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Design Brief

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Advanced Instructional Design

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Introduction

Instructional-design theories are used to facilitate human learning using a goal/design oriented approach to learning. They are prescriptive in nature as they offer guidance to best achieve a perceived goal. Design-theories can range from cognitive, emotional, social, physical to spiritually desired learning outcomes (Reigeluth, 1999b).

For this paper, we will analyze six instructional-design theories using Reigeluth and Moore's (1999) framework for comparing instructional strategies and Hirumi's (2002) three levels of planned interactions. To gain insight into our own design project, we have chosen the following theories: Mayer's (1999) designing instruction for constructivist learning, Schwartz, Lin, Brophy & Bransford's (1999) toward the development of flexibly adaptive instructional designs, Hirumi's (2008) brain-based learning, Merrill's (1999) instructional transaction, Reigeluth's (1999) elaboration theory, and Lewis, Watson & Schaps' (1999) recapturing education’s full mission.

Designing Instruction for Constructivist Learning

Introduction

Richard Mayer’s SOI Model was developed to promote constructivist learning through the use of text, lecture and multimedia messages. The goal is to encourage active sense-making along side the continued use of book-based instruction. In order to accomplish this task, Mayer suggests techniques to encourage learners to ‘select’, ‘organize’ and ‘integrate’ information. These methods are used to foster the learner’s cognitive processes to encourage active sense-making (Mayer, 1999).

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 1.1. Types of learning addressed by Mayer's Theory

The types of learning addressed by Mayer's theory are Applying Skills, Understand Relationships and Apply Generic Skills (Refer to Table 1.1). The SOI method focuses on searching, organizing and integrating information; therefore it is important that the learner is able to comprehend said information, apply identification skills and synthesize information alongside prior knowledge. Even though all three areas are considered relevant for this theory, *apply generic skills* is not the emphasis of this method. It has a secondary emphasis in comparison to *apply skills* and *understand relationships*. These desired outcomes closely match Reigeluth and Moore's (1999) descriptions for these three types of learning.

Control Of Learning

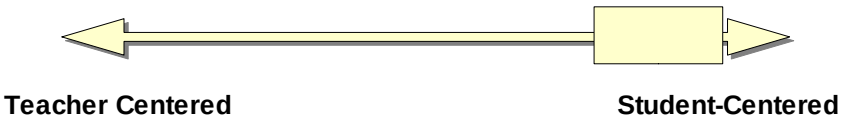


Figure 1.1. Control for learning prescribed by Mayer's Theory

The control of learning for Mayer's theory is Student Centered (Refer to Figure 1.1). Mayer situates his model in a constructivist approach to learning. He states this as, when the "learners actively create their own knowledge by trying to make sense out of material (Mayer, p. 143)". Overall, the SOI model focuses on activation of the learner's cognitive processes of selecting, organizing and integrating. The student is responsible for the selection of relevant information, organizing incoming information and integrating information. Together these

elements dictate the control of learning to be student-centered. It is important to note that Mayer provides suggested instructional techniques for encouraging students to select, organize and integrate material, however we feel that this is not the focus of the model and have decided to maintain the control as student-centered.

Focus Of Learning

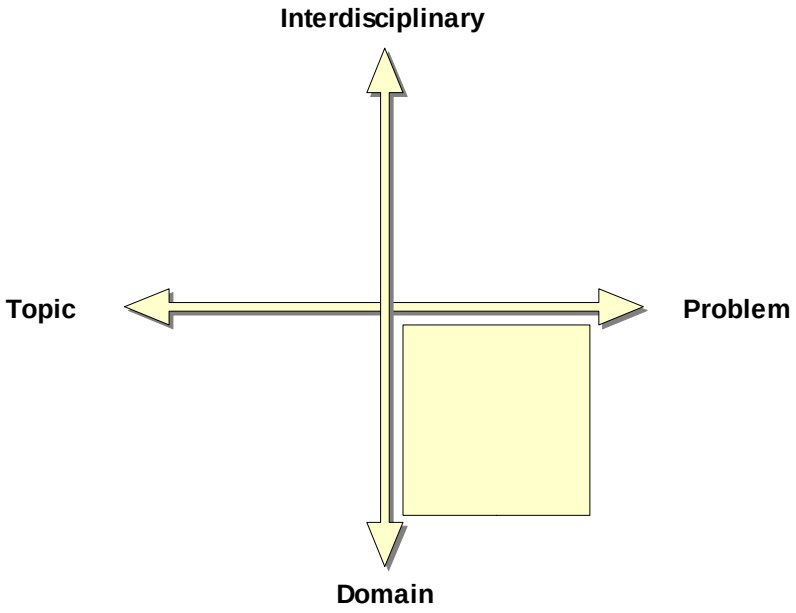


Figure 1.2. The focus of Mayer's Theory

The focus of learning is heavily embedded in the problem solving quadrant (Refer to Figure 1.2). This theory focuses on the learner's being able to select, organize and interpret information explicitly for text, lecture and multimedia. Although the content could be interdisciplinary, we felt it was important to distinguish the theory as domain specific due to the explicit disassociation of "behaviorally active learning" (Mayer, 1999a, p. 157).

Grouping For Learning

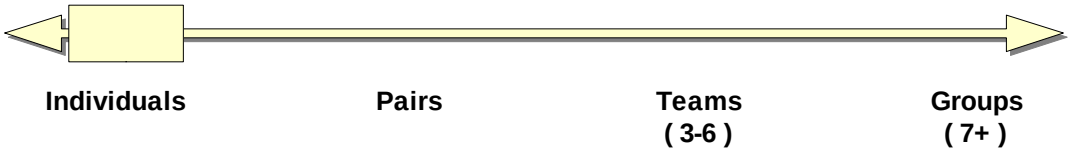


Figure 1.3. Grouping of learnings prescribed by Mayer's Theory

The grouping for learning is situated as the individual (Refer to Figure 1.3). The focus of the theory is on an individual's cognitive processes of selecting, organizing and interpreting information. Therefore all tasks are completed by a sole learner rather than in any group setting. As stated previously, Mayer does provide specific techniques for instructional design to promote a student's cognitive acquisition however the individual must complete the processes alone.

Interactions For Learning

<table>
<tr><th colspan="6">Level 3 Interactions:
Learner-Instruction</th></tr>
<tr><td colspan="6">● 1st Process: Selecting appropriate information from the material
● 2nd Process: Organizing selected information into coherent representations
● 3rd Process: Integrating; making one-to-one connections between representations and prior knowledge</td></tr>
<tr><th colspan="6">Level 2 Interactions:
Learner-Human / Learner-Non-Human</th></tr>
<tr><td colspan="6">
<table>
<tr><th colspan="3">Learner-Human Interactions</th><th colspan="3">Learner-Non-Human Interactions</th></tr>
<tr><td>Learner-Instructor</td><td>Learner-Learner</td><td>Learner-Other</td><td>Learner-Content</td><td>Learner-Interface</td><td>Learner-Environment</td></tr>
</table>
● Developed information can be Learner-Instructor interaction; lecture
● Possible feedback would involve a Learner-Instructor interaction
● Selecting appropriate information can occur in the Learner-Content and Learner-Interface interactions; textbook and multimedia
</td></tr>
<tr><th colspan="6">Level 1 Interactions:
Learner-Self</th></tr>
<tr><td colspan="6">● Organizing selected information
● Integrating information with prior knowledge</td></tr>
</table>

Table 1.2. Planned interactions of Mayer's Theory

In Table 1.2 the planned interactions prescribed by Mayer's theory are presented. Level 3 interactions are 3 steps chosen to 'highlight crucial cognitive processes in constructivist learning (Mayer, 1999a, p. 148). The processes are:

1. Selecting appropriate information,
2. Organizing selected information, and
3. Integrating information with prior knowledge.

Mayer's level 2 interactions are Learner-Instructor, Learner-Content and Learner-Interface. The instructor interacts primarily through lecture and secondarily with feedback. Students engage with content via textbooks, lectures and multimedia sources in order to select information. Level 1 Learner-Self interactions consist of the student selecting, organizing and integrating information cognitively.

