Handbook of Teaching and Learning:

A Theoretical and Practical Review of the Literature on Modern and Recent Theories of Learning.

by

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Abstract

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Learning and teaching are two interrelated processes that are of primary concern to educators. This project begins with a thorough investigation of the foremost modern educational theories that seek to explain the process of teaching and learning. The second section examines landmark educational theories which contribute to the modern understanding of teaching and learning. Finally, the project explores some practical instructional activities that have been developed out of the more theoretical research.

Chapter 1: Introduction

Understanding the process of learning

When most people picture a classroom or any other educational setting, they expect one basic phenomenon to be occurring; learning. In a recent meta-analysis, McLaughlin and his fellow researchers (2005) conducted an extensive review of professional literature on learning theories and concluded that learning occurs when the learner focuses on the relevant information and exerts some level of mental effort to think about it. Based on this understanding, they named their framework "Student Content Engagement," or SCE. The researchers present a framework for understanding learning as a process that normally occurs in the student's mind when the required conditions are met.

This meta-analysis is quite extensive and provides an excellent framework for examining teaching and learning, but the authors themselves point out the limitations of this framework. They admit that their model generally leads to learning, but that SCE and learning are not one and the same. So, this framework is incredibly useful in understanding learning, but not on it's own. There must be some flaw or omission in this model if it is not synonymous with learning.

Teachers are employed to do something that results in students learning something. It follows, then, that teachers need to know as much about learning as possible. Until such time as a "perfect" framework for understanding teaching and learning is developed, teachers will have to settle for understanding as many "good" frameworks, such as SCE, as possible. The term "good" implies that various frameworks for understanding learning have both utility and limitations. It is a value judgment that requires a deep understanding of various ways of examining teaching and learning, as well as how those theories do and do not fit together. While a perfect model to understand learning may never be possible, any attempt to understand various incomplete frameworks for examining learning can lead to a better understanding of the big picture we call learning. Please note that the first section is intended to explore each theory independently, with comparisons and analyses in the second section.

Significance of the Project

The handbook on teaching and learning that results from this project contains both theoretical and practical knowledge to help teachers support student learning. It can be used by the researcher as a reference tool and as a refresher on teaching and learning and as a tool to share this information with other educators. In addition, and much more importantly, the process of constructing this handbook required the researcher to delve into the research on teaching and learning and think critically about it. The process of investigating the literature and writing about it in this manner helped prepare the researcher for possible further degree and/or certification programs in the field of education. Thinking deeply about the research on teaching and learning resulted in significant learning on the part of the researcher, and learning about teaching and learning is the goal of this program.

Definition of Terms

COGNITIVE ENGAGEMENT: The extent to which students are mentally processing information on a level much deeper than simple memorization and memory recall as they interact with selected content. Student engagement is a pre-requisite of cognitive engagement. [See STUDENT ENGAGEMENT and PROCESSING]

FLOW THEORY: A model for understanding learning which focuses on student perceptions of their own skill level and the challenge of an activity. Flow is the condition of maximum learning as perceived skill and challenge are balanced at a high level. An imbalance between perceived skill and challenge, or a functional lack of both, result in unfavorable conditions for learning known as apathy, relaxation, and anxiety.

GOAL THEORY: A model for understanding learning that focuses on the reason a student has for attempting to complete an activity. These reasons fall under two categories: mastery orientation and task orientation. [See TASK ORIENTATION and MASTERY ORIENTATION]

MASTERY OREINTATION: The reason to attempt a task is to learn as much as possible and develop skills. The focus is on the process of completing the task, not the outcome of completing the task. Because the focus is on developing skills rather than displaying current skills, current skills level is not a factor in student effort. Both low and high skill level students can learn more through the process of completing the task.

PROCESSING: That which occurs in the mind of a student as they receive, manipulate, store, and recall information. Processing results in the changes to the brain that we call learning.

STUDENT ENGAGEMENT: The extent to which a student is paying attention and/or participating in an activity, including their interest and attention levels. This does not factor in actual or assumed mental processes, but focuses on outwardly observable physical signs that a student is focusing on an activity. Student engagement is a pre-requisite of cognitive engagement. [See COGNITIVE ENGAGEMENT]

TASK ORIENTATION: The reason to attempt a task is to complete it. The focus is on the outcome of the task, not the task itself. This outcome is then used in social comparisons or receives other external validation, such as a grade from a teacher. If an undesirable outcome is expected due to low skills, the student will seek to avoid the task in order to save face and protect their ego. If a desirable outcome is expected due to high skills, the student will attempt to complete the task as quickly and effortlessly as possible to showcase their skills.

TRADITIONAL CLASSROOM: A teacher-centered learning environment where the role of the teacher is to transmit their knowledge to the students. Students are expected to remain physically engaged as they pay attention and memorize information as it is presented. Students are not required or encouraged to process information at deeper level, effectively preventing them from being cognitively engaged. [See COGNITIVE ENGAGEMENT]

Chapter 2: Review of the literature

Modern Theories of learning

Student Content Engagement. McLaughlin's SCE framework (McLaughlin et al., 2005) represents a meta-analysis of decades worth of professional research in psychology and education, but the authors themselves admit that they have failed to establish a causal relationship between student content engagement and learning. Their understanding is that learning occurs when the learner mentally interacts with the selected content knowledge. This occurs when all of the required conditions are met. They divide these conditions into four basic categories: Student Motivation, Occasion for Processing, Physiological Readiness, and Subject Matter Content Level. According to McLaughlin, SCE occurs when all of these conditions are met.

McLaughlin et al. (2005) describe motivation as what causes a student to pay attention and participate in a learning activity. They explain that motivation is directly tied to the student and learning activity at a specific point in time. While students are expected to have a relatively stable level of motivation in regards to education, their level of motivation is influenced by numerous internal and external factors. After alluding to a wealth of research on various motivational theories, the authors settle on a model of understanding motivation that focuses on both reasoning behind motivation as well as outwardly observable signs of attention. This two-part understanding of motivation appears to be based on an understanding certain student perceptions and student engagement. The understanding of student perceptions examines learning in terms of student perceptions of skill and challenge, while student engagement focuses on factors that lead to the student visibly paying attention and participating. As mentioned earlier, the McLaughlin model of motivation includes both the outwardly observable signs of attention, or student engagement, in addition to the reasons a student has to be motivated. This makes the McLaughlin model of motivation valuable and relevant to the goal of understanding the learning process. This model of understanding student motivation is closely aligned with the ideas of Flow Theory and student engagement, both of which are explored in more depth below.

The second McLaughlin category of conditions that must be met for SCE, and ideally learning, is Physiological Readiness. "Category" is a key word here, as they include four different subsections under this heading: Attention, Stress, Disabilities, and Nutrition and Sleep. While there is no easily quotable definition of Physiological Readiness, they describe it as a student's ability to pay attention and perform the cognitive processes required for them to learn, in terms of their physiological state, including the aforementioned sub-categories. While a thorough investigation of each of these factors is not prudent at this time, the stress category is worth mentioning. The authors present a research-based understanding of stress with a moderate stress level as producing maximum performance. This model constitutes the only graphic in their article and fits very closely with Flow Theory. They describe the condition of non-stress as not awake and not alert, while total stress results in panic. This is a very interesting model to understand stress because increased stress is often viewed as inherently negative. According to this model, non-stress results in the same level of performance as total stress.

Subject Matter Content Level is the third condition that must be met in order for SCE, and hopefully learning, to occur. Basically, the difficulty of the knowledge that the student is supposed to acquire must present a reasonable challenge. If the challenge is completely beyond their abilities, learning is unlikely to occur. There is an extensive psychological research base to this construct, from which they express an agreement in the literature that new knowledge can only be learned in the context of what is already known. The authors explain that people learn by attaching new knowledge to what they already know. The major learning theories of Piaget, Vygotsky, and modern neuroscience are briefly mentioned.

One of the most significant things that the authors include in this section is their definition of "knowledge." This is critical because they use the term "knowledge" to describe what it being learned. Many researchers would define knowledge as limited to simple memory recall, the most basic of cognitive processes. However, the authors take a paragraph to explain that "knowledge" in their research refers to all types of knowledge at various cognitive levels. This is a critical component of cognitive engagement theory, which is similar to student content engagement, but places a stronger emphasis on the cognitive processes occurring in the student's mind than on the content itself. Because the teacher is expected to be a content expert, cognitive engagement is a practical framework for examining the implications of this research for improving learning. Cognitive engagement is also very closely related to McLaughlin's final condition for SCE, Occasion for Processing.

McLaughlin describes processing as the ways that the brain gets, uses, keeps, and recalls information. He goes on to identify processing as the cause of changes in the brain that we call learning. If processing causes learning, then it follows that processing is a critical part to understanding the learning process. In addition to defining processing, McLaughlin's description is a perfect explanation of the cognitive engagement theory of learning. However, McLaughlin named the fourth SCE category Occasion for Processing, not Processing. An Occasion for Processing occurs when there are conditions that increase the likelihood of processing, as observable through outwardly observable behaviors. The authors chose this approach because processing is a cognitive process occurring within the student's brain, making it very hard to measure. This is a very practical decision on their part, but it very well may be the reason that their SCE model is not synonymous with learning. In their development of a framework to understand the learning process, they chose to leave out the very process that results in learning.

The Student Content Engagement framework represent a very modern, comprehensive, and research-based framework to explain the learning process. However, the authors admit that their model leads to learning but is not a complete picture of the learning process. One deliberate omission that they make is to focus on the conditions under which processing is likely to occur, rather than the conditions under which it does occur or the processing itself. While their decision is well justified, this may contribute to the difference between SCE and true learning. A deeper understanding of their model and additional research would be needed to confirm or refine the SCE model.

Flow Theory. Flow is a state where a person is deeply focused and committed to completing a task. It is the state where a person is working, or learning, at their fullest potential. According to Shernoff, Csikszentkihalyi, Schneider, and Shernoff (2003), flow is the experience of and individual when their skills are fully utilized to complete a task that their skills are sufficient to complete (p. 160). Flow is achieved when an individual's perception of the challenge of the task at hand and their abilities to complete it are balanced, with both at a high level. When perceived challenge and skills are not balanced or not at a high level, flow is not reached and a person is not working up to their full potential. Three of these situations when flow is not achieved are relaxation, anxiety, and apathy. (Shernoff et al., 2003)

Relaxation occurs when an individual perceives that their skills are far greater than the challenge (Shernoff et al., 2003). Minimal effort is put forth because minimal effort is required to complete the task. A relaxed student is not developing skills because they do not need to do so in order to complete the task. In this situation, increasing the difficulty of the task is usually the best way to reach flow. A harder task will require more effort from the student and require that they develop their skills further in order to complete this harder task.

