Theoretical underpinnings that help frame why students with varied backgrounds might struggle

**Jerome Bruner**\(^1\) – posits that our ability to learn is based on our past experiences and we typically develop a basic understanding of most concepts at a young age. However, people learn a concept in the same progression regardless of the age at which they first experience a concept.

The three stages are enactive, iconic, and symbolic. The **Enactive Mode** is where we *begin to form conceptual understanding*. At this stage, we represent our knowledge nonverbally. Most young children begin to formulate a concept of “age” while they’re quite young. When you ask a 2 year-old how old she is – she shows you 2 fingers. Because humans develop a huge array of neural pathways at this early age, the speed of development is relatively slow. If someone did not develop a concept of age when they were young, her/his encounter with “age” would still have to begin nonverbally (even if this first encounter occurs when the person is 27). However, the difference between a 2 year-old and the 27 year-old is it would take the 2 year-old perhaps two years or more to move to the next stage, where it might take the 27 year-old only one or two experiences in the enactive mode since the neural pathways are fully developed by this age.

The second stage is the **Iconic Mode**, where we *represent understanding through intuitive manipulatives, or visuals that look like the meaning of a concept*. When we want to help a 4 year-old begin to develop an understanding of addition, we might provide the child with 2 pictures of apples (or the real thing) and 3 more pictures of apples. Before the child can add abstractly using mental math (without pictures of apples), s/he will touch each picture and count as s/he goes, functioning in the iconic mode. In literature, we might have several pictures that tell a story, but the pictures are given to the student in the wrong order. The child functioning in the iconic mode is able to hear the story, maintain the order of events of the story in her/his mind, and after the story is told, put the pictures in the correct order. In music, children functioning in the iconic mode are able to think about a song they know quite well (like *Twinkle, Twinkle, Little Star*, perhaps), and use iconic representation to show either the rhythm or the rhythm and melody of the song.

The final stage is the **Symbolic Mode**. At this level, the *person can function with standard notation*. In math, we can use standard numbers, but only with the functions we’ve previously experienced. So we

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may be able to add and subtract, but to start building the concept for multiplication means we need to move back to at least the iconic mode – where we experience grouping items – to build the underlying process that enables higher level functioning. Again, when we move to algebraic equations with a missing variable, we need to return to the iconic mode (likely quite briefly) to build a visual picture/understanding of the underlying process before returning to the symbolic. In language arts, we are able to create a vivid story that helps the reader paint a mental picture through standard letters that form words. In music, the person functioning in the symbolic mode can use standard music notation to record musical thoughts or read music notation to perform a composition.

This relates to students with varied backgrounds in these ways:
1) students enter our courses with a vast array of understanding and may need multiple entry points to understand what we’re describing. They may need to see or work with some manipulative (possibly in an online environment) that helps them work with a concept in a way that makes it accessible before other material will be understandable;
2) difficult topics may need to be “dialed back” briefly for most students if the material is not intuitive, at least on the surface. This may mean that the “lecture” portion of class provides more active learning opportunities that present material in the iconic mode.

Piaget\textsuperscript{2} – Accommodation and Assimilation

Piaget had many thoughts on how we learn, but one important idea here is the connection between assimilating information that seems intuitive and accommodating information that appears to be in direct conflict with previously held ideas/beliefs. This can be applicable at any age, but seems especially problematic in post-secondary schooling.

Let’s use a mundane topic as an example. Two students are enrolled in a psychology course. One has heard many times that a person only uses 10% of his/her brain. S/he has come to believe this is true. The other has heard the same thing, but has also heard that there is no truth to the statement; it’s simply an old wives tale. In the psychology course the professor makes the statement that even when people sleep, they use the majority of their brain – and that the tale that we only use 10% of the brain is a false statement. In fact the professor provides fMRI and PET scans that clearly show far more than 10% of the brain at work. The student who had doubt prior to the class can easily assimilate the research debunking this myth. Assimilation is a relatively easy process. The other student, confronted with evidence that directly refutes a publically held belief, cannot so easily accept the professor’s claim, nor the accompanying evidence.

This applies to college students in many ways – but especially when we experience students who struggle to “learn” a new concept. To the expert in the field, the development of the concept is easy – and occurred a long time before. If the novice, however, hasn’t had the type of experiences that allow him/her to understand the basis of the concept, developing knowledge will be quite challenging – and take far longer than a professor believes should be necessary.

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\textsuperscript{2} Piaget, J. (1951). \textit{The psychology of intelligence}. London: Routledge and Kegan Paul
Most learners don’t achieve their ultimate performance level independently. There is a gap between their current achievement and their ultimate potential. Most students have the ability to achieve far more if they are provided with instructional support from a teacher, parent, mentor, or peers, than they could achieve alone. The gap between what a student can achieve independently and what s/he can achieve with assistance Vygotsky termed the Zone of Proximal Development (ZPD). Some suggest that the more robust and appropriate the level of support, the smaller the zone of proximal development will be.

The Zone of Proximal Development (ZPD) has several implications for students with varied backgrounds. For one, if learning occurs in community, each learner will bring unique perspectives and insight into the learning community. One team member’s weakness can be erased through another team member’s strength. The notion of “together we’re smarter than any of us individually” comes into play here.

Secondly, if student success requires some level of support until enough of the structure exists to function independently (much like we see as new buildings are erected on campus), then faculty or student support necessary to begin the learning process, should be “removable” when the student has developed enough scaffolding (background knowledge) to make disciplinary thinking possible. Faculty or student support may be some form of mentoring, the introduction of intuitive strategies, web/written materials, etc.

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Chunking – how we group information to reduce cognitive load

An expert in a field can look at many pieces of seemingly disparate information and make sense out them. Novices require much more cognitive power to try to connect those pieces of information. *The way that an expert groups information is called chunking*. For instance, in the picture below, a novice music theorist will frequently mislabel the chordal progression because s/he has no means of grouping that information. The experienced theorist sees an Italian sixth ($Ii^6$) chord (typically the movement from an inverted augmented minor 4 to a major 5 chord with only 3 pitches where the movement is outward). An $Ii^6$ requires viewing a chordal progression rather than individual chords.

![Allegro vivace](image)

This example makes it rather easy to see how atomistic thinking combined with advanced cognitive load could clog a student’s thinking processes, however when one knows how to group the data provided, the expert can glance at the chordal structure, easily identify it, and use that information to more easily perform the music accurately.

There are several applications to students with varied backgrounds. Students who enter with little knowledge of the subject will view each bit of information as discreet – not connecting the various individual bits of information. A professor who considers strategies to help the student make the connections will likely see students progress much further and much more quickly than the instructor who only provides information. Additionally, faculty who focus on paths to student success will explore the root causes underpinning student failure and will look for means to provide support in a way that encourages the student to think about the discipline like an expert in the field.

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5 Cognitive Load Theory begins with the idea that our working memory is limited with respect to the amount of information it can hold, and the number of operations it can perform on that information.