Support For Learning

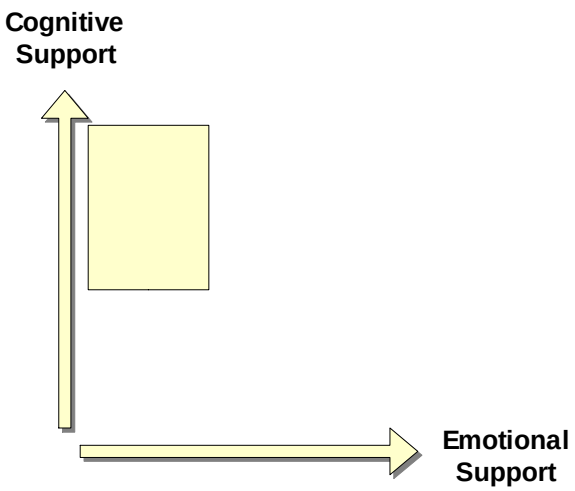


Figure 1.4. Support for learning prescribed by Mayer's Theory

The support for learning is completely situated in cognitive support (Refer to Figure 1.4). The purpose of this theory is for students to engage in active cognition through selecting, organizing and integrating content alongside their prior knowledge. Teachers are given techniques to encourage the development of these tasks using a “non-discovery, non-manipulation approach to constructivist learning” (Reigeluth in Mayer, 1999a, p. 142).

Benefits And Limitations

Benefits of this theory is that it takes into account the learner's cognitive processes and provides techniques to encourage development. This enhances transfer of information increasing the likelihood of retention. It also depicts the use of constructivist approaches within a textbook, lecture and multimedia based learning environments. Overall, it provides an opportunity for cognitive learning to occur within passive environments, textbooks, lectures (Mayer, 1996; Mayer 1999a), multimedia (Mayer 1999b; Mayer & Moreno, 2007) and computer-based instruction (Mayer & Moreno, 2002).

Although the benefits are clearly listed within given literature, the limitations of the SOI methods are not explicit. We find that the model is narrowly focused on three cognitive processes, selecting, organizing and integrating information. Additional models could link other intellectual skills into a similar theoretic design lending the model to greater use by designers and instructors. The narrow focus of the model is only listed as a limitation because it does not address alternative intellectual skills.

As this theory lends itself well to current educational curriculum, due to its adapted constructivist learning concepts within an expository and computer-based environments, we believe it can have significant impact if implemented properly. Constructivist methods tend to be difficult to employ in classroom settings; however, with this theoretical framework, we feel it eases the burden on the instructor to completely adapt all aspects of learning.

Toward the Development of Flexibly Adaptive Instructional Designs

Introduction

Schwartz, Lin, Brophy & Bransford (1999) offer a model for instructional design that attempts to balance structure and flexibility in classroom instruction. Structure is valued for its assurance that important principles of learning will be adhered to. Part of the reason Schwartz et al. developed this theory was their observation that some teachers maladapted instructional theory to old ways of doing things (p. 189). Flexibility is valued because it allows instruction to be tailored to teacher strengths and student and community needs. This flexibility is consistent with the need for customization as opposed to standardization in the new paradigm of instruction (Reigeluth, 1999, p. 18).

Schwartz, Lin, Brophy, & Bransford view design as “a collaborative and emerging process involving 'initial designers,' teachers, community members, and even students themselves” (p. 189). They offer STAR LEGACY as an example instructional design for studying this collaborative, flexibly adaptive process. The following section analyzes the type of learning, control of learning, focus of learning, grouping for learning, interactions for learning, support for learning and the benefits and limitations the theory provides as observed in STAR LEGACY.

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 2.1. Types of learning addressed by the Flexibly Adaptive Instructional Design Theory

STAR LEGACY can be used for multiple types of cognitive learning as suggested by Table 2.1. Reigeluth (1999) suggests that the STAR LEGACY provides instruction for the

higher order thinking skills, while simultaneously developing the lower levels of learning (p. 57). This is done through problem solving activities that enable students to develop skills, apply them generically, while building relationships of understanding in several domains (Schwartz et al., 1999; Reigeluth, 1999). Given this problem solving focus, this theory is not intended for memorizing information.

Control Of Learning

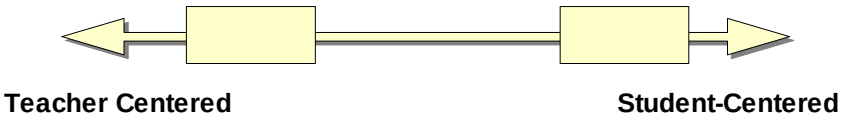
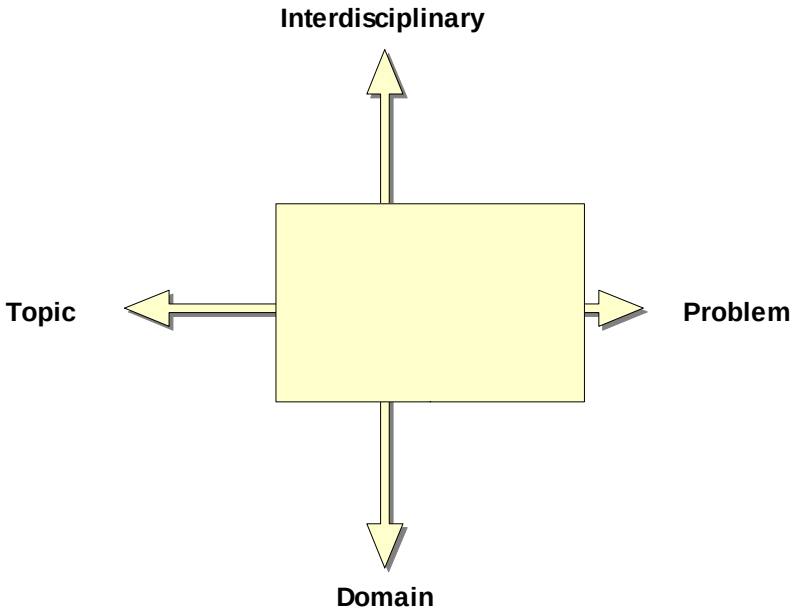


Figure 2.1. Control for learning prescribed by the Flexibly Adaptive Instructional Design Theory

The control of learning is distributed in STAR LEGACY as depicted in Figure 2.1. As previously mentioned, Schwartz et al. view design as a collaborative process involving designers, teachers, community members, and students. The figure therefore could be extended to include these additional roles. Illustrating the influence of each role could be difficult in a fixed graphic as various forms of influence emerge throughout the process.

Focus Of Learning



The focus of STAR LEGACY is multi-faceted as illustrated in Figure 2.2. It focuses most directly on problems (which can address specific topics or domains), but the flexible design leveraging multiple perspectives and progressive deepening allows for an interdisciplinary focus.

Grouping For Learning

Figure 2.3. Grouping of learners prescribed by the Flexibly Adaptive Instructional Design Theory

STAR LEGACY is designed for groups (7+) of students as depicted in Figure 2.3. The design has been applied to K-12 and higher education classrooms as well as corporate training groups.

Interactions For Learning

<table>
<tr><th colspan="6">Level 3 Interactions:
Learner-Instruction</th></tr>
<tr><td colspan="6">Steps (Reigeluth, 1999):
● Step 1: Look Ahead and Reflect Back Binoculars
● Step 2: The initial challenge (beginning of the inquiry cycle)
● Step 3: Generate ideas (about issues and answers)
● Step 4: Multiple perspectives (present models representing...)
● Step 5: Research and revise (to help students explore a challenge)
● Step 6: Test your mettle (formative assessment)
● Step 7: Go public (last step of the inquiry cycle)
● Step 8: Progressive deepening (iterate the inquiry cycle)
● Step 9: General reflection and decisions about legacies</td></tr>
<tr><th colspan="6">Level 2 Interactions:
Learner-Human / Learner-Non-Human</th></tr>
<tr><td colspan="6"><table>
<tr><th colspan="3">Learner-Human Interactions</th><th colspan="3">Learner-Non-Human Interactions</th></tr>
<tr><td>Learner-Instructor</td><td>Learner-Learner</td><td>Learner-Other</td><td>Learner-Content</td><td>Learner-Interface</td><td>Learner-Environment</td></tr>
</table></td></tr>
<tr><th colspan="6">Level 1 Interactions:
Learner-Self</th></tr>
<tr><td colspan="6">● Motivation
● Reflection</td></tr>
</table>

Table 2.2. Planned interactions of the Flexibly Adaptive Instructional Design Theory

Table 2.2 depicts three levels of interactions prescribed by Schwatz et al. (1999). Level 1 learner-instruction interactions consist of nine major steps, six of which occur in a progressive cycle. The nine major steps are: (1) look ahead, (2) pose the initial challenge, (3) generate ideas, (4) review multiple perspectives, (5) research & revise, (6) “test your mettle,” (7) go public, (8) progressive deepening, and (9) reflect and produce legacies, where steps two through seven are

repeated in a cycle as development progresses. Level 2 and Level 1 interactions occur in the context of instruction prescribed by Level 3 interactions.