Anxiety occurs when an individual perceives that their skills are significantly below the level of the challenge (Shernoff et al., 2003). This causes an inner turmoil because the individual feels that they cannot master the task no matter how much effort they put forth. While a student in this state can still develop their skills by attempting to complete the task, they are unlikely to do so because they perceive that the outcome will be failure regardless of their level of effort (Hardré, Crowson, Debacker, & White, 2007). In this situation, it is ideal to increase the student's perception of his or her own abilities. This allows the students to reach flow and maximizes their learning potential. The other option that is often more realistic is to decrease the level of the challenge. Either way, a balance must be found between a student's perception of their skills and the difficulty of the task. However, lowering the difficulty of the task for a student with low skills can lead to apathy.

Apathy occurs when perceived challenge and skill are both either very low or functionally non-existent. An individual feels that they do not have the necessary skills related to completing a task, but is justified in not putting forth effort because there really is not a significant task to complete (Shernoff et. al, 2003). Apathy could even be considered the opposite of flow, because unlike relaxation and anxiety, neither of the required conditions for flow are being met. In this situation, the difficulty of the task must be increased so that the student can put forth effort and has room to improve.

However, the student's perceptions of their own abilities must also be increased so that they feel that they are able to complete the task if they put forth the required effort. Both of these conditions must be met in order to achieve flow, as only increasing either the task difficulty or the perception of skills will result in anxiety or relaxation respectively.

Student engagement. Uekawa, Borman, and Lee (2007) identify student engagement as the general attitudes that students have toward school. "Engaged" students are those who are interested in a particular activity and pay attention to it or participate in it. The level of student engagement that a student displays is therefore assessed in terms of their attention to and interest in a particular class activity. Student engagement could then also be referred to as a student's physical engagement with a classroom activity (Yoon, Ho, & Hedberg, 2005). Student engagement is very similar to SCE, as explored later in the analysis section.

Students who are engaged in a particular learning activity are more likely to put forth the effort required for them to learn something (Walker & Greene, 2009; Duschl, Schweingruber, & Shouse, 2007). There are many different factors that contribute to student engagement, but the specifics are unique to every student in every learning situation. While it is the job of the teacher to make sure that students are engaged and learning (Trigwell et. al, 1999), these factors of student engagement are all centered on student perceptions.

Students are more likely to be engaged when they place some value on the learning activity. In other words, they must feel that they will benefit in some manner from completing a task or mastering some skill. This occurs most often when the student perceives that the teacher's goals for a particular learning activity are aligned with his or her own. This is known as perceived instrumentality (Walker & Greene, 2009). Students quickly become unengaged with a learning activity when they do not perceive some personal benefit in it.

Patall, Cooper, and Wynn (2010) found that student choice in the classroom increases student engagement and academic achievement. They frame their discussion in terms of increasing student motivation, but it fits with our established understanding of student engagement. Their research focused on homework as a specific pedagogical strategy that could be manipulated in order to support perceived student autonomy by giving students a choice among homework assignments on multiple occasions. In line with previous work in self-determination theory, which states that individuals prefer to have some control of their lives and are more invested and engaged when they do, the researchers found that student choice did in fact benefit the students. Academic achievement, as measured by student class grades, was significantly higher among students in the experimental group that were given a choice between two different homework assignments on multiple occasions. The most significant benefit measured was the rate of homework completion. The drawback to this model was that an additional burden was placed on the classroom teachers to develop, distribute, collect and grade twice as many different homework assignments. A possible solution for this problem discussed by the researchers was to have multiple teachers work together and share assignments, possibly through some sort of internet database. To further investigate the link between homework choice and student's perception of autonomy support, students were surveyed before and after the experiment to determine their overall perception of autonomy support from their teacher. Results indicate that students receiving a choice in homework do perceive significantly higher autonomy support. Interestingly, this difference is almost entirely accounted for by the choice in homework assignment. This would indicate that choice of homework increases the likelihood that students will perceive autonomy support in other interactions with their teacher as well.

Student engagement theory focuses on outwardly observable signs that a student is paying attention and participating in class activities. It does not factor in actual cognitive processes, which result in learning. Therefore, student engagement represents an incomplete model for understanding the learning process. However, its relative simplicity makes it an easy tool to help understand precursors to learning.

Goal Theory. The purpose that a student has for attempting to learn is based on the goal that each student sets for himself or herself in completing a task (Hardré et al., 2007). Goal theory holds that the achievement goals which students set for themselves on a particular task strongly impact their effort and engagement (Ames & Archer, 1988). Student goals fall into two basic categories: task performance and task mastery.

Performance goals are often adopted when the student's motivation is external. This is often the case when the student is focused on the outcome of the task such as a grade, praise, or some form of social comparison (Hardré et al., 2007). Performance-goal orientation values a student's ability to outcompete others or complete a task with relatively little effort (Ames & Archer, 1988). Performance goals are based on the outcome of a task rather than the task itself. This performance orientation results in high motivation and cognitive effort among students with high-perceived ability level. These students strive to outcompete each other and look forward to fairing well in terms of social comparison, grades, or other external evaluation of their performance. However, the opposite is true for performance-oriented students with low-perceived ability level. These students are likely to avoid the task because they expect the outcome to be failure regardless of their effort. Student motivation to complete a task is very low when the only value in a task is a successful outcome and the student is expecting failure before they even begin. It is far more likely that the student will avoid a display of their comparatively low abilities (Hardré et al., 2007).

As opposed to performance orientation, mastery goals value the task itself. Mastery-oriented students measure their own achievement in terms of personal growth and learning rather than external evaluation of the outcome (Archer & Ames, 1988; Hardré et al., 2007). Because this orientation values growth rather than current ability, perceived ability does not subdivide students into two groups as it does under the performance orientation.

Archer and Ames (1988) found that student's adoption of mastery- or performance-based achievement goals was based on their perception of the classroom environment. Teachers influence their students' goal orientations through emphasizing one goal system or the other. The researchers found that students who perceive that performance goals are more present in the class environment focused on their own ability, mostly perceiving their ability negatively and attributing failure to a lack of ability. They also found that the students who perceived mastery goals to be more present in the class environment used more effective learning strategies, had a preference for more challenging tasks, and effort is the difference between success and failure. It is worth noting that the population in this study consisted of middle and high school students at only one school. This school consists of students labeled as "academically advanced" based on their ability to score about the 80th percentile on an admissions test. This population was very homogeneous and did not include any students of "average" or "below average" academic abilities.

Hardré, Crowson, Debacker, and White (2007) expanded upon this work and confirmed that Archer and Ames's (1998) findings hold true in more rural and less homogeneous populations. Their rural population of 900 students represented many different racial and ethnic groups and students from all ability levels. They found that achievement goals are a significant predictor for student engagement, with the performance-orientation and low perceived ability subgroup having the lowest level of engagement. Perception of instrumentality, perception of a supportive classroom environment, and perception of ability were all found to interact with achievement goals and be positive predictors of student engagement. It is important to note that data collection consisted of a one-time student survey, even though the factors measured are all subject to significant change over time.

In summary, students approach a learning activity based on their own goal for that activity. These two basic goal orientations are referred to as task-orientation and mastery-orientation. While neither orientation is inherently bad, mastery-orientation is generally preferable because it can facilitate quality learning for all students, regardless of their skills and perceptions of those skills. These students are focused on their own learning and do not seek external validation of their performance. Task-orientation is sufficient for students that feel they have strong skills to complete a learning task, but their motivation is external and they are not focused on the task itself. They are looking to outcompete other students or receive some other external validation of their performance. The very negative aspect of task-orientation is that task-oriented students who feel they have relatively low abilities have no motivation to attempt the learning task. They have already accepted failure as the only possible outcome and see no value in the task itself. These students have every reason to avoid the task in order to avoid failure, negative feedback, and validation of their perception that they have low abilities.

This understanding of the approaches that students take to learning enables a better understanding of the assumptions about learning that underlie other frameworks of how students learn. For example, a researcher whose only data on student learning is a multiple-choice test of factual information reveals that they are task oriented. Identifying this orientation allows us identify an assumption about learning that is fundamental to both that research and that researcher's interpretation of it. It is then possible to reexamine the research from a different goal-orientation perspective.

Cognitive engagement. Waldrip, Fisher, and Doorman (2009) investigated the relationship between student perceptions and cognitively engaging teaching practices from the opposite direction. Their goal was to identify exemplary teachers by assessing student perceptions. They describe exemplary teachers as focusing students on mastery learning, as in mastery goal orientation, by optimizing the learning environment to increase cognitive and affective outcomes. Their description includes elements of goal theory, Flow Theory, student engagement, and cognitive engagement, making it very relevant to the current discussion. Cognitive engagement is the piece missing from the SCE framework, as discussed below in the analysis.

Bruce Waldrip and his fellow researchers (2009) began by administering a survey to students that had previously been developed to assess students' perceptions of their classroom environments. This questionnaire, titled, 'What is Happening in this Class?,' has been validated in secondary classrooms in multiple countries but was shortened from seven scales to five because they were adapting for use with slightly younger students. These five scales were student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. The questionnaire was administered to 3,098 Australian middle school science students from 150 different teachers. Based on student responses to these questionnaires, 25 exemplary science teachers were identified by scores on at least four of the five scales that were at least one standard of deviation above the norm. A subset of students in each of these 25 exemplary classrooms and the 25 principals were then interviewed to confirm that mastery-level teaching was occurring. In describing these follow-up interviews, the researchers write that

> It is apparent from these interviews that these exemplary teachers tried to interest students in the learning process, understood the needs of their students in the learning process, created an environment in which the students wanted to be involved in learning, and had a learning environment with which students were comfortable and which they felt was conducive to their learning. (Waldrip et al., 2009, p. 11)

The researchers are identifying affective factors rather than cognitive processes, but our current focus is the student engagement that is a prerequisite of cognitive engagement. It would have been helpful for the purposes of this discussion if the researchers had observed the actual classroom environments and identified the teacher actions, teacher dispositions, and specific pedagogical practices that set these exemplary teachers apart, but that was not the researcher's goal. Their goal was to confirm that exemplary teachers can be identified through student perceptions as reported on a specific questionnaire, and they accomplished that goal.

