perceptual senses. Norman illustrates his point well with numerous examples, such as the "computer's" version of tic-tac-toe versus the perceptual version. (Norman 53-55) I did not discuss this in the main sections of this paper because Piaget and Papert present similar ideas. They describe the effectiveness of learning through "concrete operations" and one's perceptual senses. However, Papert also addresses other important issues in learning, such as fixing incorrect intuitions and the importance of self-confidence. I found Papert's ideas particularly appealing, and I believe that these ideas should be applied in the school system.

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