Most of the Level II learner-human and non-human interactions take the form of traditional learner-instructor interactions. STAR LEGACY assumes a classroom of students being led by an instructor. Throughout the steps, there are numerous opportunities for learner-learner interactions given this assumption. For example, Scwartz et al. suggest that learners contrast their ideas with other learners during the idea generation step in order to identify distinctions and share the knowledge that is distributed throughout the classroom. During the look ahead, initial challenge, and multiple perspective steps, learners interact with content to help create an authentic problem experience. The research and revise step and the process of going public allow the learner to interact with other non-humans by leveraging external resources including the Web.

The Level 1 learner-self interactions promoted explicitly by this theory are motivation and reflection. Schwartz et al. suggest that the look ahead feature of STAR LEGACY should "serve as a motivational teaser that raises both curiosity and aspirations" while providing a benchmark for reflection and self-assessment (p. 195). Reflection is a focus of the going public feature in each iteration of the progressive cycle. It is also an explicit focus in the final stage of reflection and the production of legacy resources for future learners. Schwartz et al. suggest the reflection should enable learners to appreciate their own learning and recommend using self-comparisons rather than peer comparisons to enable that realization (p. 206).

Support For Learning

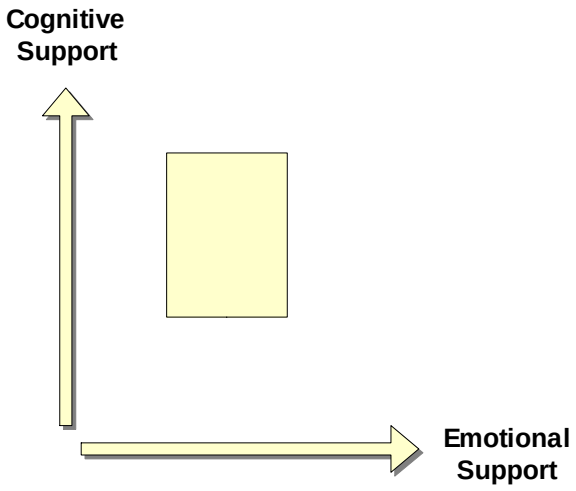


Figure 2.4. Support for learning prescribed by the Flexibly Adaptive Instructional Design Theory

Figure 2.4 depicts the more-or-less balanced support for learning offered by STAR LEGACY. The design is based on providing cognitive support, but the flexibility in the design enables emotional support to be provided. Specifically, the use of multiple perspectives, the selection of legacies, and the use of reflection throughout the design allow for learning in the affective domain to emerge.

Benefits And Limitations

A flexibly adaptive design theory as exemplified by the STAR LEGACY software shell has the benefits desired by the authors of adhering to learning principles and providing the flexibility necessary to customize instruction to learners. David Merrill (2002) identified five principles of effective instruction. He summarized the first principle as follows: “learning is promoted when learners engage in solving real-world problems” (p. 44). Thus, the first step of look ahead and reflect back aligns with this first principle. Merrill concludes that “the

Vanderbilt approach is a good illustration of the phases of instruction and the five general principles" (p. 51).

Limitations of the theory are based on the assumption of a teacher and group of learners adapting the instruction. Learning contexts that require learners to work as individuals without the physical presence of an instructor would have to alter the design significantly. However, the general approach and steps could still be used. Alterations would be focused on Level II interactions – primarily learner-instructor and learner-learner interactions.

Analysis of Hirumi's White Paper on Brain-Based Learning Principles

Introduction

In conjunction with a project sponsored by Florida Virtual Schools, Dr. Atsusi Hirumi at the University of Central Florida and a educational gaming development company, 360Ed, initiated efforts to design and develop several educational games based on *Brain-Based learning*. To properly frame the effort, Dr. Hirumi authored an as yet unpublished white paper on the implications that brain-based learning has on educational game design. The following analysis is based on the details this white paper provides to instructional designers who would use the brain-based learning approach to inform instructional design and development of games.

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 3.1. Types of learning addressed by Hirumi's White Paper

Design guidelines and constraints formulated on neurobiological studies of human learning (note: for the purposes of this paper, *Brain-Based Learning – BBL* – will be the

abbreviated equivalent of *neurobiological studies of human learning*) for the construction of educational games includes all of Reigeluth and Moore's four types of learning as indicated in Table 3.1. The choice of which area(s) will be part of any educational game that builds off BBL principles and instructional guidelines is left to the instructional designer. Within any of these game designs, an instructional designer might have the learner memorize information, understand relationships, apply specific skills, or apply generic skills.

Control Of Learning

Figure 3.1. Control of learning prescribed by Hirumi's White Paper

Probing the mechanisms of learning through neurobiological research implies a focus on the individual learning experience. The current popular teaching and learning paradigm in the western world is to move from a teaching-centered approach to a learner-centered (i.e., student centered) approach. Discovering the biological components and processes that lead to understanding learning would be highly supportive of the learner-centered control for learning. However, as illustrated in Figure 3.1, we see the dual nature of current thinking in applying BBL to the development of instructional solutions. The reason for this is primarily historical: while advances are continuously being made by the two leading branches of research, evolutionary biology and neurobiology, little work has been done to bridge those findings into prescriptive guidelines for the field of education. The work done by Caine and Caine (1991, 1997) would seem to currently fill the position of *foundational* in the sense that their work represents an early effort by using a scientifically based approach to identify teaching and learning principles that

are informed by neurobiological research findings. Caine and Caine's first work seeks to identify important variables that influence learning and then to contrast traditional teaching with new teaching methods informed by 12 BBL principles. Their focus was clearly teacher-centered. Hirumi (2008, unpublished, pp. 2-3) builds off their foundation by adding an additional column that presents how those BBL teaching principles apply to the design of game-based learning, which is clearly student-centered. Thus, we have the duality nature of the control for learning.

Focus Of Learning

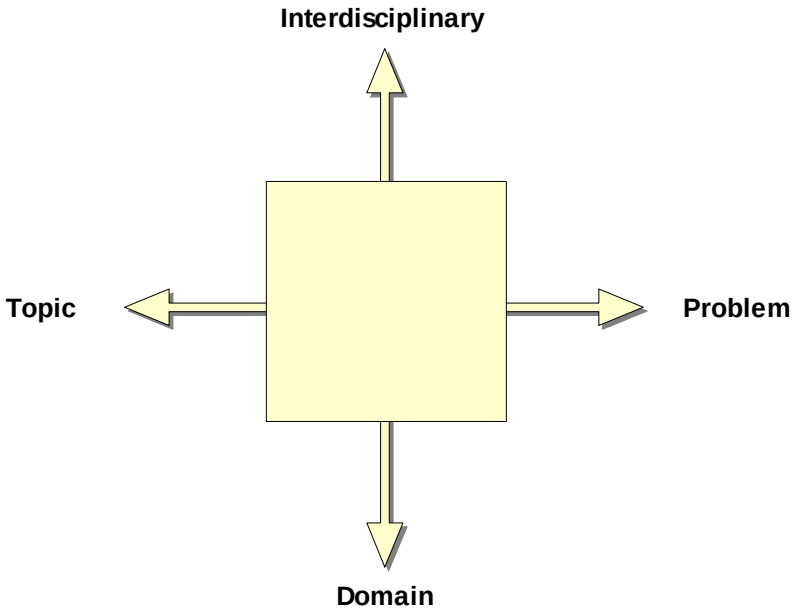


Figure 3.2. Focus of learning prescribed by Hirumi's White Paper

As depicted in Figure 3.2, the focus of learning as implied by Hirumi (2008) would have an equal capability of being applied to any of the learning quadrants. Since BBL principles are derived from the evolutionary and biological mechanisms that support learning in humans, those principles will be applicable to any of the diverging foci.