The findings of this research are important to this review because they clearly show that the classroom environment established by the teacher affects student perceptions. In addition, the researchers were able to confirm that cognitively engaging teaching practices were present in these classes. Building on previous research indicating that student perceptions strongly influence student engagement (Hardré et al., 2007; Archer & Ames, 1998), we have now established that student perceptions are the link between the class environment established by the teacher and student engagement. In addition, we have established that this occurs when teachers focus on the needs of their students and are able to meet those needs.

In a follow-up experiment to expand upon the findings that student perceptions can be used to identify exemplary teachers, Allen and Frasier (2007) administered the same questionnaire to a different group of 4th and 5th grade science students and a modified version to their parents. Student grades on the science subtest of the Stanford Achievement Test and final science grade averages were also collected to study the correlation between science achievement and exemplary teaching. In addition, student attitudes towards science were assessed using the Attitude to Scientific Inquiry and Enjoyment of Science Lessons scales from the Test of Science Teacher Attitudes, an assessment tool developed and validated in previous research. Interestingly, parent perceptions of the class environment were found to be an even better predictor of student achievement than student perceptions. Also interesting and more relevant to our discussion of student engagement, the students scored very high on the Task Orientation scale. This means that they were very focused on task completion and outcomes rather than the learning process of the task itself. This would be viewed as a negative according to goal theory, unless they were all possessed of higher than average skills to begin with.

Even more interesting and relevant, the researchers themselves develop something of a task-orientation by focusing on student outcomes as opposed to the learning itself. It would have been interesting if the researchers had collected baseline data as the beginning of the year and investigated the correlations of student and parent perceptions to actual learning in a value-added model. They did this in addition to assessing perceptions based on the understanding that mastery, engaging teaching practices are the cause of positive perceptions, but they did put significant emphasis on student outcomes. Because they are not the stakeholders in education that place a significant focus on grades and other outcomes, this research is important because it correlates student perception of the class environment to achievement. This establishes the importance of student perceptions to anyone that might place a higher value on student grades than meaningful learning. If they agree that these perceptions are improved by engaging teaching practices, then we have also established the value of student engagement to those who are task oriented.

Analysis of modern theories of learning

Utility and limitations of the SCE framework. McLaughlin and his fellow researchers (2005) analyzed modern theories of learning to create their SCE framework. However, they chose to leave out the fundamental process that they themselves indentify as the cause of learning. The result of this decision is a “good” model, with both utility and limitations, rather than a “perfect” model of learning. Based on research in cognitive engagement, we know that the final piece of this puzzle is processing. This is an excellent example of how many researchers limit their research to student engagement, which is critical prerequisite of learning, but miss the bigger picture by leaving out the cognitive processing that directly results in learning.

McLaughlin and his fellow authors explain that they decided to leave out processing because it is hard to assess cognition and there is comparatively little quantitative research on it. They chose to focus on student engagement because it is much easier to assess and there is a much larger body of research on it than on cognition and processing. This decision results in a model that gives a complete model of student engagement, making it incredibly useful tool for teachers to understand the pre-requisites of learning. However, student engagement is not the purpose of education.

Teachers are tasked with getting students to learn. So, the utility of the SCE framework is limited because it does not include the final step that results in learning. What teachers need, then, is to ensure that all of the conditions for learning are met and then gets students to cognitively process. Rather than the Occasion for Processing identified by McLaughlin (2005), students need to actually process. In order for learning to occur, both student engagement and cognitive engagement are necessary.

Student engagement and cognitive engagement. Student engagement is a concept very similar to cognitive engagement, but it is important to note the difference between the two. As discussed earlier, student engagement is the student’s attitude toward a learning activity, including their interest level and attention (Uekawa et al., 2007). The level of student engagement that a student displays is therefore assessed in terms of their attention to and interest in a particular class activity. Student engagement could then also be referred to as a student's physical engagement with a classroom activity (Yoon et al., 2005).

Cognitive engagement differs in that it focuses on the level of mental effort and type of mental processes occurring within the student's mind. Kong and Hoare (2011) use the term "cognitive content engagement" and describe it as the deep mental processing of a student as they engage with reasonably difficult content through activities which encourage that depth of processing (p. 309). Here, the focus in on mental processes, as opposed to student engagement, which focuses only on physical participation in an activity.

To further complicate the discussion of student engagement and cognitive engagement, not all educators agree upon the definitions of these terms. Walker and Greene (2009) use the terms interchangeably. They begin with the term "cognitive engagement" in their title but then use "student engagement" in their review of the research and research questions. They fail to clearly define either term or the relationship between them. Student and cognitive engagement are difficult to examine in the literature because not all educators agree about them.

To expand upon this idea, consider a student listening to a lecture. The lecture consists of the teacher presenting factual information and explanations to students in some manner. If the student is sitting attentively and focusing on the lecture, they would be considered to display at least moderate student engagement. They are physically attentive to the activity and focusing their attention on it. They are doing exactly what the teacher expects of them, which is to sit passively and receive the factual information being presented to them. However, the same cannot be said of their cognitive engagement.

Because cognitive engagement is dependent upon active cognitive processes within the student's mind, the student is most likely not cognitively engaged at a high level. While they are physically and mentally focused on the activity, they are most likely not processing the information at a challenging cognitive level. However, it is possible that the student is focusing on some deeper meaning, like relating the information to what they already know or forming opinions of the information presented. However, this is not what the teacher is expecting them to do so this deeper processing at a higher cognitive level would be highly unlikely. In summary, student engagement does not always cause cognitive engagement.

While student engagement does not always cause cognitive engagement, a lack of student engagement does strongly imply a lack of cognitive engagement. It is highly improbable that a student who does not display physical signs of engagement is cognitively engaged. For example, a student who is ignoring a class activity and not participating (lack of student engagement) would not be thinking deeply about the material (lack of cognitive engagement). Student engagement is therefore important to a discussion of cognitive engagement because it is a precursor to it. As a child must learn to walk before they run, a student must be physically engaged before they are cognitively engaged.

Goal theory and cognitive engagement. Walker and Greene (2009) are the researchers who use "student engagement" and "cognitive engagement" interchangeably, but their actual research investigates links among student perceptions, student goal orientations, and what we earlier defined as cognitive engagement. Specifically, they investigated the relations among student perceptions of the classroom achievement goals, self-efficacy, perceived instrumentality of the learning activities, and sense of belonging. They then investigated how each of these factors relates to adoption of achievement goals and engagement. Citing earlier work, they explain the link between achievement goals and student learning as

> Mastery goals have often been linked to positive academic behaviors such as effort and persistence while studying, the adoption of self-regulated learning strategies, willingness to seek help, the use of meaningful cognitive processing strategies, long-term retention, and intrinsic motivation. (p. 465)

Here they are linking adoption of mastery goals to what we earlier defined as cognitive engagement. In a study of self-reports from 249 high school students from 3 locations across the midwestern United States, they found that student sense of belonging, self-efficacy, and perceived instrumentality were predictive of mastery-goal orientation. Based on the link they made between adoption of mastery goals and what seems to be cognitive engagement, one would then expect the same factors to predict cognitive engagement. The results indicate two of the same factors predict cognitive engagement, but that self-efficacy did not. This does support the link between adoption of mastery goals and cognitive engagement, but also indicates that they are not one and the same. In addition, statistical analysis confirmed that adoption of mastery learning goals was not a predictor of cognitive engagement. In interpreting this research, it is important to note that the researchers never clearly defined cognitive engagement and only explained that it was measured using student responses to a survey. Without understanding what was being measured, it is hard to interpret the results in a meaningful way. However, it is clear that a variety of factors based on student perceptions contribute to adoption of mastery goals and what the researcher referred to as cognitive engagement. It is also clear that adoption of mastery goals and high levels of cognitive engagement are correlated, but there is not a causal relationship.

A "good" model of the learning process. As stated earlier, learning results when students are cognitively engaged with the content (McLaughlin et al., 2005). This means that they are actively processing information at a level beyond simple memorization and recall. An underlying assumption is that students are first physically engaged, with all conditions for student engagement being met. There are many factors and pieces of student engagement that are best understood through McLaughlin's SCE framework (2005). Not surprisingly, students learn the best when they are focused on their own learning rather than external validation of their ability to complete a task. Their learning potential is highest when they have a challenging task that is within their abilities to complete, but only if they push themselves.

We now have the closest thing to a "perfect" model for understanding the learning process as possible, constructed from a number of other "good" models, as we currently can. We have focused on students and their learning, but none of this research is really intended for use directly by students. Rather, it is intended for teachers to help their students learn. Teachers are the link between the latest educational research and actual student learning. However, this is not always the case. Sadly, many teachers still present information to students in a way that does not require or encourage cognitive engagement Trigwell et al., 1999; Yoon, Ho & Hedberg, 2005; Geelan et al., 2004). Many teachers do not cognitively engage their students, and as a result, their students do not learn very much.

Implications for improving learning

Roll of the cognitively engaging teacher. In contrast to a traditional classroom setting, the role of the teacher must change in a cognitively engaging classroom (Trigwell et al., 1999). The teacher must help and guide the student to build their own knowledge through active processes, not act as the sole source of information and do all the work to impart their knowledge to the student. In the words of Yoon, Ho, and Hedberg (2005), the teacher's role must change from "presenter" to "designer of the learning environment." Keith Trigwell and his fellow researchers (1999) referred to this traditional model as "information transmission" that results in a "surface approach to learning," and the cognitively engaging model as "more oriented towards student learning and to changing the students conceptions" that result in "a deeper approach to learning" (Trigwell et al., 1999, p. 57). David Geelan and his fellow researchers (2004) referred to the traditional model as, "Teaching for the examination," and the cognitively engaging model as, "teaching for understanding"(p. 447). While different researchers use different terminology, there is a general consensus that teachers should focus on what the students are doing, rather than what they are doing as teachers, and that meaningful learning is an active process. There is also a consensus that the teacher has a very significant effect on the approach that students take to learning (Ames & Archer, 1998; Geelan et al., 2004;

Yoon et al., 2005; Hardre et al., 2007; Rita & Martin-Dunlop, 2011; Shernoff et al., 2003; Trigwell et al., 1999).

