Welcome to Session 1: Teaching Machines, Development, and Learning. In this session I will describe the relationship between Skinner’s teaching machines and the digital teaching tools available today. Switching gears, we will consider development and learning, and what Vygotsky and Piaget believed about interactions between these two processes.
B.F. Skinner is a major figure in psychology and education. Known for behaviorism, his work exemplifies the integration between research and practice in education. Operant conditioning is a core concept in behaviorism: it describes the mechanism through which behavior can be shaped when desirable outcomes (e.g., getting food or avoiding a shock) are contingent upon specific acts. Studies conducted across species demonstrated that even complex behaviors could be elicited through application of operant condition techniques. However, this is only possible if the right stimulus is provided for a given individual and if the component skills of the complex behavior are understood beforehand. Skinner used these principles to inform the creation of teaching machines.
The rudimentary components of a teaching machine can be seen in this training box used to shape a rat’s behavior. When a desired behavior was demonstrated a food reward would appear. An electrified floor grid delivered aversive stimuli when a specifically undesirable behavior was demonstrated. Using this approach, complex behaviors could be shaped. Through repeated experiences when a behavior occurred, initially by chance, and was rewarded, the behavior would be demonstrated more frequently and even combinations of behaviors in specific order could be elicited. In the creation of operant conditioning tools – teaching machines - for people, the machine’s purpose could be explicitly described and even shaped by the learner’s needs. Food-based rewards or pain-based punishments weren’t needed as individuals were motivated intrinsically or for extrinsic reasons such as grades or certificates.
In this slide you can see two pictures of teaching machines. Skinner’s “teaching machines” may look dated and mundane, but in many ways, they were years ahead of their time. The same design principles he used are applied in the creation of educational apps. Further, many of the benefits he described are similar or identical to those used to market digitally based learning aids directly to the learner but also to the teacher or materials designer.
I draw your attention here to two important features of teaching machines: (1) they constrain the order of the information students see and (2) the order of presented information can change during successive tries according to the student’s performance. The control is mechanical rather than digital but in many ways, modern educational software does the same thing, albeit with more bells and whistles (and animations, and cute rewards, and, and, and. . .) but the principle is the same: provide students with structured information that is based on a deep understanding of the material to be learned.
Here is a sample of how the information was structured in one of his teaching machines. Ask yourself whether you think a school child you know or have known might more effectively learn vocabulary this way as compared to a commonly used approach asking students to define the word and use it in a sentence or in a paragraph along with other assigned words.

If you are interested, you can see other samples of the materials that were “programmed” into the teaching machines in the optional reading. It doesn’t take long to scan the article and get the gist. I imagine that this kind of information would be a fun piece to leave lying around a faculty break room or the like to give your colleagues a blast from the past!
Skinner outlined multiple benefits to the student for this approach:

Student engagement was guaranteed because a constant exchange between the student and the materials was required;

A self check for accuracy was built in to provide immediate reinforcement of correct responses and to control whether when students could begin later material;

Just-in-time material and hints supported students with information they are “just” ready to understand and engage with. In the best case scenario that means the design respects Vygotsky’s Zone of Proximal Development).

I’m sure it’s easy to recognize these same benefits holding for digital learning aids whether they are sophisticated games that adapt themselves to learner needs or simply computer-based versions of flashcards.
The benefits of the teaching machines weren’t limited to the student. Skinner also saw these as ways to improve pedagogical approaches quickly and efficiently. Pilot testing would allow the designer to determine if many students erred on the same items. Since the approach was standardized and items could be changed individually, adjusting the error-inducing material and reassessing with new students was straightforward. A similar approach allowed designers to efficiently test and optimize the order and manner information was presented.
What might Skinner think about the flexible and widespread use of digital teaching tools? I suspect that he would see a close connection between them and his teaching machines. In particular, I think he would be excited by the potential to improve pedagogy using big data generated by digital teaching tools. In closing this segment, let me suggest that as you read Skinner’s views on the technology of teaching, you take time to appreciate the somewhat timeless nature of the pedagogical challenges and potential solutions he described. In the next slides, we switch gears, and I present a brief and more general overview of the concepts of development and learning including how Piaget and Vygotsky viewed them.
Piaget and Vygotsky both worked to understand children's development and learning. Each recognized that biological and social factors as well as children's own behaviors, thoughts, and feelings would influence the trajectory of these processes. However, they differed in the emphasis they placed on the factors in their own research and held different views on how development and learning interacted.
In one of the articles you will read this session, Vygotsky describes competing views about whether development precedes and drives learning or vice versa. Vygotsky argued that the interaction between development and learning was best understood when we conceive of development in terms of a zone rather than a single marker. This approach honored the fundamentally dynamic nature of development. He used the term Zone of Proximal Development (ZPD) and described the floor of the zone as the current developmental level while the ceiling was the currently reachable level if appropriate learning experiences are available and pursued. Note that Vygotsky wrote about the zone in terms of a relatively short period of time during which children receive direct scaffolding from someone more advanced than the learner.
In contrast, Piaget held that learning is dependent upon the developmental state. As you will recall, Piaget theorized that children progressed through stages of cognitive development. Further, he argued that the developmental processes that underlie transitions between stages were overarching forces and that they could also be used to explain learning. These forces were biological maturation, physical and social experiences, and a more complex factor: equilibration or self-regulation. He further divided equilibration into the unequal partners of association and assimilation. Association here is similar to the linkages Skinner would say are fostered by operant conditioning. Piaget held that these were not adequate to explain learning. Instead, Piaget thought that assimilation, where a child actively integrates new stimuli into a previously developed schema, was the primary driver. Unless schema were already in place, further learning could not take place. In addition, the character of the schema a child could possibly create would be constrained by his or her current developmental stage. In Piaget’s thinking, equilibration, the balance between the processes of association and assimilation were fundamental to development. In addition, the simple aspects of learning that can be described as association were dependent upon knowledge structures that were previously acquired through the active assimilation process. Piaget held that his proposed stages were universal, evolved characteristics of human development and that they were as fundamental to the process of growing as other biological growth imperatives. To explain why there would be individual and cultural differences in developmental changes, Piaget invoked the potential complexities generated through interactions between his four

[Development and Learning: Piaget]

- Prioritized development over learning
- Processes that underlie, cause, and shape development are broader than, but also subsume those that explain learning
forces of biological maturation, physical and social experiences, and self-regulation.
In common parlance we use the words development and learning almost interchangeably. We talk about students developing or learning skills. We discuss developmental and learning disorders. As education professionals, we are concerned about supporting students to either develop or learn social skills. In the scientific community there is overlap as well, but with development more often, but not always, used to refer to biologically driven processes of maturation. I’ll posit here that in some cases the lines between development and learning are straightforward. For example, puberty would be considered a developmental process while acquiring the skills necessary to drive would be considered a learning process. One dividing line between the two might be that development is something that will naturally occur given adequate nutrition, social exposure, etc...while learning requires exposure to specific experiences. Such experiences might be unique to the individual or be common within a culture, but they are not a predictable outcome of the human condition more generally. However, if you consider the process of learning to speak a language, there is room for argument about how and when it is better described as a developmental or learning process. This is also an interesting place to highlight how the interaction between the two processes may be experience dependent. For example, the manner in which a child learns multiple languages when raised from birth in a poly-lingual environment will be different from how a second language is learned AFTER one or more is already known. As we continue in the course, I invite you to consider how different psychological processes might help explain or unearth additional aspects of the complex relationship between development and learning.