Grouping For Learning

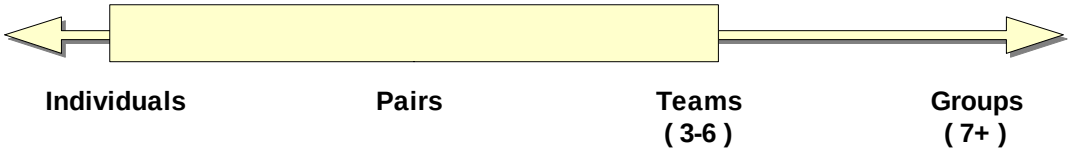


Figure 3.3. Grouping of learners prescribed by Hirumi's White Paper

As discussed earlier in this section, BBL principles are based on current, scientific evidence on the mechanisms of human learning. This said, the grouping for learning should span the full spectrum simply because the spectrum presents only humanity. As provided in Figure 3.3, the span does not go past teams of 3-6 individuals. While this author is unsure of whether this is a true statement as there exists world-wide significant resources being focused on the development of electronic games, it is for the moment impossible to know if others might be applying BBL principles to large groups of players. This author's reasoning is that because current known efforts to design game-based learning based on BBL principles remains relatively new, they still require being researched for effectiveness and are thereby clearly unready to be scaled up to the Massively Multi-User Online Role-Playing Games (MMORPGs) , such as Ultima Online or EverQuest.

Interactions For Learning

Level 3 Interactions:
Learner-Instruction

- Principle 1. The brain is a complex adaptive system
- Principle 2. The brain is a social brain
- Principle 3. The search for meaning is innate
- Principle 4. The search for meaning occurs through “patterning”
- Principle 5. Emotions are critical to patterning
- Principle 6. Every brain simultaneously perceives and creates parts and wholes
- Principle 7. Learning involves both focused attention and peripheral perception
- Principle 8. Learning always involves conscious and unconscious processes
- Principle 9. We have at least two ways of organizing memory
- Principle 10. Learning is developmental
- Principle 11. Complex learning is enhanced by challenge and inhibited by threat
- Principle 12. Every brain is uniquely organized

Level 2 Interactions:
Learner-Human / Learner-Non-Human

Learner-Human Interactions			Learner-Non-Human Interactions		
Learner-Instructor	Learner-Learner	Learner-Other	Learner-Content	Learner-Interface	Learner-Environment

Level 1 Interactions:
Learner-Self

- Relaxed alertness
- Orchestrated immersion in complex learning experiences
- Active processing of learning experiences (Gulpinar, 2005)

Table 3.2. Planned interactions of Hirumi's White Paper

As depicted in Table 3.2, planned interactions at level 1 will be based on the 12 BBL principles as identified by Caine and Caine (1991, 1997). These principles should drive the design choices instructional designers together with game developers will make. Because of the relative newness of this design approach, there currently is no process or other guidelines to

inform instructional designers and game developers; hopefully, this situation will be remedied by formative and design-based and development research methodologies in this area over the next few years.

Table 3.2 highlights planned interactions at level 2 as being focused on learner-learner, learner-content, and learner-interface interactions. Since the nature of the instructional solution will be educational games, there will likely be little to no learner-instructor interaction, nor to learner-other as most interactions will probably take place through game play. Following the same reasoning, it is unlikely that there will be learner-environment interactions either. This leaves us with the highlighted interactions that depict the likelihood that instructional designers and game developers will permit player-player interactions, as well as interactions with content (as presented through the imaginations and talents of multimedia specialists and game developers) and the game's electronic interface.

Finally, Table 3.2 highlights planned interactions at level 1 as described by Gulpinar (2005) are the "...three fundamental, and in fact not separable, elements of optimum teaching..." (p. 302) that are derived by the 12 principles: relaxed alertness, orchestrated immersion in complex learning experiences, and active processing of learning experiences. Designing for these three fundamental elements, Hirumi (2008) provides us with a set of instructional design guidelines for educational games. Each focuses on specific internal cognitive states or processes that have been transformed from Caine and Caine's (1991, 1997) teaching implications supplied from neurobiological research findings. The full list of guidelines follow:

- Present content through a variety of tactics, such as simulated activities, group interactions, artistic variations, and musical interpretations.

- Consider players physical, psychological and emotional states during game design. Consider learner’s readiness to learn and how games may be designed to promote readiness as well as elicit desired emotional reactions.
- Present scenarios, tasks, and stories that stimulate players’ curiosity and arouse the mind's search for meaning. Consider inquiry-based instructional strategies.
- Present information in context (stories, real life science, thematic instruction) so the learner can identify patterns and connect with previous experiences.
- Build game worlds and design gameplay to evoke emotions and promote positive attitudes among students and teachers and about their work. Use story to evoke empathy.
- Design game worlds and utilize stories to avoid isolating information from its context. Design activities that require complex brain interaction and communication.
- Place environmental devices outside the learner's immediate focus to influence learning. Create characters (e.g., mentor) whose enthusiasm, modeling, and coaching present important signals about the value of what is being learned.
- Use "hooks,” “Easter eggs,” or other motivational techniques to encourage personal connections. Encourage "active processing" through reflection and metacognition to help students consciously review their learning.
- Recognize players’ knowledge and interests by connecting new information to prior experiences. Present, as well as ask players’ to prepare stories and create game worlds that integrate facts and skills into players’ daily or past experiences.

- Use simulations and other techniques that create or mimic real world experiences and use varied senses. Examples include demonstrations, projects, metaphor, and integration of content areas that embed ideas in genuine experience.
- Provide access to a variety of multimedia resources to attract individual interests and let players express their auditory, visual, tactile, or emotional preferences.
- Present players with suitable levels of challenge and game play to elicit "flow" state (Hirumi, 2008).

Support For Learning

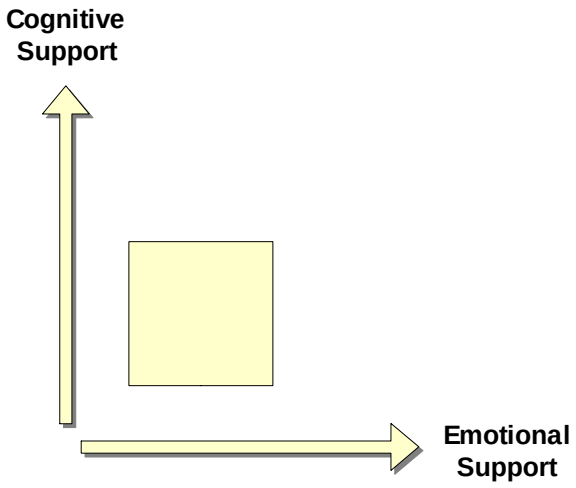


Figure 3.4. Support for learners prescribed by Hirumi's White Paper

In BBL, support for learning will emphasize instructional design approaches that include both cognitive and emotional support. As depicted in Figure 3.4 and from the previous discussion on learner interactions, we see and understand that this balanced approach makes sense because the BBL principles specifically interweave emotions with cognition: "Emotions and cognition cannot be separated. Emotions can be crucial to the storage and recall of information" (Hirumi, 2008, p. 3). For game developers and instructional designers, this

translates into including feedback systems that are both cognitive and emotive, as well as imbuing the electronic environment or game play with them.

Benefits And Limitations

Gulpinar's (2005) premise behind a BBL influence on design and development of instructional solutions is “the assumption behind Brain-Based Learning and Brain-Based Assessment is that research in neuroscience should guide learning and assessment” (Gulpinar, 2005, p. 302). What is implicit with this thinking is the major benefit that “...neuroscience and cognitive neuroscience ... [*has provided a*] ...theoretical basis for other learner-centered and constructivist approaches/models such as Experiential Learning, Multiple Intelligence, Cooperative Learning, ... [*and*] ...Self-Regulated Learning” (Gulpinar, 2005, p. 302).

Limitations to BBL theories are rooted in how fresh the research is with the simple fact that this research is largely descriptive in nature. Transforming descriptive theory into prescriptive design theories is difficult and we “...may completely miss the mark” (Reigeluth, 1999b, p. 13). Another important limitation is that despite the wealth of knowledge we have recently gained, we still know very little about how the brain works: “Although the whole picture about the understanding of how experience gets into the brain, how the brain organizes itself to get, remember and forget the knowledge cannot be clearly demonstrated...” (Gulpinar, 2005, p. 300).

Instructional Transaction Theory (ITT): Instructional Design Based on Knowledge Objects

Introduction

The instructional transaction theory was developed in an attempt to automate the instructional design process (Merrill, 1999). The theory provides a precise way to describe knowledge representation, instructional strategies, and instructional design prescriptions. This precision is intended to enable an expert computer system to be developed that can prescribe instruction (p. 399).

The instructional transaction theory emphasizes what Reigeluth (1999b) calls component methods (p. 10). ITT identifies knowledge objects and their elements (slots) as the components of knowledge and instructional transactions as the components of strategy for manipulating the elements of knowledge objects. With these components identified, ITT provides a methodology for synthesizing these components into instructional prescriptions that an expert computer system can deliver.