Yoon, Ho, and Hedberg (2005) confirmed a model to explain student engagement as the effective combination of a learning task, the appropriate level of teacher support, and useful materials. It is the teacher's job to select and provide these elements and create a cognitively engaging learning environment. Both this model and a more traditional model agree that it is the teacher's job to select and provide appropriate materials. While this cognitively engaging model relies on the teacher to provide the amount of support needed to ensure that students are both challenged and successful, the traditional model expects the teacher to provide complete support and do the work for the students. The other critical difference in this model is the idea that the teacher must select appropriate learning tasks (Yoon et al., 2005). The more traditional model assumes that lecture is the most effective way to transfer knowledge from the teacher to the student so there is not a need to select among possible tasks or methods of instruction.

In the traditional classroom setting it is the job of the teacher to do the talking and thinking. If we assume that the teacher is a professional and can suppress personal attitudes and values and exert maximum effort on a regular basis, then these factors should not affect student learning. In the modern and cognitively engaging classroom, we shift our focus away from the teacher and on to the students. We must then acknowledge that our students are not professionals and that their personal attitudes and beliefs are important factors in their level of cognitive engagement and in their learning (Duschl et al., 2007). For example, a student who has always felt successful in science classes and earned high grades is more likely to work hard on a challenging science task than a student who regularly fails science assignments and has never felt successful in science. They are far more likely to experience frustration and give up on the task at the first sign of challenge. In addition, a student that does not value the goal of a learning task is far less likely to put forth mental effort and be cognitively engaged (Duschl et al., 2007). One of the many ways in which a teacher can encourage students to value learning a particular content is to promote more than just a basic level of understanding (Trigwell et al., 1999).

Geelan, Wildy, and Wallace (2004) hypothesized that the traditional model, or, "teaching for the examination," is not always inferior to the more cognitively engaging model, or, "teaching for understanding"(p. 447). While their work should only be considered preliminary, they argue that their findings support the notion that a more teacher-centered, traditional approach can facilitate student learning that results in students achieving high scores on a high-stakes examination. These researchers compared teaching style to student achievement as the basis of their research. However, the researcher themselves admit that high achievement scores on these examinations may indicate high levels of memorization rather than student understanding of the content on a deeper level.

The authors defend that a deeper level of understanding was observed and recorded during videotaped lessons. Their example involves a student explaining the physics at work during a hands-on activity conducted by his classmates. Based on this example, it seems that the teacher utilized pedagogical techniques that some would consider cognitively engaging. In addition, the researchers report that the tests are not designed to assess students on any deeper level that knowledge and memory recall. So, what Geelan and his colleagues really showed was that mixed pedagogical practices can be as effective at helping students pass a memory-recall test as more cognitively engaging practices. While they do not go into great detail, the authors do conclude that their findings to do not indicate that a teacher-centered, shallow approach to learning should be adopted rather than teaching for deeper understanding.

Learning activities that support cognitive engagement

Learning results from a student interacting with the intended material and processing it at some level (McLaughlin et al., 2005). It is important to note that the focus is on the student, not the teacher, and that two verbs are associated with the student. This means that learning is an active process of a student. Because traditional lecture-based and teacher-centered instruction are contrary to this basic definition of learning, it is important to identify what makes certain classroom activities more supportive of cognitive engagement, and therefore learning, as well as identify specific examples of pedagogical practices that support cognitive engagement.

There is a general consensus that active learning is more effective than passive reception of information (Yoon et al., 2005; Shernoff et al., 2003; Uekawa et al., 2007; Trigwell et al., 1999). Geenlan and his fellow researchers state that this is not necessarily the case, but their argument is suspect upon further review and they appear to contradict themselves within their own article. To understand how passive learning compares to active learning in terms of cognitive engagement, it is valuable to examine this concept directly.

Uekawa, Borman, and Lee (2007) investigated how classroom activities affect students' perceptions of the class as well as their engagement. While they use the term "student engagement," this included measurements of both student attention and cognitive processes. Because of the inclusion of cognitive processing, it would seem that they are actually measuring what we have already established as cognitive engagement. What Uekawa and his colleagues referred to as student engagement will therefore be referred to as cognitive engagement for the purposes of this review. They also investigated the intervening role of race and ethnicity on the cognitive engagement that results from certain types of classroom activities. The participants in this study were 345 students from three different cities in the Unites States, each student being observed an average of 6.8 times. The participants were a subset of a larger study of the impact of the National Science Foundation's Urban Systemic, so the sample was one of convenience. The students completed short surveys designed to assess cognitive engagement, student affect, and class activity at random times throughout the class period.

As indicated in Figure 1, the results indicate that the type of class activity does in fact affect how students respond to the class content and interact with each other. Classroom conversation and level of drowsiness were found to mediate the relationship between activities and engagement levels. Specifically, lecture was found to encourage student socialization on non-content topics and increase drowsiness in comparison to group work. This finding strongly indicates that group work encourages higher levels of cognitive engagement than lecture.

The results were not the same among ethnic and racial groups when comparing cognitive engagement during lecture and independent work. For example, Asian students were found to report much higher levels of cognitive engagement during individual work than lecture, but Hispanics in one city actually preferred lecture to independent work.

Levels of cognitive engagement under these conditions were much more sensitive to race and ethnicity.

Comparative levels of cognitive engagement during group activities and independent work were also sensitive to race and ethnicity, but nearly as much as when comparing independent work to lecture. In general, students reported significantly higher levels of cognitive engagement during group work. However, Asian students reported higher levels during independent work and students who identified as Black reported equal levels during group work and independent tasks.

The important findings to take away from this are that group work fosters higher levels of cognitive engagement than lecture and that independent tasks foster higher or equal levels of cognitive engagement among non-Asian students. The implications for teachers when selecting cognitively engaging learning activities is that group activities are preferable to lecture, with independent work generally coming in second dependent upon student race and ethnicity. If nothing else, group work is more cognitively engaging than lecture.

Conclusion

While it is the job of every teacher to help students learn, no "perfect" model has yet been developed so that they can fully understand the learning process. Instead, many "good" models exist which help teachers understand certain aspects of the learning process. For example, McLaughlin's SCE framework (McLaughlin et al., 2005) incorporates many other theories including student engagement, achievement goal orientation, and Flow Theory, but does not include the actual cognitive engagement that leads to learning. Teachers can then better understand the learning process through a combined understanding of both SCE and cognitive engagement than through either model alone. It follows, then that knowledge of even more models of understanding learning can lead to an ever-improving understanding of the learning process which is invaluable to anyone tasked with helping students learn.

Chapter 3: Landmark learning theories and practical implications from the research

Introduction. The project began with a thorough investigation of the most modern, evidence-based theories on learning in the hopes of uncovering a perfect, ideal framework for understanding the learning process. While this was well intended, it quickly became apparent that there is no "perfect" model or framework for understanding teaching and learning. The emerging trend was that there are many "good" models for understanding teaching and learning, each with strengths and weaknesses. It appears that the best way to really understand the process of learning is to thoroughly understand as many "good" models as possible. This is the understanding that drove the rest of the project.

This product contains both the theoretical and practical knowledge of available educational research to help teachers support student learning. It also provides evidence of a thorough investigation and deep understanding of the most salient research on teaching and learning that is currently available to the researcher. Additionally, it may serve as a resource for current and future educators.

Constructivism. Many American teachers are required to incorporate cognitive constructivist teaching practices into their lessons. It is often referred to as the best available method of teaching and learning (Powell and Kalina, 2001). However, many teachers are not fully versed in constructivist learning theory. The two most prominent constructivist, learning theories are Piaget's cognitive constructivism and Vygotsky's social constructivism.

Cognitive Constructivism. Jean Piaget first described cognitive constructivism in 1953(Piaget, 1953). However, he was not a teacher and his research was not done in a classroom. Rather, he was a developmental psychologist who developed his theories based primarily on observations of and interactions with his own children. His book, Origins of Intelligence in Children, consists mainly of the author stating his interpretation of a particular aspect of cognitive development and an example of his own observations to illustrate each point. Piaget's methods might not be considered very rigorous by modern standards for scientific research, but his concept of cognitive constructivism is an integral part of our modern understanding of the learning process.

Piaget describes intelligence, the result of learning, as mankind's ultimate adaptation to our environment. This comparison of intelligence to the biological process of adaptation is not a metaphor, but an actual explanation of intelligence. He explains intelligence from the viewpoint of a biologist, which may be confusing to some educators, but is a positive for educators with a background in the biological sciences.

Piaget begins by explaining that part of intelligence is hereditary. Humans are born with a nervous system and sensory organs that they inherit from their parents. While each brain is unique, there are certain distinctions that set all human brains apart from other types of brains, such as those of monkeys. However, it is the physical structure and a predisposition for the brain to function in certain ways that is inherited, rather than intelligence itself.

This mind that results from hereditary intelligence, or predisposition to think in certain ways is then exposed to experiences through our sensory organs. Actual intelligence is the result of this mind trying to make sense of experiences, which Piaget calls "adaptation." To do this, the mind must use mental structures in which to organize information as it builds knowledge (p.1-5).

At first glance, a modern biologist many disagree with Piaget's use of the word adaptation. Currently, biologists use this word to describe how a species evolves through natural selection in order to increase reproductive fitness and survival. In other words, adaptation is a process of change that cannot occur within a single individual. When Piaget uses the word, he is referring to a process that constantly happens within a single individual. While Piaget can be said to be using the word differently, he cannot be said to use the term incorrectly because he clearly defines how he uses the term.

Biological organisms need internal structure to survive and prosper. Therefore, so must the mind. Piaget calls these mental structures that hold information in the mind "schemas"(Piaget, p.6). As an individual has new experiences, their mind adapts to incorporate each new experience in one of two ways: assimilation or accommodation. Assimilation occurs when the mind can fit the knowledge from a new experience into its existing schema. In other words, the knowledge can be added to the schema without altering anything that is already there.

In response to many new situations, the mind is not able to assimilate new knowledge because it conflicts with existing schema. Therefore, the existing schema must be modified in order to adapt. Piaget named this process is called "accommodation" (p. 6). Understanding this state of conflict, or disequilibrium, between the existing schema and what a student is experiencing and how students resolve it through adaptation provides educators with a powerful tool for correcting student's incorrect knowledge. Practical applications of this theory will be explored later in the project. [See "Constructive Controversy" and "Discrepant Teaching Events"]

There are some important assumptions behind cognitive constructivism. Cognitive constructivists theorize that learning, or adaptation, is a process that occurs within an individual as they seek to build their own understanding of experiences and attempt to fit them in with their existing knowledge structure. The first assumption is that learning is an active process within the student, rather than something that the teacher does to the student. This has significant implications for teachers because the role of the teacher is to help students add to their existing schemas through assimilation and as they challenge and modify their schemas through accommodation. This is a very different mindset for a teacher if they are accustomed to thinking in terms of their actions that result in student memorization.

The individuality of learning is another critical part of cognitive constructivism. If each individual builds their own meaning based on their experiences, then each individual is unique. Additionally, students may be constructing completely different meaning, even when they are having the same experience. Based on their existing schemas, it is even probable that one student may need to build meaning though accommodation while another student is learning through assimilation. Again, this has significant implications for teachers. It means that every learner is unique and a one-size-fits-all approach to teaching will almost never result in the desired learning by all students. In addition, a teacher will not be able to effectively help students adapt to new experiences until they understand each learner's existing schemas.

Social constructivism. Social constructivism was first described by Lev Vygotsky (1963) in response to Piaget's work (1952) in cognitive constructivism. Please note that while Vygotsky's work was first published in English 1963, it was written in 1953. Vygotsky largely agreed with Piaget, but argued that social interaction and collaboration are crucial to how students build meaning. This social interaction is in addition to the internal adaptation process that forms the basis of cognitive constructivism, not instead of it. It is fortunate to the purpose of this project; specifically understanding various theories of learning and how they fit together, that Vygotsky directly addresses Piaget's theories in his own writing. Vygotsky clearly explains what he feels are Piaget's shortcomings, how his own research corrects those misunderstandings, and furthermore how his own theoretical framework builds upon the corrected original with concepts like inner speech, concept development, scientific concepts, and zone of proximal development. In addition, and very relevant to this project, Vygotsky explains the instructional implications of social constructivism.

Vygotsky believed that the study of the development of thought and language must be one and the same because they are so interconnected. He explains that Piaget believes that child thought and language use are typically egocentric. In other words, they use language for verbal communication, but it is not intended to communicate with others. Rather, they are using speech in an attempt to further their own mental processes. In the modern vernacular, this process is known as "thinking out loud." It is also called non-directed speech, as verbal language is being used, but it is not directed at an external source. Vygotsky agrees with Piaget on egocentric thought and language in young children, but disagrees with him about what happens to it as the child develops.

Vygotsky explains that Piaget believes that this egocentric speech is replaced by directed speech, or speech directed towards something external, as the individual attempts to interact with and influence the world around them. Basically, that egocentric language usage is eliminated. Vygotsky identifies this point as the fundamental difference between his theory of development and Piaget's. Vygotsky believes that non-directed speech is not eliminated, but rather becomes internalized. He calls this "inner speech." This inner speech then becomes one of the primary means through which an individual processes information internally. Communicative speech is then developed to serve a more social purpose. Specifically, communicating with other people. This process is in addition to egocentric language usage, which evolves into inner speech, rather than instead of it. Vygotsky theorizes that Piaget arrived at these incorrect conclusions because his research was focused primarily on individual play. Because of this, he thinks that Piaget's conclusions can be generalized only to children in solitary environments. In other words, Piaget's theory is incomplete because he minimized the social aspect of development of both thought and language.

According to Vygotsky, thought and language are like two partially overlapping circles. While both processes can happen independently from the other, the result is not developmentally productive. For example, recitation is speech without thought. An individual can recite a poem, using speech, without actually understanding it. This recitation does not result in development. The overlap of thought and language, known as "verbal thought," is where processes occur which lead to the development of both processes. This verbal thought includes both inner speech and outward communicative speech.

Vygotsky explains that concepts are formed in the mind and represented there by a word or symbol. The notion that concepts are represented in the mind by words is another illustration of the connection between thought and language. Because the use of a word does not impart a perfect and complete understanding of a concept, a concept develops as an individual develops the specific way in which they use a word. Again, note the connection between thought and language.

The instructional implications of word knowledge as the beginning of developing a concept, rather than the end of it, are significant. If word knowledge is only the beginning of learning about a concept, then educators must help students to develop concepts beyond just memorizing a definition. This basic assumption begins to prescribe a certain set of epistemological belief about the very purpose of learning.

Vygotsky differentiates among different types of concepts that an individual can know and develop. Specifically, there are concepts that individuals will develop on their own without prompting and are unique to each individual because they are so inherently practical, such as how to walk, and those that are a bit less practical in value and usually require prompting to develop. This second type of concepts, which focuses on correct information about how the world works, is of more interest to secondary educators. Vygotsky calls these concepts "scientific concepts." Again, the development of each of these scientific concepts starts with a word to represent it in the mind and continues as the individual develops the way in which they use that word. A second a very critical component of scientific concepts is that each concept includes relations to other scientific concepts. This theory of developing scientific concepts organized in the mind based on how they relate to each other seems to agree with Piaget's schema theory. While each researcher focuses on different aspects of how schema is developed, the basic principle seems to be something they agree upon.

The final concept from Vygotsky's work, which will be discussed here because of its relevance and salient instructional implications, is the Zone of Proximal Development, or ZOPD. However, we must first explore the role of the teacher in the process of concept development. Leading up to the ZOPD is where Vygotsky explores the role of the teacher and the classroom and there is no reason why that patter should not be mirrored here. Remember, Piaget viewed concept development and learning as an almost completely individual and internal process. This minimizes the role of the teacher and other students in the classroom. The role of the teacher in Piaget's model is simply to provide the students with new experiences which they then construct meaning from. Vygotsky's model is fundamentally and radically different because of the roles which language and social interaction play.

According to Vygotsky, concept development, or learning, is an internal process that can be very strongly influenced. Specifically, through social interaction and communication, an individual can be exposed to other persons' understanding of a concept that they are developing. The individual can then compare other understandings with their own understanding and chose to accommodate or assimilate. Under this assumption, we can quickly understand the role of the teacher.

Hopefully, the teacher has a more completely developed understanding of any particular scientific concept that they are trying to help a student learn. Through the use of language, they can communicate this to the student. Rather than having to develop every concept understanding from scratch and completely independently, a student can very quickly be exposed to a more developed concept understanding. This also helps us understand the role of interaction with peers. While a particular peer may or may not have a more developed understanding of a particular concept, it provides another viewpoint to consider. Additionally, a peer is at a more similar developmental level than the teacher and is likely basing their concept understanding on very similar experiences. So, while peer interaction may not expose a student to as developed an understanding of a particular concept as interacting with the teacher, it may provide them with a more accessible understanding that is easier to assimilate or accommodate.

The fact that teachers can greatly speed up concept development, or learning, by communicating their own understanding of a concept is not a prescription for lecture. This is because the communication in not completely effective and the teacher's mind is not identical to the student's. In other words, both language and developmental level play a role in the learning process.

Language is not completely effective at transferring concept understandings. Each individual has unique language skills, based both on their hereditary predisposition for language usage and how experience with language has shaped their skills. Because of this, both the teacher and the student have different language skills and both transmission and reception of a concept understanding are imperfect. Additionally, the teacher and student are at different developmental levels. Simply put, a student may not be mentally able to understand a concept in the same manner as their teacher. However, the assistance of a teacher can help them understand a concept in a more fully developed manner that they would be able to independently. This more fully developed understanding that a student may develop through communication with a teacher is known as the ZOPD.

The ZOPD is not the same as the student's actual developmental level. Rather, it is more advanced because of collaboration with a teacher and/or peers. It is an every-changing ability level, or zone, which is unique to each individual at any given point in time. Vygotsky gives the example that a farmer must consider all of the developing trees in his orchard when evaluating it, not jus the fruit it has already produced. In other words, it is what a student will be able to do, not just what they are already able to do. However, Vygotsky also cautions that in order to develop, there must be a reasonable possibility that an individual can learn to do what they cannot currently do.

Vygotsky explains that instruction must be based on tomorrow's instruction, not on yesterday's. Cognitive constructivist learning theory never directly addressed the implications on instructional design, but probably would have focused on designing today's instruction based on students' current levels than on predicting future developmental levels. According to Vygotsky, the role of the teacher is to further development, not just train students based on their current level. He compares instruction based on current developmental level to the training of animals. Once the influence of instruction on development is realized, that instruction is no longer useful.

A further implication of the ZOPD is that not all students will benefit from the same instruction. If instruction is designed to teach students something which there is no possibility of them learning, development will not occur because instruction is exceeding their ZOPD. At the same time, instruction based on a student's current developmental level will also not result in development because no further development is needed to meet the instructional goals. To complicate things further, each student has a unique ZOPD related to all aspects of instruction at any given point in time. It is improbable that students' ZOPDs will always overlap such that one instructional practice will result in learning for all students. However, the teacher influences ZOPD, so the teacher may be able to adjust ZOPDs to some extent simply by adjusting how much assistance each student receives. For example, a teacher can theoretically provide additional assistance to a weaker student with a lower ZOPD, thereby raising the student's ZOPD so that they might benefit from a particular instructional practice. At the same time, that teacher might provide less assistance to a very strong student, thereby making the task relatively harder for that student and providing an opportunity for the student to develop. However, "providing assistance" may be an oversimplification.

To provide the appropriate assistance, a teacher must first have an intimate understanding of each and every student's ZOPD, each of which is ever changing and unique to every instructional situation. Additionally, there are an infinite number of factors that determine ZOPD which may be beyond the teacher's reasonably ability to be aware of. For example, coming down with a cold may lower a student's ZOPD while extra confidence born from winning last night's polo game might raise it. To make things more impossible, Vygotsky states that instruction must be based on tomorrow's instruction. So, the teacher must be able to accurately predict tomorrow's ZOPD as well as being able to accurately assess today's ZOPD, then implement the ideal instructional practice for each learner and adjust the level of assistance provided to each student as they teach. Social constructivism makes teaching sound far more complicated and difficult than simply providing experiences for students to construct mean from, as in cognitive constructivism.