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 4.1. Types of learning addressed by the Instructional Transaction Theory

Table 4.1 depicts the types of learning that the instructional transaction theory supports. Merrill (1999) describes three classes that relate to the three types of learning identified above. These three classes are: 1) Identify, 2) Interpret, and 3) Execute. Identify transactions relate to memorizing information, interpret transactions address the understanding of relationships, and execute transactions address the application of skills. These three classes are grouped together as

component transactions (Merrill, 1999, p. 405). It is assumed that the two remaining transaction groups (i.e., abstraction and association transactions) address the application of generic skills.

Control Of Learning

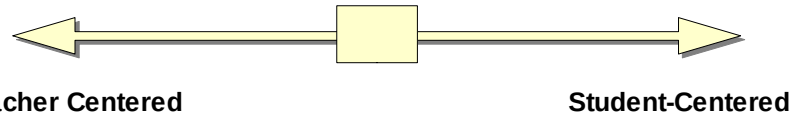


Figure 4.1. Control for learning prescribed by the Instructional Transaction Theory

Figure 4.1 depicts the control of learning in the instructional transaction theory. Learners do have some control over how they learn by virtue of the controls the interface allows. However, the computer system, which is designed to adapt instruction to learner needs, prescribes learning in real time. This is certainly a degree of control with which the learner must contend, which is represented above as "teacher-centered." Neither learners nor the system dictate *what* the instructional goals will be. Merrill states that the instructional transaction theory "is not concerned with the curriculum selection question of what should be taught" (p. 400). Instead, his theory focuses on the knowledge learners need and how best to facilitate learning it.

Focus Of Learning

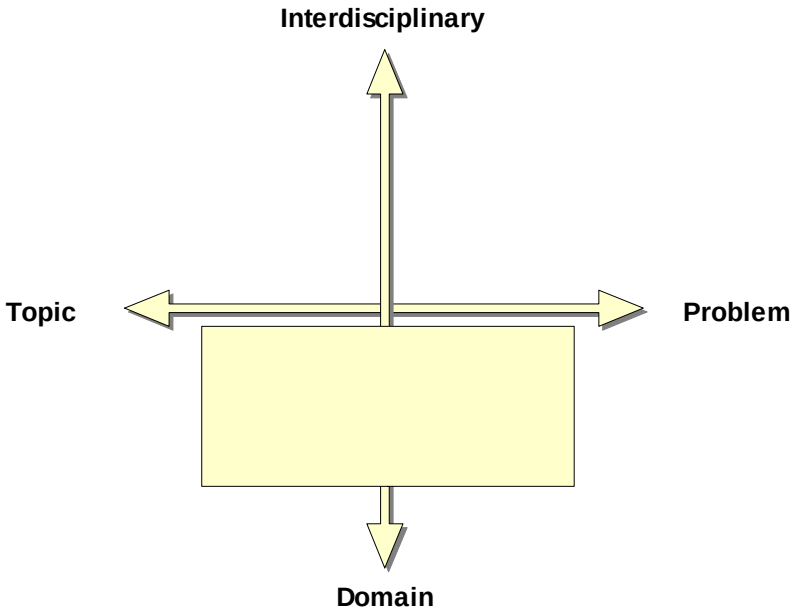


Figure 4.2 depicts the focus of learning for the instructional transaction theory. ITT focuses on topics, domains, and problems. The instructional transaction theory is capable of providing transactions that focus on specific topics or domains. Merrill identifies transactions specifically focused on troubleshooting goals, which suggest a problem solving focus.

Grouping For Learning

Figure 4.3. Grouping of learners prescribed by the Instructional Transaction Theory

Figure 4.3 illustrates the assumption that the instructional transaction theory is designed for the individual rather than groups. The assumption of the computer system and the adaptation to a single learner's needs suggest the lack of grouping.

Interactions For Learning

Level 3 Interactions: Learner-Instruction					
● Step 1: Present the knowledge of demonstration skill ● Step 2: Provide practice with feedback ● Step 3: Provide learner guidance for a given type of learning outcome					
Level 2 Interactions: Learner-Human / Learner-Non-Human					
Learner-Human Interactions			Learner-Non-Human Interactions		
Learner-Instructor	Learner-Learner	Learner-Other	Learner-Content	Learner-Interface	Learner-Environment
Level 1 Interactions: Learner-Self					
● Not clearly stated					

Table 4.2. Planned interactions of the Instructional Transaction Theory

Table 4.2 depicts the three levels of interactions prescribed by Merrill (1999). Level 3 learner-instruction interactions consist of three major steps: (1) presenting the knowledge or demonstrating the skill, (2) providing practice with feedback, and (3) providing learner guidance for a given type of learning outcome. These three steps are the three essential phases representing Gagne's nine events of instruction. An instructional strategy that incorporates these activities for a given type of learning outcome is what Merrill calls an instructional transaction (p. 402). Merrill's instructional transaction theory assumes a computer program is executing instructional transactions that leverage knowledge objects to adapt learning to individual needs in real time.

Given the assumption of the computer program, level 2 interactions focus on learner-content and learner-interface interactions. The learner-content interactions focus on learners

interacting with knowledge objects in the context of interactive, simulated learning environments. This advanced content is extremely interactive and based on networks that describe the relationships between processes, entities, and activities. Different transactions have different amounts of instructional overlay, so some content allows for unconstrained exploration while other content might have significant learner guidance. Merrill suggests that an effective learning environment must provide different forms of learner guidance (p. 415).

It is important to identify the interactions between learners and the computer interface, given this is the primary means learners use to interface with content. Hirumi (2002) reminds us that "learners cannot deal with content information if they are unable to use the interface" (p. 14). Merrill did not describe any user testing or design principles used to develop the user interface that delivers instructional transactions, but this is a critical interaction for this theory.

Merrill (2002) does not elaborate on Level 1 learner-self interactions. Given the importance Merrill places on efficiency, Merrill might assume motivated and self-directed learners are interacting with the instructional transactions and simply need to learn the objective now.

Support For Learning

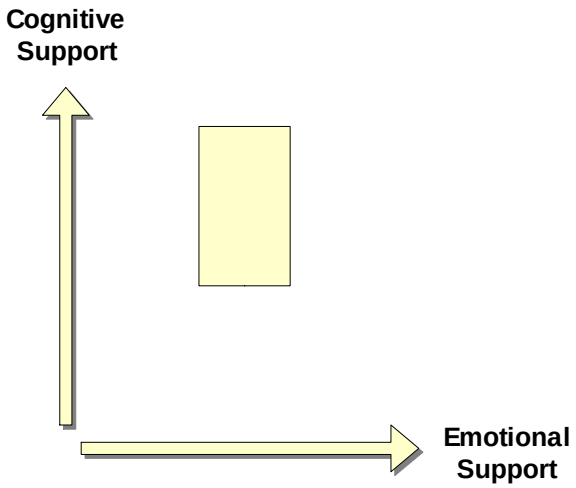


Figure 4.4. Support for learning prescribed by Instructional Transaction Theory

Figure 4.4 suggests that the instructional transaction theory provides far more cognitive support to learners than emotional. However, Merrill (2002) does suggest that the methods of the theory have been used to "implement technical training as well as soft skill training" (p. 404).

Benefits And Limitations

This theory features several benefits. It focuses attention on effective instructional strategies and their components. This focus on effectiveness is coupled with a focus on a efficiency. Automating instructional design, such that a computer can deliver effective instruction allows for efficient, just-in-time learning. This automated design can additionally allow for "instructional strategies that can be adapted to individual learners in real time as they interact with the instructional materials" (p. 404).

Limitations of the theory originate from the assumptions the theory adopts. Of these, the assumption that a computer program will deliver the instruction can be seen as the greatest limitation for using this theory in a classroom context. That is, this theory is designed for individuals interacting with a computer program. This learning context is very different from a

traditional learning context involving a teacher and a classroom full of students. However, if one accepts the assumption that a computer will deliver the instruction to an individual, another limitation or challenge emerges. While efficiencies and automation may be possible in the long run, initially production of knowledge objects and instructional transactions will pose a learning curve for many designers. Additionally, it is not clear what sort of computer program will be capable of delivering these instructional transactions and whether that computer program will be available to a designer.

The Elaboration Theory: Guidance for Scope and Sequence Decisions

Introduction

The sequencing of instructional content is an important part of the instructional design process, even more so with the paradigm shift from teacher-centered to learner-centered. Content that will be used for instructional purposes within any of the learner-centered approaches, such as simulations, apprenticeships, goal-based scenarios, problem-based learning, and other situated learning techniques will "...require a more holistic approach to sequencing, one that can simplify the content or task, not by breaking it into pieces, but by identifying simpler real-world versions of the task or content domain" (Reigeluth, 1999a, p. 427). Reigeluth's Elaboration Theory provides a robust framework for approaching the task of sequencing instructional content that will be used for medium to complex kinds of cognitive and psychomotor learning. The following is an analysis of his Elaboration Theory.