Analysis of Constructivist Learning Theories. Both Piaget and Vygotsky provide "good" frameworks for understanding the process of teaching and learning. While Vygotsky's work builds upon Piaget's and seeks to correct what he sees as the flaws in cognitive constructivist learning theory, the fact that Piaget's model is much simpler is also one of its strengths. Because it is simpler, it may be of even more utility in some ways because it is easier to understand. Cognitive constructivism provides basis of understanding learning as an active, individual process where an individual constructs his or her own meaning from experiences. It also provides us with schema theory, where individuals organize knowledge into a framework. Individuals learn by assimilating new knowledge into their existing framework when information in simply new, and must resolve an inner conflict when their new experiences conflict with their existing schema. While all of this describes cognitive constructivism, it also describes social constructivism. Because Piaget minimizes the role of social interaction and language in his model, it is easier to understand.

Vygotsky's social constructivism is the more complete model, but also the more complicated and difficult to understand model. Vygotsky plays up the role of both internal and external language. Externally, a teacher or peer can communicate their understanding of a concept directly to a student. While this communication is not perfect for a variety of reasons, it can lead a student to develop their own understanding far more quickly than on their own. Internally, language skills are critical because each concept is represented in the mind by a student's understanding of a particular word. Language skills also form the basis of a student's ability to internally process information using their inner voice. This focus on the use of language not only provides a far more complete understanding for teachers, it also defines the role of the teacher.

Unless a teacher completely rejects social constructivism, the concept of Zone of Proximal Development must play a central role in their professional life. It defines the difference between how a teacher trains their students, and what it means to really teach them and further their development. However, an astute observer may also realize that specific or ideal instructional practices are not mentioned, but only the intent of them and the learning that results from them. This means that Piaget's and Vygotsky's constructivist learning theories are of significant theoretical value but limited practical value. However, much of the practical work in modern education is based on constructivist learning theory. It would then seems appropriate to explore this more recent work, of higher practical value to educators, now that, an understanding of constructivism has been established.

Metacognition and self-regulated learners. Metacognitive learning theory builds on earlier social constructivist earning theory(Belet and Guven, 2011). According to Vygotsky(1962), teaching and learning is what drives development. Hopefully, people do not stop learning and developing when they exit the formal educational setting and no longer have a teacher. Developing lifelong self-regulated learners is a commonly accepted educational goal (Pihlainen-Bednarik and Keinonen, 2010). Without a formal teacher, an individual would then need to know how to direct his or her own learning in order to continue developing. While social constructivist learning theory does not elucidate a mechanism through which an individual can regulate his or her own learning, this is exactly what metacognitive learning theory does.

Defined most simply, metacognition is thinking about thinking and the monitoring and regulation of thinking (Pryulta, 2012). According to Pihlainen-Bednarik and Keinonen (2010), metacognition is a critical part of the learning process which includes students' thinking about 'what do I know?' and 'how do I learn?' In other words, metacognition is students being aware of the learning process. As students develop their metacognitive knowledge and skills, they are able to direct their own learning more and more. In other words, students learn to teach themselves or "self-regulate" their own learning. As students become more aware of their own thinking and learning processes, they become better learners (Prytula, 2012). In other words, improvement in students' metacognition results in improvements in students' learning (Pihlainen-Bednarik and Keinonen).

Experienced and inexperienced teachers. Doganay and Ozturk (2011) confirmed that the use of metacognitive teaching strategies is an important differences between inexperienced and experienced teachers. The researchers do not provide their exact definition of an "experienced teacher," but they do explain that experience is the result of accumulated knowledge as well as experience. In other words, it includes increased knowledge in addition to practice. While they did not explicitly state it, there research also seems to assume that experienced teachers are more effective than inexperienced teachers.

The researchers conducted a comparative study of seven inexperienced teachers, with 2 months to 1.5 years of practice, to seven experienced teachers, each with 20-25 years of practice. Data on teacher use of metacognitive teaching strategies, or teaching which is designed to help students regulate their own learning, included 90 hours of observation and teacher interviews using a previously validated tool to assess the teachers' awareness of metacognition, the Cognitive Awareness Skills Evaluation Form.

Doganay and Ozturk found that experienced teachers are both more aware of metacognition and incorporate it into all aspects of the teaching and learning process to a greater extent. Experienced teachers focus on engaging, student-centered activities that promote student thinking and focus their feedback on developing student thinking. Because they are less aware of metacognition, inexperienced teachers utilize teacher-centered activities that do not promote student thinking. Because the class activities focus on content rather than learning, teacher feedback is also focused on content. Additionally, inexperienced teachers are unable to address learning problems because they are not observing student learning. So, experienced teachers are able to identify when and how a student is having trouble learning and help them fix the problem so that they can learn the correct content on their own. On the other hand, inexperienced teachers can identify that a student has not learned particular content, but cannot identify the learning problem or help the student fix it.

These findings have significant implications in the field of education. First, knowledge of metacognition is a key difference that separates experienced and inexperienced teachers. If new teachers lack years of practice, by their very definition, then teacher training programs and professional development for new teachers should focus on developing awareness of metacognition and metacognitive teaching strategies. Additionally, it helps identify what separates a truly experienced teacher from a teacher with many years of practice who is still teaching in an inexperienced manner. Professional development for inexperienced teachers with many years of practices would then need to have a similar focus on awareness of metacognition and metacognitive teaching strategies.

Metacognitive strategy use and episimological beliefs. Doganay and Ozturk (2011) identified the use of metacognitive teaching strategies as a feature which separates experienced teachers from inexperienced teachers, defining experience as a combination of many years of teaching practice and a social constructivist learning environment. In their model, teaching practice usually results in a move to a more social constructivist educational model, which in turn increases the teacher's awareness of metacognition. While their work has significant implication for education, it presents a model for understanding teaching and learning which is far from complete.

Bilet and Guven (2011) greatly expand upon this theoretical understanding through their investigation of the relationships between teacher epistemological beliefs and use of metacognitive teaching strategies. "Epistemological beliefs" is another term whose exact meaning is not agreed upon by all researchers, but it can generally be understood as the nature of knowledge. More specifically, epistemological beliefs are individuals' varying beliefs and perspectives about what can be known, what defines information, and how it can be known. For example, social constructivism represents a certain set of epistemological beliefs, while lecturing for content memorization and recall represents a very different set of epistemological beliefs. Developing epistemological beliefs would be a likely mediating factor between years of practice and experienced teaching, as in Doganay and Ozturk (2011), so they provide an important part of understanding metacognition and the teaching and learning process.

Bilet and Guven (2011) sampled 812 pre-service teacher trainees in Turkey, collecting personal and academic information as well as administering two previously developed and validated assessment tools. The first assessment determined students' beliefs about learning and the nature of knowledge, while the second determined their use of metacognitive strategies. Statistical analysis was then used to determine correlations among various factors. While the findings are too numerous to discus here in detail, results did indicate that pre-service teachers, who Doganay and Ozturk (2011) would label as "inexperienced," did indeed have relatively immature and undeveloped epistemological beliefs regarding the nature of knowledge and the nature of learning. The authors discuss how maturing epistemological beliefs lead teachers to adopt more social constructivist teaching practices, but it is a little hard to follow because they do not define immature or mature epistemological beliefs for any of their three factors, nor do they include the epistemological belief assessment tool. The final relevant finding to the current discussion is that there was a strong correlation between years of pre-service teacher training and maturity of epistemological beliefs, of which the implications will be discussed below.

These findings help us understand why years of teaching practice generally correlate with the use of social constructivist teaching practices, but even more importantly it helps us understand why that is not always the case. To be exact, not all teachers with many years of practice employ social constructivism or metacognitive strategies, while many new teachers do. This occurs because epistemological beliefs can rapidly develop and mature throughout a teacher-training program, while some practicing teachers do not develop their epistemological beliefs on their own, despite many years of teaching practice. These findings provide a very useful understanding of the role of metacognition in the teaching and learning process.

Research-based instructional practices. To this point, this project has focused on educational research that is mainly theoretical. The types of activities that should be occurring and the types of cognitive processes students should be utilizing have been established, but no specific instructional practices have been explored. The focus will not shift to the practical educational research that has developed from these landmark-learning theories such as cognitive engagement and constructivism.

Discrepant teaching events. Discrepant events are a type of demonstration performed by the teacher, most often a science teacher, in which students watch and observe unexpected results (Longfield, 2009). These discrepant events are designed to not only help students learn something new, but to unlearn something incorrect and replace it with something correct at the same time. This is identical to Piaget's concept of accommodation, or modifying an existing knowledge structure when a new experience conflicts with the current one (Piaget, 1952). While discrepant events fit with many of the tenets of cognitive constructivist theory, the fact that they are performed by the teacher while the students passively observe conflicts with the very essence of constructivist learning. To improve upon discrepant teaching events, Longfield describes an instructional practice he calls, "discrepant teaching events."

Like discrepant events, discrepant teaching events are an instructional practice that results in a planned, unexpected outcome. The difference is that students are actively involved in the event and experience it first hand. The move to a more student-centered learning activity, with students participating and experiencing rather than passively observing, is constructivist in nature. In addition, it is not specific to the science classroom. Longfield gives an example from his own classroom in which he gave students fictitious quiz grades and had them work in small groups to determine weather the grades should be curved according to the mean, median, or mode. This activity was designed to combat the incorrect knowledge that statistics cannot be used to influence the interpretation of data. Students quickly discovered that their own individual grades would be different depending on which measure of central tendency was used to develop the class curve and began promoting the curve which result in the highest grade for themselves. Once students were actively using statistics in an attempt to encourage separate, specific interpretations of same data, the students quickly began a discussion of the very misconception that the teacher wanted them to challenge. The teacher created a student experience that resulted in a powerful learning opportunity, without ever telling them what he wanted them to learn.

Discrepant teaching events are a great example of a modern educational research with practical value to the classroom teacher. However, this is a very advanced instructional technique and is not designed for daily use. Facilitating a discrepant teaching event requires the teacher to have intimate knowledge of the student population, including their knowledge, their misconceptions, and how they will react under low to moderate stress. To make things more complicated, the prior knowledge and misconceptions must be indentified very discretely and indirectly. For example, the teacher in the previous example would have ruined everything if he had started the class by asking them to share what they knew about using statistics to manipulate the interpretation of data. Additionally, the teacher must facilitate the class discussion very carefully to lead it in the right direction without giving things away. Again, this is powerful instructional practice to help students correct misconceptions, but it requires great skill and planning to utilize effectively.