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 5.1. Types of learning addressed by the Elaboration Theory

The emphasis in Reigeluth's theory is to support instructional designs for complex cognitive tasks and/or structures. The elaboration theory takes advantage of the relationships between cognitive tasks or cognitive structures, such that the sequencing of the design builds from simple towards increasingly complex until sufficient levels of expertise are reached. For complex tasks, the simplifying conditions method (SCM) sequencing strategy "...enables learners to understand the tasks holistically and to acquire the skills of an expert for a real-world task from the very first lesson" (p. 433). For cognitive structures, the instructional designer makes use of cognitive scaffolding in the sequencing of the content to make easier the transition to increasingly complex structures. As illustrated in Table 5.1, the point of the theory is to facilitate learners towards task and/or domain expertise, both of which are dependent upon understanding relationships and applying specific skills.

Control Of Learning

Figure 5.1. Control for learning prescribed by the Elaboration Theory

In the elaboration theory, the control of learning is on the student-centered side of the spectrum (see Figure 5.1) as the theory intends to improve the development of instructional content that is more student- (i.e., learner) centered than teacher-centered. The formation of the

theory was in response to the paradigm shift from teacher-centered to learner-centered. To keep the instructional content highly meaningful, while simultaneously motivating for learners, the elaboration theory includes identifying real-world tasks or content domains and separating complexity levels. The resulting sequence of instruction, from simple to complex, will then become accessible, meaningful, and realistic to learners.

Focus Of Learning

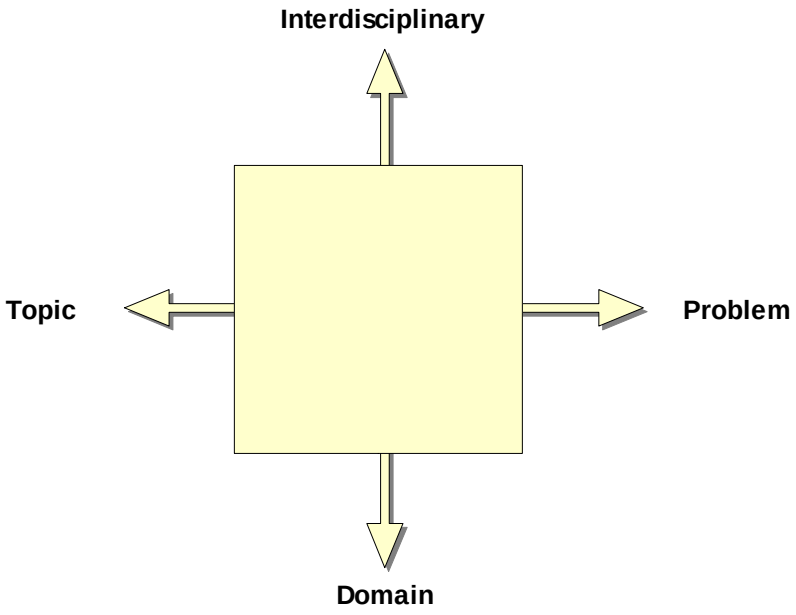


Figure 5.2. The focus of Learning of the Elaboration Theory

The theory supports each focus of learning equally, as illustrated in Figure 5.2. Generally speaking, where the theory is at a disadvantage is when the topics in the course are unrelated, such as with technical literacy courses that cover topics like word processing, computer graphics, and electronic spreadsheets. For such instances, one topic sequence is not likely to be better than another.

Grouping For Learning

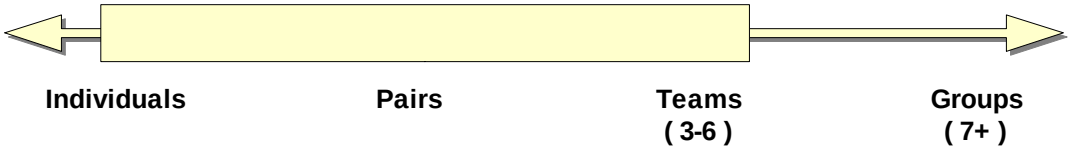


Figure 5.3. Grouping for Learning of the Elaboration Theory

As depicted in Figure 5.3, the theory is designed for nearly all groupings of instruction. The elaboration is designed to support sequencing of instructional content for the three sectors in business (private, public, and non-profit) as well as for K-12 and Higher Education. Reigeluth specifies: "Technology is evolving to the point where we can create flexible, computer-based learning tools that students can use – while they are learning – to create or modify their own instruction" (p. 430). He goes on to allude that soon multimedia systems and the teacher will be able to collect information about individuals and/or small teams of learners and then be able to sequence appropriate instructional content for them. This thinking implies that as the multimedia systems sophistication improves, individual learners can receive well-sequenced instructional content from the multimedia system directly.

Interactions For Learning

Level 3 Interactions: Learner-Instruction
● Phase I: Prepare for Analysis and Design ● Step 1: Preparation ● Phase II: Identify the First Learning Episode ● Step 2: Simplest version ● Step 3: Organizing content ● Step 4: Supporting content ● Step 5: Size ● Step 6: Within-episode sequence

- Phase III: Identify the Next Learning Episode
- Step 7: Next version
- Step 8: Organizing content, supporting content, size, and within-episode sequence
- Step 9: Remaining versions

Level 2 Interactions:
Learner-Human / Learner-Non-Human

Learner-Human Interactions			Learner-Non-Human Interactions		
Learner-Instructor	Learner-Learner	Learner-Other	Learner-Content	Learner-Interface	Learner-Environment

Level 1 Interactions:
Learner-Self

- Relevance
- Recognition
- Motivation

Table 5.2. Planned interactions of the Elaboration Theory

Table 5.2 depicts three levels of interactions prescribed by Reigeluth's Elaboration Theory (1999). Level 3 learner-instruction interactions consist of three phases that comprise nine major steps, which recycles after step nine back to the beginning of phase III (i.e., step 7). The three phases are respectively titled: Phase I: Prepare for Analysis and Design; Phase II: Identify the First Learning Episode; Phase III: Identify the Next Learning Episode.

Phase I comprises step 1: Preparation – Lay the groundwork for your analysis and design.

Phase II comprises steps 2 to through step 6:

> Step 2: Simplest version. With the SME, identify the simplest version of the task that is representative of the whole and describe the conditions that distinguish it from other versions.

Step 3: Organizing content. Paying attention to whether the nature of the task is procedural, heuristic, or a combination of both, analyze the organizing content for this task version.

Step 4: Supporting content. Focusing on whether the episode (that represents the current content version) is at risk of being either too large or too small for a single episode, conduct an analysis on the supporting content for this task version.

Step 5: Size. Determine that size of the episodes for the course fit the amount of learning for this task version.

Step 6: Within-episode sequence. With respect to the learning approach (e.g., problem- or project-based), determine the level of appropriate guidance you will provide the learner.

Phase III comprises steps 7 through step 9:

Step 7: Next version. Help the SME identify the next “most simplest” version of the task.

Step 8: Organizing content, supporting content, size, and within-episode sequence. Same as steps 3-6 in Phase II.

Step 9: Remaining versions. Repeat Phase III, except the first substep in step 7 for each simplifying condition until the instructional time is over or that the level of desired expertise is reached.

As described previously, the theory emphasizes application for learning relationships and applying skills to successively higher levels of expertise. The nature of the Level 2 learner-human and non-human interactions can be in any of the interaction types. This broad inclusion of all the interaction types reflects the full spectrum of people, systems, content, user interfaces, and environment for which instruction might be necessary. In keeping with Reigeluth's style of narrative in his article, the question is not *which* interaction to use, it's rather *when* to use which

interaction. The choice of interaction will be dictated by the learning need and the simple to complex range of expertise required.

The Level 1 learner-self interactions promoted explicitly by this theory are relevance, recognition, and motivation. Since the theory directs the building of episodes that are as authentic as possible, the learner will find the relevance in the learning content and be motivated to acquire the expertise. For the case of learning complex tasks, the learner will reach "...holistic understanding of task results...[*that will result*]... in the formation of a stable cognitive schema to which more complex capabilities and understandings can be assimilated" (p. 433). For the case of learning cognitive structures, recognition comes from the use of scaffolding approaches to permit the learner to recognize the appropriate relevance and how to apply what has already been learned towards learning the next level.

Support For Learning

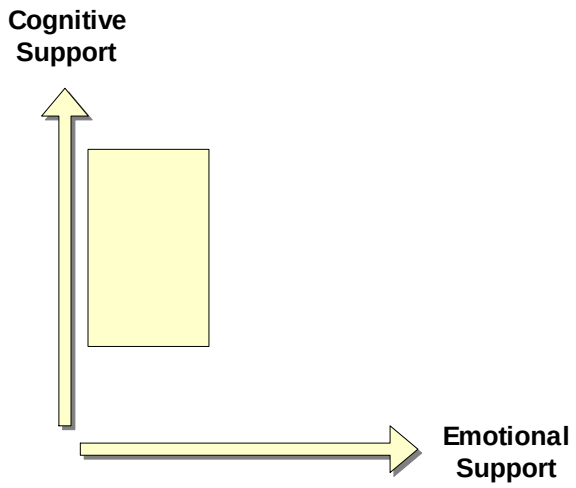


Figure 5.4 Support for learning prescribed by the Elaboration Theory

As illustrated by Figure 5.4, the elaboration theory's support for learning focuses nearly completely in the cognitive support axis. As stated by Riegeluth in the article's forward, the

focus of the theory is "...intended for medium to complex kinds of cognitive and psychomotor learning, but does not currently deal with content that is primarily in the affective domain" (p. 426). While the support for learning framework differentiates between types of feedback that are either cognitive or emotional in nature, Reigeluth recognizes that instructor feedback to correct a cognitive error can play a role in a learner's attitude, feelings, and confidence. That said, the elaboration theory emphasis is on designing episodes of learning, which primarily lie within the cognitive domain. The elaborations are to become increasingly complex and build off preceding episodes. Within an episode, an instructional designer could include elements that provide emotional support within the framework, despite that Reigeluth does not describe doing so within the Phases or Steps of the process.

Benefits And Limitations

The following can be counted as benefits to using this theory: (1) using holistic sequences will foster meaning-making and motivation; (2) learners can use this content (i.e., if it is delivered in the right medium) to make their own scope and sequence decisions; (3) the approach facilitates rapid prototyping; (4) the theory represents an important component that contributes to coherent design theories. Others have found that it works well when applied to distance learning or hyper-media applications as the approach produces content that keeps students focused and interested, as well as permitting student control (Selepeng-Tau, 2000).

There are few limitations to the theory. Such limitations can include the following: (1) it wasn't originally designed to support sequencing instructional content for the affective domain; (2) it does not provide within the framework how and where to include emotional support; and (3) there is always the risk that someone working as an instructional designer will apply the sequencing theory to content where there are no relationships between the topics.

Recapturing Education's Full Mission: Educating for Social, Ethical, and Intellectual Development

Introduction

Lewis, Watson & Schaps' theory focuses on fostering 'social, ethical, and intellectual development to build caring relationships, ownership, reflection, internal motivation understanding of prosocial values, and academic development (Lewis, Watson, & Schaps, p513)". They describe their theory as a 'community caring' approach to instruction for an intended K-6 audience. They cite the American Gallup poll ranking of 25 important possible goals for school as a driving force for the need of social and ethical education; 'to develop standards of what is right and wrong' ranked second.

The major steps of this theory are literature-based reading, development of discipline, cooperative learning, and school-wide activities. These are sequential processes that incorporate social and ethical themes through reading, discussion, and modeling to foster internal motivation and cognition (Lewis, Watson, & Schaps, 1999).

Types Of Learning

Memorize Information	Apply Skills
Understand Relationships	Apply Generic Skills

Table 6.1. Types of learning addressed by Community Caring Theory

The types of learning addressed by Lewis, Watson and Schaps' theory are Applying Skills, Understand Relationships and Apply Generic Skills (Refer to Table 6.1). The community caring methodology provides specific guidelines using comprehension, procedural knowledge, and cognitive strategies as a means to meet their goal. They are inter-related and equally important in this theory. According to Reigeluth and Moore (1999), these guidelines fit well into

the three chosen types of learning. Although it can be argued that memorizing information is necessary, to a degree, for comprehension to occur, Lewis et. al (1999) focus on actively constructing understand rather than rote-memorization techniques.

Control Of Learning

Figure 6.1. Control for learning prescribed by Community Caring Theory

The control of learning for Lewis, et. al's theory is both Student and Teacher Centered (Refer to Figure 6.1). This model focuses on a constructivist approach with instructor guidance throughout the learning process. The student is ultimately responsible for their cognitive development; however, the teacher uses selected techniques to promote acquisition. Students work alongside their peers and teachers within pairs and groups. They reflect and discuss literature embedded with social and ethical themes selected by their teachers. Due to the connected relationships among the teacher and students, we feel the control for learning is both teacher- and student-centered; however he heavily weighted the theory to the student's control.

Focus Of Learning

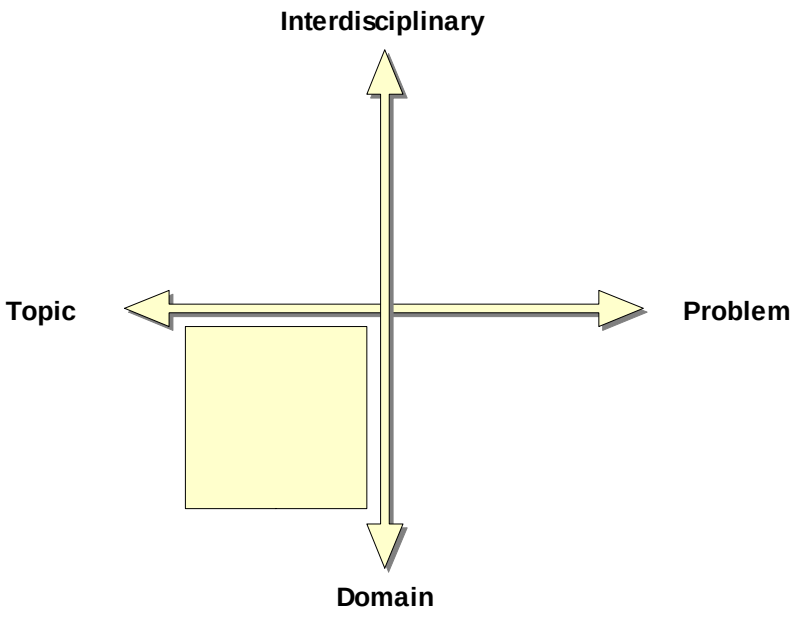


Figure 6.2. The focus of Community Caring Theory

The focus of learning occurs in the topic and domain specific quadrants (Refer to Figure 6.2). Community caring theory's goal is to instilling 7 qualities of intellectual, social and ethical development. These are competence, knowledge, thoughtful, caring, principled, self-disciplined, and self-motivated characteristics of human interaction. The explicit focus of social and ethical development within literature-based reading lends itself to a topic and domain focus of learning.

Grouping For Learning

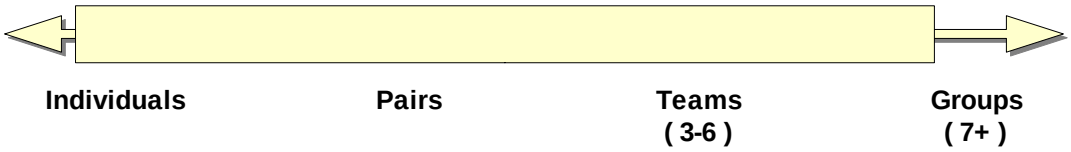


Figure 6.3. Grouping of learnings prescribed by Community Caring Theory

The grouping for learning is situated in individual, pairs, teams and groups (Refer to Figure 6.3). The focus of the theory is on an individual internal motivation and cognitive development through pair, team and group interactions. Students read, discuss and reflect with their peers and teachers to elicit internal change. These activities are implemented in pairs and teams. Large group scenarios are possible when conducting school-wide activities, which is a later step of the design theory.