Constructive Controversy. The term "controversy" generally has a negative connotation. Most teachers work hard to avoid controversy in their classrooms, but Johnson and Johnson (2009) describe an instructional technique which requires it. They describe constructive controversy as creating intellectual conflict among students that is resolved for a positive outcome. They also fully acknowledge how destructive and discouraging controversy can be to students learning.

According to Piaget, accommodation occurs when an individual learns something new that conflicts with what they already know (1962). The conflict between what it known and what is being learned is unpleasant for a time, but the resolution of that conflict is beneficial. Vygotsky's work later described the important role of social interaction among students and the critical role it plays in student learning (1963). Constructive controversy is a combination of these two basic principles, simply creating the conflict between or among students, rather than within a single student's mind, so that students must work together to resolve it. This allows for the use of language and collaboration among students. Additionally, the teacher can monitor the conflict and resolution far more easily than a conflict within a single student's mind.

Johnson and Johnson are very clear about the nature of conflict and what separates constructive conflict from more destructive conflict. Simply put, conflict can be resolved constructively when all parties share the common goal of exploring and understanding each other's point of view, working together, and are willing to accept a new conclusion. Competitive debate occurs when both parties interact only for their own goals, rigidly stick to their current conclusion, and are unwilling to compromise or accept a new conclusion. Between these two extremes is concurrence seeking, which is not really destructive or constructive. In this interpersonal conflict resolution model, all parties share the common goal of resolving the conflict as quickly as possible. This model minimizes both the negative and positive aspects of controversy.

Much like discrepant teaching events (Longfield 2009), constructive controversy is an advanced instructional technique which is not intended for daily classroom use. However, when everything works correctly, the result is deep and meaningful student learning. Again, the teacher must have a very good understanding of student's current knowledge and how they will react under stress. Additionally, this technique should not be utilized if the teacher cannot ensure, to a reasonable extent that no students will engage in competitive debate. Competitive debate is not social constructivist in nature because students are working against each other, rather than collaboratively, and are unwilling to consider new information or viewpoints. When this occurs, there is a very high likelihood that the results will be negative. This research has high practical value to the classroom educator, but needs to be utilized deliberately and cautiously. The teacher needs to know their students extremely well and have a good working relationship with them, plan extensively, and closely monitor group progress during the instructional activity to make sure that groups are not slipping into more destructive forms of conflict.

Concept mapping overview. Concept maps are a visual representation of students' schema. James Novak, who first developed concept mapping in the 1970's, describes concept maps as a visual schematic of concept meanings, connected by propositions (Novak and Gowin, 1984). The most simple concept map consists of two concepts connected by a single line that is labeled with a preposition. For example, the concept of "tree" might be connected to the concept "plant" by a line labeled "is a," because a tree is a plant. These maps can become infinitely complex as more concepts and their interrelationships are added.

Concept mapping is a practical and direct application of many of the previously mentioned learning theories, most notably social constructivism, metacognition, and student engagement. It consists of students developing and exploring their schema visually. Individual concept mapping fits with Piaget's cognitive constructivist notions that students build meaning as they develop their schema through assimilation and accommodation (Piaget, 1952). When students collaborate on concept maps, they explore each other's schemas through external language usage and represent concepts with a word and then develop the meaning of that word. These notions fit with Vygotsky's social constructivist learning theory (Vygotsky, 1963).

Concept mapping as an assessment tool. Teachers can assess student learning and indentify specific misconceptions by examining student concept maps more effectively than through more traditional assessments like multiple choice tests(Waters, Smeaton, and Burns, 2004, and Hay, Tan and Whaites, 2010). David Hey and his colleagues compared concept maps produced by learners with and without related professional experience, known respectively as non-traditional and traditional students. They found that adult learners with previous professional experience related to the content being studied were able to produce detailed concept maps with rich detail. The researchers interpreted these detailed concept maps as evidence of thorough concept mastery. However, 18% almost failed a more traditional multiple-choice assessment on the same content. They studied both non-traditional and more traditional students, defined as entering college directly after secondary education without related professional experience, who were enrolled in the same dental radiology course in London. The more traditional students faired far better on the multiple-choice assessment, while they produced far less detailed concept maps. The researchers interpreted this to mean that the traditional students had developed very limited and highly theoretical understandings of the content. However, they performed well on the multiple-choice test because that is what the assessment was designed to measure. So, typical teacher-created multiple-choice exams are a more effective assessment when the teacher is looking to measure shallow understanding of limited concepts, while concept mapping is a more effective tool when teachers are trying to assess deep understanding.

While the researchers studied populations whose ages do not fit with the stated purpose of this project, each group represents a different learning model. This is what makes this research so relevant. The non-traditional students have rich prior knowledge and are able to develop far more complete understandings of concepts than the traditional students. These more traditional students do not make the same connections between what they are learning and prior learning, resulting in far less complete concept development. However, they are able to learn more concepts at a less complete level. They represent two different sets of epistemological beliefs, which educators must choose between just as they chose between assessment tools.

Teacher epistemological beliefs with determine their choice between traditional multiple-choice tests and concept maps. It really depends what the teacher's epistemological beliefs are and specifically what the teacher wants their students to be able to do with what they learned. In the case of this study, the coursework involved dental radiology safety. While the professors had traditionally relied on multiple-choice assessments, they were convinced through the course of the study to rely more on concept mapping because they placed a very high value on student's ability to apply the course content. While most educators are not faced with the same obvious safety concerns, with the exception of the science lab class, in the event that their students are not able to apply what they have learned to the real world, they may wish to consider this example when reflecting on how deeply they want their students to learn new concepts and how they will assess that learning.

Concept map structures. James Novak thought that an ideal concept map starts with a central idea at the top and then includes increasingly specific connected details as the learner moves down the map and further from the central idea (Novak and Gowin, 1984). He evaluated student concept maps quantitatively based on how complete and accurate they were, specifically by counting the number of correct connections and comparing that number to a pre-determined criterion. Kichin, Hay, and Adams (2000) expanded on Novak's work and identified three different general frameworks which students use in creating concepts maps. These researchers found that teachers are able to gain further understanding of student's level of understanding, as well as their ability to develop schemas, by evaluating concept maps qualitatively as well as quantitatively. As student concept understanding deepens and matures, so does the basic structure through which they represent their schema as a concept map.

The first, and most basic, structure is the 'spoke.' In this framework, a single layer, of supporting details are each connected to a central idea, but not to each other. This structure represents a very limited and basic concept understanding. Because the details are not interconnected, the addition or deletion of any one detail does not affect the rest of the map. The lack of interconnections indicates that students do not understand how the various details are related.

The second maps structure is the 'chain.' This model consists of concepts linked in a single line of understanding. Each concept is linked only to those concepts directly above and below it. Unlike the spoke, any additions or subtractions of details in this framework threaten the meaning of the entire chain. This model demonstrates that the student is beginning to make interconnections among the details, but their concept development is still not very mature.

The final, most ideal framework is the 'net.' In this model, many layers of interconnected details surround a central idea. Because of the many interconnections, there are many paths through the net. The addition or deletion of a detail has a discernable impact on the overall understanding, but no single change threatens the entire concept understanding. The multitude of interconnections indicates that the student has a deep understanding of the concept.

The authors discuss the implications that these findings have on collaborative learning. They suggest that the teacher places students with different map structures together. This way, students are exposed to the most diverse schemas possible. This fits very well with Vygotsky's notion that a student's ZOPD increases when they are exposed to their peers' different concept understandings (1963). They also suggest that grouping by concept map type may give the teacher a way to group typically high-achieving students with traditionally low-achieving students while avoiding the stigma for the lower-performing students commonly associated with mixed-ability grouping.

Concept mapping and co-teaching. While there are many models of coteaching, they generally involve two or more teachers working simultaneously with the goal of maximizing student learning. Collaborative concept mapping can be a very effective learning strategy in this model because both teachers can provide instant feedback and guide student learning (Jang, 2010).

Syh-Jong Jang examined the effect of collaborative concept mapping in a co-teaching environment on student learning, as measured by student test scores. Additionally, student and teacher journals were examined qualitatively to deepen the researcher's understanding. The study supported the findings that this methodology increased student achievement, increased student interest, and was an effective method of co-teaching. This was in comparison to a more "traditional" teacher-centered methodology that resulted in the second teacher assisting more than co-teaching.

Jang also noted that concept mapping is a metacognitive strategy, allowing students to become better learners as well as mastering subject content. Concept mapping teaches students to examine their own schema, develop internal consistency, and actively seek out help when they identify inconsistency or a knowledge gap.

This research provided quantitative evidence that collaborative concept mapping can improve student learning, even when measured by more traditional assessment tools that place less of an emphasis on meaningful student learning. Qualitative analysis of students' journals did not suggest an exact link between concept mapping and test performance, but it did generally suggest that students felt concept mapping helped them learn the content better.

The author does point out some important considerations that came to light in the journals. First, some students try to just copy their more able or motivated peers. However, having multiple teachers in the classroom allowed for close supervision to quickly identify and correct this behavior. Because there were two teachers, one teacher has the freedom to focus for a time on the copying while the other teacher continues providing feedback to the other students. Additionally, some of the students reported that they did not like concept mapping because it was difficult to write so many words and label all of the relationships. However, they still performed better on the summative assessment just like the students who reported that they did enjoy it.

While the population for this study consisted of fourth-grade Taiwanese students, rather than adolescent learners in America, this population is important because they did not have previous experience with concept mapping, not unlike most American middle and high school students. These findings should be generalizable to other populations of learners who do not have experience with concept mapping in co-teaching settings.

Concept mapping and the big picture. Concept mapping is a particularly effective learning strategy for students identified with Autism Spectrum Disorder, or ASD, due to the cognitive predispositions associated with Autism (Roberts and Joiner, 2007). From an educational perspective, one of the most significant of these cognitive predispositions that negatively impacts learning is the tendency to focus on individual details to the point that it is hard to understand an overall concept. In constructivist terms, students with ASD tend to have a predisposition to focus on the individual concepts and details with little development of the connecting prepositions and interrelationships. This impairs these students' ability to develop an overall understanding of a concept and relate it to other concepts in comparison with students not identified with ASD. Fortunately, students with ASD have another cognitive predisposition that can be exploited to overcome this weakness through concept mapping.