Interactions For Learning

Level 3 Interactions:
Learner-Instruction

- Step 1: Literature based-reading
- Step 2: Developmental discipline using intrinsic motivational techniques
- Step 3: Cooperative learning group work
- Step 4: School-wide activities

Level 2 Interactions:
Learner-Human / Learner-Non-Human

Learner-Human Interactions			Learner-Non-Human Interactions		
Learner-Instructor	Learner-Learner	Learner-Other	Learner-Content	Learner-Interface	Learner-Environment

- Teacher provides modeling opportunities through Learner-Instructor interactions
- Teacher 'read-alouds' are a Learner-Instructor interaction
- Students reading with partners and discussing literature are Learner-Learner interactions
- Reading and discussing the literature are Learner-Content interactions
- Students emotional attachment to their school is a Learner-Environment interaction
- School and community involvement is a Learner-Environment interaction

Level 1 Interactions:
Learner-Self

- A student's personal cognitive development is a Learner-Self interaction
- Fostering internal motivation through the development of inherent interest and challenge, is a Learner-Self interaction

Table 6.2. Planned interactions of Community Caring Theory

In Table 6.2 the planned interactions prescribed by the Community Caring theory are presented. Level 3 interactions consist of 4 steps used to foster social, ethical and intellectual developmental via literature based reading. The steps are:

1. Literature based-reading rich in social and ethical themes
2. Developmental discipline using intrinsic motivational techniques
3. Cooperative learning group work
4. School-wide activities

Lewis et. al provided guidelines for instructional approaches to “create a caring community of learners” (Lewis et. al, p. 518). Level 2 interactions can be extracted from these guidelines as Learner-Instructor, Learner-Learner, Learner-Content, and Learner-Environment. The teacher reads-aloud, provides practice, modeling and feedback opportunities for students. The students engaged in peer reading, group discussions, and group reflection around the content. Then learners associate with their school through school-wide activities extending 'values of respect, fairness, and kindness' beyond their classroom peers. Level 1 Learner-Self interactions consist of the student's internal motivation and cognitive development.

Support For Learning

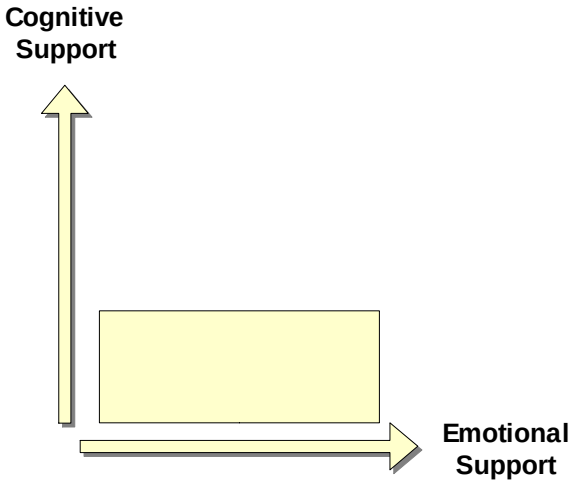


Figure 6.4. Support for learning prescribed by Community Caring Theory

Support for learning is depicted in Figure 6.4 as being primarily emotional support with a small amount of cognitive support. Lewis et. al's theory focuses primarily on affective development of social and ethical values. They propose an integrative approach bridging affective and cognitive learning through literature reading. Major methods to achieve these goals are listed as literature based-reading, developmental discipline, cooperative learning, and school-wide activities.

Benefits And Limitations

Benefits of the community caring theory are that it promotes social, ethical and intellectual change. It makes students aware of social and ethical themes through literature and engages students individually, in pairs, and in groups. Students are given the opportunities to reflect and discuss their opinions which enhances transfer of knowledge. This aids a student's psychological needs of belonging, competence and autonomy (Watson, Battistich, & Solomon, 1998). It can also be employed as a preventative technique for behavioral problems (Battistich, Schaps & Wilson, 2004).

Similar to other theories analyzed in this paper, little information was provided on any potential negative effects or limitations. Lewis et. al mentioned a lack of effort to spread such affective support for students. After a brief literature review, we found two research projects have taken place after this chapter was published. In general, they cited positive effects of the employed programs (Battistich, Schaps, Watson, Solomon & Lewis, 2000; Battistich et. Al, 2004). We feel this approach is good for affective learning. It can influence social and ethical change for students using the literature as the authoritative voice rather than explicitly using the instructor. It can encourage students to thinking about the content without feeling they are being preached to by the teacher.

Conclusion

Theory Comparisons

Six theories to direct the design and development of instructional solutions were analyzed following a framework developed by Reigeluth and Moore (1999) with additions provided by Hirumi (2002). The framework provides a means by which theories can be compared and contrasted, as well as to facilitate an instructional designer's consideration of whether a particular theory is appropriate for a given project. In Table 7.1 – Theory Analysis Summary Results, we have an overview of the high-level detail results from the analysis. Immediately following the Summary Results Table is another table (Table 7.2) that contains a legend to facilitate reading the results .

Theorist	Type	Control	Focus	Grouping	Interactions	Support
Mayer – Constructivsm	AS + UR + (some) AGS	SC	Domain + Problem	Individual	IL + LC + LI	C
Schwartz et al. - Flexibily Adaptive	AS + UR + AGS	TC + SC	Problem + some of others	Groups	IL + LL + LO + LC	C (more) + E
Hirumi – BBL	MI + AS + UR	TC + SC	All areas	Individual to	LL + LC + LI	C + E

Theorist	Type	Control	Focus	Grouping	Interactions	Support
	+ AGS			Teams		(balanced)
Merrill – ITT	MI + AS + UR	Centered	Domain (Topic + Prob)	Individual	LC + LI	C (more) + E
Reigeluth – Elaboration	AS + UR	SC	All areas	Individual to Teams	All	C (more) + E
Lewis et al. - Affective	AS + UR + AGS	Towards SC	Topic + Domain	Individual to Groups	IL + LL + LC + LE	C + E (more)

Table 7.1. Theory Analysis Summary Results

Framework Item	Descriptions
Type	Type of Learning: MI is Memorize Information; AS is Apply Skills; UR is Understand Relationships; AGS is Apply Generic Skills
Control	Control of Learning: TC is Teacher-Centered; SC is Student-Centered
Focus	Focus of Learning: Interdisciplinary – Domain and Topic – Problem
Grouping	Grouping for Learning: Individual – Pairs – Teams – Groups
Interactions	Interactions for Learning: IL is Instructor-Learner; LL is Learner-Learner; LO is Learner-Other; LC is Learner-Content; LI is Learner-Interface; LE is Learner-Environment
Support	Support for Learning: Cognitive or Emotional

Table 7.2. Theory Analysis Legend

A few interesting observations can made by reviewing the comparison Summary Results Table. First, by reviewing the Grouping values, an instructional designer can see that the theorist intends the application of the theory to be for either the individual or perhaps small groups. Further, those same theories largely can be applied to either individuals or to electronic learning solutions, which can be verified by noting the interaction values and checking if the values include LL (Learner-Learner), LC (Learner-Content), and LI (Learner-Interface). Amazingly enough, nearly all the theories are Student- (i.e. Learner) Centered, which might be taken for a sign of the times. Equally interesting is the fact that nearly all of the theories include an emotional component to the Support for Learning component. This might be an indication that even if the theorists did not intend it, their theories can or do support both cognitive and emotive support, which seems to be gaining acceptance as an important component for learning (judging

simply by the amount of published material on the topic, and that it is even a component within the 12 principles of BBL that are based on neurobiology research).

All of the theories carry benefits and limitations. Following the analysis process, some considerations surfaced: Mayer's theory was found to be a wonderful integration of constructivist theory and today's current educational practices (expository methods: textbook, lecture & multimedia), which can lend itself nicely to any computer-based training or multimedia supported environment. Schwatz et al.'s theory has some similarities to Mayer's: both take constructivist perspectives that leverage multimedia. However, some instructional designers will hesitate to recommend it for certain projects as its focus is on a classroom of students (i.e., grouping of learners). Also, Merrill's instructional transaction theory might be difficult to implement. While it is focused on individuals learning in a computer based environment, the knowledge object and instructional transaction components might make the implementation difficult, as well as that there may be an economies of scale assumption associated with this theory – there must be a significant commitment to implement enough of it to leverage its benefits. It's not obvious if instructional development for a single goal will support such an advanced theory. Brain-based Learning shows some promise, even at its relatively new stage. However, it is possible to leverage Mayer's theory and include the 12 BBL principles within the instructional design guidelines and have both. Reigeluth's Elaboration Theory is also strong and might be considered on equal footing with Mayer's.

In the affective domain, the Lewis, Watson & Schaps approach is a good method to influence social and ethical change for students. The approach uses the literature as the authoritative voice (rather than the instructor), which is a smart approach to an affective change. It makes the students 'think' about the content of the literature instead of them listening to a

teacher 'preach' about beliefs. It does cross over into cognitive support by having the students engage in individual and paired reading sessions and then reflect and discuss with peers, the teacher, and in groups. While this may be a good approach, it will not fit well to support goals for a formative research project.

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