Students with ASD generally have very strong visual processing skills, so visual learning strategies like concept mapping can be particularly beneficial(Roberts and Joiner, 2007). Concept mapping allows students with ASD to develop the interconnections among data by catering to their strong visual processing skills.

Roberts and Joiner investigated the efficacy of concept mapping in comparison to more traditional instructional practices on a group of 10 children from 10 to 14 years old. Interestingly, the largest measured effect of the concept mapping intervention was the improved scores on traditional recall-based summative assessments in comparison to the control group. Additionally, the students' summative concept maps were not observed to improve significantly in comparison with their pre-intervention concept maps. The authors note that their sample size was very small, at 10 students in each group, and suggest that this small sample size may be the reason that the effect on concept mapping was not statistically significant.

Roberts and Joiner focused on the efficacy of concept mapping as an instructional strategy specifically for students with ASD, as it allows the students to help understand the overall picture by allowing them to utilize their strong visual processing skills. While its was not their intent, these findings can also help explain the educational benefits of concept mapping for students who have not been identified with ASD. As long as their visually processing skills are not so weak that they interfere, concept mapping should be similarly effective for students not identified with ASD who generally understand the big picture but struggle with the individual facts. Concept mapping includes both the connections and the individual concepts, so learners struggling with either should benefit from concept mapping unless they have particularly weak visual processing skills.

Wait-time. Mary Budd Rowe (1974) determined that on average, teachers give students 0.9 seconds to respond to a question in class before they repeat themselves, answer their own question, pick a different student, or in some other manner interrupt the student's mental processes as they attempt to think before responding to the question. She named this pause between teacher prompting and student response 'wait-time 1.' This is the time that students use to process the question, recall information, and come up with a response. Through her observational research, Rowe also identified a second type of wait-time, which she calls 'wait-time 2.' Wait-time 2 is the time between when the student stops speaking and the teacher resumes speaking. This second type of wait-time was determined to be very important to the quality of student responses, as students typically responded in bursts of incomplete thoughts separated by pauses of 3 to 5 seconds. Again, she observed that teachers typically allowed around 0.9 seconds of wait-time 2 before interrupting or terminating the student's thought process.

After identifying and quantifying both wait-time 1 and wait-time 2, Rowe determined through experimental research that 3 seconds is the average ideal wait-time. However, the ideal wait-time length varies based on a number of factors including the difficulty of the question and the student's developmental level. When students are not given sufficient wait-time 1, the teacher effectively prevents them from responding at all. When students are not given sufficient wait-time 2, the teacher limits the completeness of the response by not allowing students to continue responding in the typical burst format with 3 to 5 second pauses.

Through her experimental research, Rowe trained teachers to increase both wait-time 1 and 2. She was then able to identify and quantify 10 separate student outcomes that improved significantly as teachers were able to regularly implement longer wait-times. Generally speaking, these student outcomes can be summed up as higher quality and more frequent student responses, interpreted as being evidence of higher quality and higher quantity student thinking and learning.

During the initial observational phase of the research, Rowe determined that most student responses come from a small faction of each class population. Additionally, teachers almost always identified this faction when asked to name the high-performing students in their class. Possibly as a way of reinforcing their own expectations of these high-performing students, teachers typically gave them double the wait-time in comparison to other students in the class. Through Rowe's experimental research training teachers to deliberately control and increase their wait-times, she determined that one of the previously mentioned improved student outcomes was increased frequency and quality of responses from the students not identified as high performing. In other words, increased wait-time resulted in quality responses from students that the teacher did not expect to respond.

In addition to helping educators understand the teaching and learning process, wait-time research has a significant practical value for any teacher who wants to improve the quality of discourse in their classroom. By allowing students the cognitive processing time they need in order to respond and then continue their response, the overall quality of student thinking and learning is increased. The research indicates that teachers typically prompt their students with a follow-up question, call on a different student, or answer their own question in under a second. This indicates that teachers are working hard, but may be working counterproductive to the goal of improving student thinking and responses. Rowe's work with wait-times is a great example of an educational practice that can actually make things easier on the educator while improving student outcomes.

Think-time. Robert Stahl(1994) expanded on Rowe's wait-time 1 and wait-time 2 with his concept of think-time. Think-time is a more general concept than wait-time, applying to any and all periods of time when both the teacher and students are quiet so that everyone can complete the appropriate cognitive processes. He promotes think-time over wait-time because it includes all pauses for cognitive processing, not just those by the teacher during student-teacher discourse. Additionally, it names a specific academic purpose to this pause in outward activity. Stahl's research promotes a 3 second think-time pause on average, just like Rowe's (1974) 3 second average pause for wait-time.

Stahl's research seeks to confirm and expand upon the research in wait-time with a more generalizable theory, rather than alter it or propose an alternate theory.

Think-time is another important theory with practical value to educators, but perhaps in a different manner than wait-time. Wait-time has a much higher practical value when it comes quality of student-teacher discourse, but think-time has a less focused practical value in relation to everything that happens in the classroom. Think-time is more theoretical in nature than wait-time, but this is what gives it the wider range of practical applications. Additionally, think-time acknowledges the cognitive role of the teacher. Teachers also utilize cognitive processes in the classroom, so there is not reason that they should not benefit just as much from sufficient cognitive processing time.

Conclusion. Help them think. After a thorough investigation of many landmark educational theories and the practical theories that developed from them, we can conclude that the teacher's job is to help their students think. This may be an oversimplification, but this is the underlying theme in recent and modern educational research. Learning is an active process on the part of the student, so they must be the ones doing it. Additionally, education is all about the thinking skills rather than the content. When students are developing their cognitive and metacognitive skills, they will pick up the content along the way. When teachers try to do all the work and focus on making students memorize the content, they effectively block the learning process.

An image of how a classroom should function seems to emerge from the literature. A modern classroom should be radically different and moderately uncomfortable to someone who believes in a traditional, lecture-based instructional model. They should feel uncomfortable because the students are doing most of the talking and not the teacher.

Upon entering an effective learning environment, they should immediately notice that students are not focused on the teacher. They are talking together in small groups, but none of the groups are talking about exactly the same thing. When the teacher does talk with a group, they are asking questions about how the group is working more often than they are asking about what the group is learning.

In this modern, research-based learning environment, an observer with more traditional epistemological beliefs should probably even think the teacher is being lazy. Rather than doing all the talking and thinking, they just ask questions and listen to the students. All of the students have to work really hard to accomplish what is being asked of them, and the teacher gives them the least amount of help possible for the student to accomplish their tasks. When it comes to grading, the teacher asks students for advice on their own grades. In this modern learning environment, the students are the ones doing all the work.

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Appendix

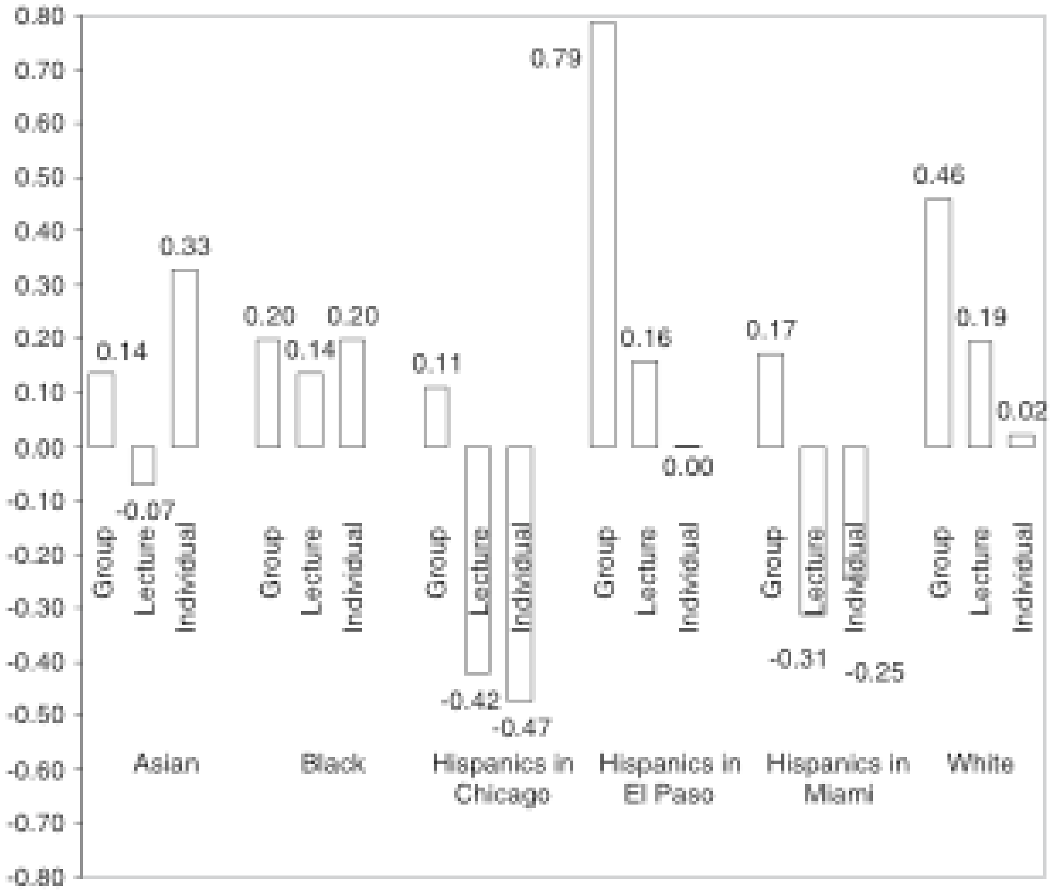

Figure 1. Student reported cognitive engagement level among class activities by race and/or ethnicity. Adapted from "Student Engagement in U.S. Urban High School Mathematics and Science Classrooms: Findings on Social Organization, Race, and Ethnicity," by K. Uekawa, K. Borman, and R. Lee, 2007, *Urban Review: Issues And Ideas In Public Education*, 39(1), p.33. Copyright 2007 by Springer Science+Business Media, LLC.